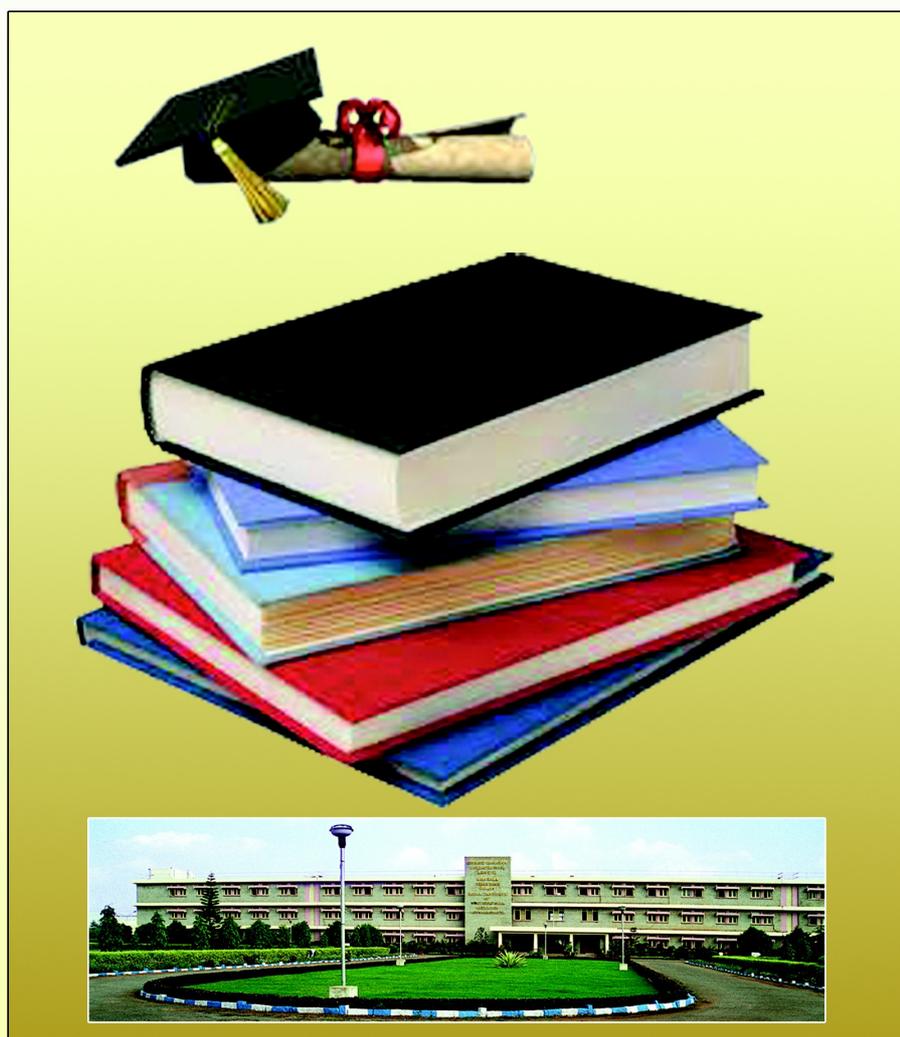


Abstracts of Ph.D and M.Sc. Theses

Research Undertaken at IHR



INDIAN INSTITUTE OF HORTICULTURAL RESEARCH
(Indian Council of Agricultural Research)
Hessaraghatta Lake P.O., BANGALORE-560089



Abstracts of Ph.D and M.Sc.Theses Research Undertaken at IIHR



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FOREWORD

Indian Institute of Horticultural Research, Bangalore, has been involved in post graduate education right from its inception and has been recognized for post graduate research by more than 17 Universities. It is playing a major role in post graduate education in the field of Horticulture and related fields by guiding students in their research work leading to M.Sc and Ph.D degrees. More than 80 scientists from different divisions are recognized to guide students in various disciplines in these Universities.

Institute has made sincere effort to improve the quality of post graduate courses in horticulture taught at different Universities all over the country. A special effort was made to design course to meet national and region specific requirement and 58 model courses were recommended in various aspects relevant to horticulture. Institute has state-of-the-art infrastructure for pursuing research at molecular level in ail disciplines. Students from various Universities are getting exposed to the advanced areas of research and hands-on training in advanced technologies.

Students from different Universities that have recognized IIHR are pursuing their Ph.D and M.Sc. programme at the Institute in various Divisions. More than 80 Ph.D and 200 Masters students have submitted their dissertations/ theses to the institute. Considering the great depth of information generated in these M.Sc and Ph.D dissertation/these, it was decided to bring out a publication of their abstracts which will be of use as ready reference for students in future.

Bangalore
29.09.2012


Amrik Singh Sidhu
Director

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DIVISION OF FRUIT CROPS.

Ph.D

Title : **Effect of variety, maturity and season on composition and quality of musts and wines (1982)**

Chikkasubbanna, UAS, Bangalore, Guide : Dr.K.L.Chadha

The effect of variety and maturity on the composition of grapes and wines of Bangalore Blue, Thompson Seedless, Black Champa and Malvasia Bianca Di-wapolis was studied. Fruits from these four varieties were harvested at five different maturity levels and the wines were prepared. Both the musts and wines were analyzed for various organic and inorganic constituents. Distinct variation in organic and inorganic constituents was noticed due to variety, maturity and season. Among the nitrogenous compounds, total nitrogen, protein and proline showed an increasing trend with maturity. Ammonia content was found to decrease in Thompson Seedless and Black Champa whereas in Bangalore Blue and Malvasia Bianca Di-wapolis it increased with maturity. Tannin content increased in Thompson Seedless, Bangalore Blue and Malvasia Bianca Di-wapolis while in Black Champa it did not show much variation with maturity. Inorganic constituents such as phosphorus, calcium and magnesium increased with maturity in all the varieties. Potassium content increased in Thompson Seedless and Bangalore Blue while in Black Champa and Malvasia Bianca Di-wapolis, it remained unchanged. Iron content increased in Thompson Seedless but not in other varieties. Zinc and Manganese remained constant while copper showed variation between samplings. In wine samples total acidity, tartaric acid and malic acid decreased while pH increased with maturity. The wine prepared from third, fourth and fifth stage of maturity scored higher rankings than wines from earlier samples. The results suggested that a Brix/Acid ratio of about 30 ± 5 is near optimum for making good quality dry wines from these varieties for this region.

Ph.D

Title : Effect of time and different doses of N and K on growth, yield and quality of Thompson Seedless grape (*Vitis vinifera* L.) (1983)

S.D.Shikhamany, UAS, Bangalore, Guide : Dr.K.L.Chadha

A field experiment was carried out with the object of improving the efficiency of nitrogenous and potassic fertilizers by split application in Thompson Seedless grape. Four annual doses, viz., 250, 500, 750 and 1000 kg each of N and K₂O/ha were tried in 12 split combinations. Application of potassium in April resulted in increased prunings weight in the following April. Higher weights of prunings were associated with reduced number of bunches/vine. Increasing levels of N and K₂O resulted in reduced length of the internode below the index leaf in December. Internodal length in December was negatively related to the cane and vine productivity and Brix-yield. Area of the index leaf in May and petiole length in June were positively correlated with mean bunch weight at harvest, though they did not vary significantly among the treatments. Petiole nutrient contents in June did not vary significantly among the treatments, while the interaction effects on the petiole nutrient contents in December were significant. Reciprocal antagonism between N and K was observed. Petiole NO₃-N and total N contents correlated positively with the mean bunch weight at harvest. Through the leaf chlorophyll 'b' content in December did not vary significantly among the treatments, it was positively related to the reducing sugars content of the berries. Growth and vigour of the vines under all treatment combinations were far in excess than that required for productivity and affected it adversely. A cane load of 50-60/vine was found to be optimum for vines spaced at 3m x 3m. An annual dose of 500 kg each of N and K₂O at a P₂O₅ dose of 500 kg/ha was found to be optimum. Split application of either N or K₂O during the growth season was not found to be favourable.

Ph.D

Title : Studies on growth and productivity of acid lime (*Citrus aurantifolia* Swing) cv. Kagzi as affected by moisture regimes (1985)

H.P.Singh, UAS, Bangalore, Guide : Dr.K.L.Chadha

Fruit yield and quality were significantly correlated with consumptive use of water and best fit of line was obtained with quadratic equation for yield and physical quality. The consumptive use of water at productive stage was estimated to be 875 mm year⁻¹. At young age, liner correlation existed between plant growth and consumptive use. Best water use efficiency was obtained at 20 KPa soil moisture potential. Stomatal intensity, cuticular thickness, specific leaf weight and transmission coefficient increased under moisture stress while stomatal size and absorption coefficient decreased. Flushing and leaf fall were cyclic and were affected by soil moisture potential. Mild moisture stress (pre-dawn leaf RWC of 90.97 to 93.00%) followed by alleviation increased the intensity of flushing and flowering. Changes in fruit weight and size exhibited sigmoid pattern and moisture stress at an early period of fruit development (I and II stage) was critical. Moisture stress caused increase in TSS, acidity, sugar and delayed the maturity. Irrigation at 10 KPa increased the yield significantly. Low soil moisture coupled with high evaporative demand caused the accumulation of NO₃-N in leaf. Accumulation and partitioning of dry matter, protein, carbohydrates and nutrients were affected by soil moisture potential. Excessive soil moisture at active period of growth was more detrimental for growth than moisture stress as indicated by leaf area increment recovery in conductance. Seed germination percent and radicle growth were significantly reduced with increasing moisture stress monitored by polythelene glycol.

Ph.D

Title : Studies on growth and development of pomegranate (*Punica granatum L.*) fruit and seed with special reference to hard and soft seededness (1986)

B.Prasanna Kumar, UAS, Bangalore, Guide : Dr.A.G.Purohit

Studies were conducted in four pomegranates varieties on time of initiation and degree of lignification of seed testa which causes hard seededness. The physicochemical changes during growth and development of fruits were also investigated. Fruit growth pattern in pomegranate followed a simple sigmoid curve almost approaching a liner relationship. Length and breadth of the fruit, fresh weight of rind and weight of seed increased continuously from fruit set to maturity. During most stages of fruit development, the seeds constituted roughly half of the fruit weight. Dry matter content in fruits increased continuously till 50 days of fruit growth and then gradually declined towards maturity, but in seeds, dry matter content increased continuously from fruit set to maturity. Specific gravity of fruits was higher in early stage of fruit development and then gradually declined. TSS increased gradually during fruit development and acid content decreased with maturation of fruits. Both reducing and total sugars continued to increase during the development of fruits. The nitrogen and phosphorus content of both fruits and seeds was maximum and highest immediately after fruit set and second highest nitrogen content was seen at maturity. The potassium content of fruit was highest at 10 and 120 days of fruit growth. The seeds contained very high potassium content both immediately after fruit set and also at maturity. The micronutrient contents of fruits were high initially, after fruit set, they declined in the intermediate stages and finally reached maximum levels at maturity. The seeds had maximum micronutrient immediately after fruit set. Histological studies revealed that after 40 days of seed growth lignification started and it was more pronounced in hard seeded varieties.

Ph.D

Title : Investigations on the effect of rootstocks in Anab-e-Shahi grape (*Vitis vinifera* L.) (1988)

B.M.Chandrasekhara Reddy, UAS, Bangalore, Guide : Dr.K.L.Chadha

An investigation was carried out on the effect of rootstocks on Anab-e-Shahi grape employing the rootstocks St. George, Teleki 5-A, Dogridge, 1616, 1613 and Gulabi in comparison with own-rooted vines to identify the most suitable rootstock. Rootstocks Dogridge and 1616 were found to impart vigour to Anab-e-Shahi grape but adversely affected the yield and yield attributes. Rootstock Gulabi lowered most of the vigour attributes and resulted in the highest yield. St.George and 1613 similar vigour attributes as own-rooted vines, but influenced the yield favourably. Rootstocks Gulabi, 1613 and St. George increased the yields through increased fruitfulness of canes. Fruit quality parameters were not influenced by any of the root stocks. Higher levels of total and $\text{NC}_3\text{-N}$ were associated with lower yields in the rootstocks Dogridge and 1616 and it was reverse in Gulabi. St. George appeared to be an ideal rootstock for economizing N inputs. Higher petiole K contents during June were associated with higher yields. Lower Mg and higher Zn contents were in general associated with higher yields. Rootstocks Dogridge, 1616 and St. George had low levels of chloride content and may be suitable for areas with high chloride in irrigation water. Among the petiole nutrients, $\text{NO}_3\text{-N}$, Mn, K and Zn contents in June and total N, Mg and CI in December were found to be useful in yield prediction. Leaf sampling in June may be useful to work out relationship between petiole nutrient contents and yields under double pruning and single cropping conditions. Rootstock Gulabi may be employed to increase productivity of Anab-e-Shahi grape. St. George and 1613 are useful on sodic soils and in locations where irrigation water has high chloride content.

Ph.D

Title : Root distribution and activity in grape cultivars as influenced by systems of training (1988)

G.S.Prakash, UAS, Bangalore, Guide : Dr.K.L.Chadha

Studies on the distribution pattern of root density and activity using radioactive ^{32}P were carried out in four grape cultivars namely, Thompson Seedless, Gulabi, Black Champa and Bangalore Blue as influenced by three systems of training *viz.*, bower, kniffin and head systems. Of the four cultivars studies, root density was found to be the highest in cultivar Bangalore Blue followed by Thompson Seedless, Gulabi, Black Champa. All the cultivars had greater root density nearer the trunk at 50 cm radial distance and at a shallow depth of 0-15 cm in the soil. In all the cultivars the highest root density was observed in the vines trained on bower system. Bower trained vines showed a greater root spread as compared to those on kniffin and head systems. Root activity was the highest in cultivar Gulabi as indicated by greater absorption of ^{32}P followed by Thompson Seedless and Black Champa. The lowest activity was noticed in the cultivar Bangalore Blue. In all the cultivars Thompson Seedless and Bangalore Blue root activity was more nearer the trunk (40 cm radial distance) at a depth of 15 cm under all the training systems. On the other hand, in the cultivars Gulabi and Black Champa, the activity was more widespread even up to 120 cm radial distance and up to, 30 to 45 cm depths. Even though, the total root activity under different training systems did not differ significantly, the spatial distribution of root activity varied. In general, both root density and activity were found to decrease with increasing depths and radial distances in all the cultivars except in Black Champa. Mathematical functions worked out for fitting root activity as a function of depths and distance indicated that only in Bangalore Blue and Thompson Seedless the spatial distribution was system followed by kniffin and head systems.

Ph.D

Title : **Genetical studies in papaya (*Carica papaya* L.)** (1990)

M.R.Dinesh, UAS, Bangalore, Guide : Dr.C.P.A.Iyer

A study was undertaken to assess the genetic potential in papaya so that the information thus obtained could form the basis for further breeding work in papaya. For this purpose an experiment was conducted during the years 1984 to 1986, at the fields of the Indian Institute of Horticultural Research, Hessaraghatta. The diallel analysis indicated the importance of additive and non-additive gene action for the sixteen characters studied. The F₁ hybrids exhibited heterosis over mid parental values (Heterosis), better parent (Heterobelfiosis) and the best parent or standard parent (standard heterosis). The parents Coorg Honey Dew and Pink Flesh Sweet were observed to be the best combiners for yield. The cv. Pink flesh Sweet was also found to be the best combiner for fruit length, fruit breadth, fruit weight, fruit volume, pulp thickness, TSS, fruit cavity index and reducing sugars. The cvs. Sunrise Solo and Waimanalo were also noticed to be good combiners for pulp thickness and TSS. Heritability (in narrow sense) values were observed to be higher for the characters plant spread, total sugars and carotene. In general genotypic correlation coefficients were higher than the phenotypic correlation coefficients between pairs of characters, indicating that strong intrinsic correlations are reduced at the phenotypic level due to environmental effects. Correlation studies indicated that yield was significantly associated in positive direction at the phenotypic level with number of fruits, fruit weight and reducing sugars, association in negative direction was significant with fruit cavity index, plant height and plant spread. The yield components number of fruits and fruit weight are significantly correlated with fruit cavity index in the positive direction. At the genotypic level, yield was correlated significantly in the desirable direction with number of fruits, fruit length, fruit breadth, fruit weight, fruit volume and pulp thickness. Association in negative direction was significant with plant height. The co-heritability estimate with regard to yield was positive in all the characters maximum estimate was obtained with fruit volume and minimum with pulp thickness.

Ph.D

Title : Phenotypic variability for qualitative and quantitative attributes of certain grape hybrids (1991)

S.Venkataram, UAS, Bangalore, Guide : Dr.Rajendra Singh

Hybrids of the crosses Anab-e-Shahi, Angur Kalan, Bangalore Blue, Black Champa, Convent Large Black, Thompson seedless and Queen of the Vineyard were evaluated with petiole nutrient contents and resistance to diseases. Hybrids derived from Anab-e-Shahi x Queen of the Vineyard (9/3), Angur Kalan x Anab-e-Shahi (5/4), and Angur Kalan x Black Champa crosses (26/8) were found to perform better. Dry matter content of the petioles appears to be a suitable index for higher yield. Higher chlorophyll 'b' content (light harvesting complex) was related to high yield in Bangalore blue. Use of Black Champa as seed parent and Queen of the Vineyard as pollen parent is good for imparting high vigour to the progeny. Duration for ripening depended on genetic constitution rather than on climatic factors. Glucose and fructose contents were high in Thompson seedless. Thompson seedless was very efficient in N uptake than Bangalore Blue. Hybrids 9/3 and 26/9 possessed higher P content which was related to high fertility. Ca and Mg contents had no relationship with yield whereas Fe, Zn and Mn showed some positive relationship. Seedless berries were obtained in hybrids derived from Black Champa and Thompson seedless. Hybrid 21/28 showed tolerance to downey mildew while Hybrid 30/14, tolerance to anthracnose and hybrid 21/28 to powdery mildew.

Ph.D

Title : **Fertigation studies in pomegranate (*Punica granatum L.*)** (1997)

N.Devakumar, UAS, Bangalore, Guide : Dr.K.Srinivas

Field experiments were conducted at IIHR, Bangalore in order to study the response of pomegranate to irrigation systems, irrigation levels, and nitrogen and potassium fertilization. Drip system of irrigation gave higher fruit yield of 14.97 and 12.38 t/ha with N and K fertilization experiments, compared to basic system (12.38 and 9.38 t/ha). The drip system was superior to basin system with respect to fruit growth, yield attributes and quality. Irrespective of the irrigation systems scheduling irrigation at 0.8 CPE was found to be optimum by registering significantly higher fruit growth, yield and quality of fruits. Irrespective of the irrigation systems and levels, application at 500 kg/ha through drip systems was optimum to get higher fruit yield (19.57 t/ha) with good quality compared to lower level of nitrogen through drip or same level of soil application through basin irrigation (15.60 t/ha). Similarly, potassium fertigation at 300 kg/ha gave higher fruit yield of 16.55 t/ha compare to soil application of potassium at 300 kg/ha under basin irrigation (13.35 t/ha). However, overall interaction between irrigation systems, irrigation levels, nitrogen and potassium levels were absent. Drip irrigation systems maintained constantly higher soil moisture compared to basin system. Drip irrigation at 0.6 and 0.8 CPE maintained soil moisture nearer to field capacity throughout the irrigation cycle, but not under basin system with same irrigation levels of irrigation were 300,600,900 and 1200 mm, under drip and basin irrigation.

Ph.D

Title : Effect of differential irrigation, soil moisture stress and mulch on growth, yield and water use in banana (*Musa paradisiaca* L.) (2003)

K.Murali, UAS, Bangalore, Guide : Dr.K.Srinivas

Field experiments were conducted at Indian Institute of Horticultural Research, Hessaraghatta, Bangalore during June 1994 to August 1996 to study the effect of differential irrigation, soil moisture stress and mulch on growth, yield and water use in Elakki banana (*Musa paradisiaca* L.).

The results revealed that irrigation scheduled at an IW/CPE ratio of 1.0 during vegetative stage recorded significantly higher fruit yield (main crop: 28.75 t/ha, ratoon crop: 24.89 t/ha) and it was lower with an IW/CPE ratio of 0.4 (main crop: 21.89 t/ha, ratoon crop: 18.81 t/ha). Similarly, irrigation scheduled at an IW/CPE ratio of 1.0 during reproductive stage recorded higher fruit yield (main crop: 27.13 t/ha ratoon crop: 23.22 t/ha) and it was lower with an IW/CPE ratio of 0.4 (main crop: 24.42 t/ha, ratoon crop: 21.52 t/ha).

Irrigation scheduled at an IW/CPE ratio of 0.8 (no stress throughout the crop growth) gave significantly higher fruit yield (main crop: 30.25 t/ha, ratoon crop: 24.41 t/ha) and it was lower with stress imposed during 201 to 240 days after planting (main crop: 23.91 t/ha, ratoon crop: 18.28 t/ha). Among the stress treatments, stress imposed during 321 to 360 Days After planting (DAP) gave higher banana fruit yield (main crop: 29.16 t/ha, ratoon crop: 23.53 t/ha) and it was lower with stress given during 201 to 240 days after planting (main crop: 23.91 t/ha, ratoon crop: 18.29 t/ha). Stress imposed during 321 to 360 DAP gave increased yield to the extent of 18.01 and 22.32 per cent with main and ratoon crops respectively as against stress imposed during 201 to 240 DAP.

Irrigation scheduled at an IW/CPE ratio of 1.0 recorded higher fruit yield (main crop: 32.47 t/ha, ratoon crop: 26.56 t/ha) and it was lower with an IW/CPE ratio of 0.4 (main crop: 23.29 t/ha, ratoon crop: 19.35 t/ha). The fruit yield was higher with mulch treatment (main crop: 26.53 t/ha, ratoon crop: 24.82 t/ha) as compared to no mulch (main crop: 23.53 t/ha, ratoon crop: 22.16 t/ha).

Ph.D

Title : Genetic investigation of pomegranate genotypes tolerant to drought using morphological, physiological and molecular markers (2005)

Nagarajappa Adivappar, UAS, Bangalore, Guide : Dr.S.H.Jalikop

Several pomegranate genotypes including commercial cultivars, exotic lines, ornamental types, F₁, F₂, BC and multiple hybrids were evaluated for morphological, physiological and biochemical parameters for drought tolerance like cell membrane stability (CMS), osmotic potential, water potential, relative water content (% RWC), root length, number of secondary roots, root fresh weight and root dry weight. 'Nana' and 'Double Flower' and their hybrids exhibited tolerance for moisture stress. Selected tolerant lines were used for DNA fingerprinting using RAPD's. Identification of RAPD markers for root traits in F₂ population for drought tolerance was developed. Data on drought related parameters have been collected for understanding the genetics of drought tolerance using six generation mean analysis.

Ph.D

Title : Studies on genetic variability in water use efficiency of grape varieties, rootstocks and their stionic combinations (2005)

J.Satisha, UAS, Bangalore, Guide : Dr.G.S.Prakash

Four grape varieties namely Flame Seedless, Thompson Seedless, Sharad Seedless and Tas-a-Ganesh of six month old plants were subjected to three levels of moisture stress viz., control, 50% stress and 100% stress for 14 days. There was marginal reduction in photosynthesis and greater reduction in transpiration with increased water use efficiency (WUE) in all the varieties from control to 50% stress. None of the varieties could survive beyond 3-4 days at 100% stress. Among the varieties Flame Seedless had highest WUE followed by Thompson Seedless at 50% stress. A nine fold increase in abscises acid content was observed in Flame Seedless at 50% stress than at control while it was about 1-3 fold in other varieties. Reduction in cytokinin content was observed with increased moisture stress. Root to shoot length ratio (RSLR) and root to shoot dry matter ratio (RSDWR) was maximum in Flame Seedless and was least in Tas-a-ganesh at 50% moisture stress.

Under similar set of experiments with five grape rootstocks namely Dogridge, 1613 C, Salt Creek, St. George and VC clone, Dogridge and salt Creek maintained higher water potential and osmotic potential (less negative values) under increased moisture stress indicating their better osmotic adjustment to maintain higher heater content. Higher WUE was observed in Dogridge and Salt Creek at 50% moisture stress as a result of marginal reduction in photosynthesis and greater reduction in transpiration rate. Higher ABA content accumulated in Dogridge with increased moisture stress resulted in reduced stomatal conductance thus minimizing transpiration rate. A three fold increase in RSLR was observed in Dogridge from non-stress to stress conditions while there was no much increases in other rootstocks. Reduced shoot length in Dogridge was attributed to less cytokinin content under soil moisture stress. Dogridge rootstock influenced the photosynthesis behaviour of Flame seedless and Sharad Seedless when they were budded on it. Sharad Seedless recorded maximum WUE when budded on Dogridge followed by Flame Seedless on Dogridge at 50% moisture stress. Flame seedless and Sharad Seedless budded on Dogridge recorded highest ABA accumulation at 50% moisture stress than when they are budded on Salt Creek and VC clone. Rootstocks strongly influenced the carbon isotope discrimination of scion varieties budded on them.

Ph.D

Title : Propagation of some grape rootstocks in enriched organic media and their subsequent graft success (2008)

Husameddin Al-Said, UAS, Bangalore, Guide : Dr.G.S.Prakash

Three experiments were carried out at Indian Institute of Horticultural Research (IIHR), Hessaraghatta, Bangalore-89 during the year 2006-07 to study the effect of various substrates and microbial combinations on rooting and graft success of grapevine rootstocks. The experiments consisted of three grapevine rootstocks viz., Dogridge, St.George and 1613 and three substrates namely plant sap, humic acid, vermiwash and a control and seven microbial combinations (M1: *Glomus mosseae* + *Trichoderma harzianum*, M2: *Glomus mosseae* + *Bacillus subtilis*, M3: *Glomus mosseae* + *Pseudomonas fluorescens*, M4: *Glomus mosseae* + *Trichoderma harzianum* + *Bacillus subtilis*, M5: *Glomus mosseae* + *Trichoderma harzianum* + *Bacillus subtilis* + *Pseudomonas fluorescens*, M6: IBA and M7: control). Among the substrates used, humic acid significantly influenced almost all the root and shoot parameters in hardwood grapevine cuttings of the three rootstocks. Next best treatments were vermiwash and plant sap. Among various microbial combinations tried, treatment M5 was the most effective for almost all the root and shoot parameters studied as compared to control. Other microbial combinations (M1, M2, M3 and M4) gave similar results as IBA treatment. Among different grape rootstocks tested, the root development was significantly superior in 1613, while St. George rootstock showed the best shoot development.

Early budbreak was recorded in the cuttings treated with plant sap which was on par with the cuttings treated with vermiwash. Among the different microbial combinations M2, M3 and M5 gave early budbreak as compared to control. The percentage of graft success and root colonization was significantly increased by humic acid, whereas other substrate treatments were not significant. The percent graft success was significantly increased by M4 and M5, while the percentage of root colonization was significantly increased by all the microbial combinations (M1, M2, M3, M4 and M5). The rootstock 1613 gave the highest percent graft success, while St. George showed the highest percentage of root colonization

Ph.D

Title : Studies on morphological and molecular characterization and conservation of mango germplasm (2010)

C.Vasugi, Annamali University, Chidambaram, Guide : Dr.M.R.Dinesh

Studies on morphological and molecular characterization and conservation of mango germplasm were carried out in the Department of Horticulture, Faculty of Agriculture, Annamalai University, during December, 2005 to December, 2009. Four systematic experiments were carried out to characterize the variability; to assess the genetic diversity; to evaluate for fruit and pickling characters and to study the effect of cryopreserved pollen. Characterization of 43 accessions maintained in the field gene bank of Indian Institute of Horticultural Research based on IPGRI (Biodiversity International) mango descriptor revealed wide variability for leaf, fruit, flower, inflorescence, pulp and stone characters. Genetic divergence and cluster analysis based on both phenotypic and molecular markers were carried out. Accessions were grouped based on similarity/dissimilarity index. Principal Component Analysis (PCA) indicated that fruit descriptors contributed more towards divergence. Cryopreserved pollen was found to be as good as fresh pollen in the inter-specific and inter-varietal crosses. Comparative evaluation of pickling accessions with the commercial and polyembryonic varieties revealed that Dantimamidi and Kovesara possessed good quality characters and was on par with the commercial varieties used in the study. Based on the evaluation of tender mango pickle quality, Chansi Appe, Dodderi Jeerige, Mani Bhatta Appe, Gorana Appe, isagoor Appe, Malange, Dantimamidi, Gurusurthy Appe and Kashimidi were identified as good pickling accessions. Possible gene donors for specific traits like attractive skin colour, pulp colour, fruit weight, pulp per cent and TSS was also observed. The morphological characterization data generated in the present study was used to develop a Mango Information System to run on Windows Operating System for ready retrieval and visual comparison.

M.Sc.

Title : **Studies on propagation of ber (*Zizyphus Mauritiana* Lam.)** (1984)

B.N.Srinivasamurthy, UAS, Bangalore, Guide : Dr.Y.N.Reddy

Studies on seed germination, rootstocks and budding aspects of ber were conducted to standardize the propagation techniques. Extracted kernels germinated better with higher percentage as compared to intact seeds. Kernels presoaked in water then treated with 1.0% thiourea gave 77.77% germination in Umran. The germination process of ber was slower in the dark. GA as presowing treatment substituted the light requirements of seeds. It was found that the germination percentage of seeds was significantly higher when the final exposure was given to red light. It was also found that better and faster germination occurred at 30 °C. Further it was revealed that ber seeds could be stored up to 8 months without any loss in viability. Based on the studies conducted, it is recommended that KNO₃ treatment be given to the ber rootstocks *in situ* under dryland conditions, to make them more tolerant to drought. Umran is best suited for raising rootstocks, as the seedlings of this variety made a faster growth than the local types. When budding was done on topped defoliated rootstocks, the bud take was earlier, the success higher and the scion growth faster when compared to intact plants. Buds taken from main axis and four month old shoots were found to give higher success.

M.Sc.

Title : Assessment of some cultivars of mango (*Mangifera indica* L.) for vegetative and fruit characters. (1985)

M.C.Subbaiah, UAS, Bangalore, Guide : Dr.C.P.A.Iyer

Observations were taken on 42 cultivars of mango collected from all over the country on various characters including vegetative growth, flowering and fruit characters, to obtain information on the extent of variability and also to help in selection of cultivars for specific purposes. The data were taken on seven year old trees. Wide variability was observed for number of growth flushes, length of shoots put forward in a year, time of flowering, length of panicles, initial fruit set, fruit number per panicle and date of harvest. The number of fruits per tree ranged from 5.0 in Langra to 247.5 in Pacharisi. In terms of fruit number. Chandrhkaran, Gola, Himayat pasand, Hyder Sahebi, Kallapadi, Kasturimamidi, Lazat Baksh, Neelum, Pacharisi, Padiri and Panakalu were found to be promising. In terms of fruit weight, Amini, Hyder Sahebi, Kallapadi, Kasturimamidi, Lazat Baksh, Neelum, Pacharisi, Padiri and Panakalu were found to be promising. The weight of the fruit was found vary from 63 g in Chandrhkaran to 647g in Amini. The percentage of pulp in a fruit ranged from 39.7 (Chandrhkaran) to 74.1 (Fazli). It was found that the cultivars Fazli, Himayat Pasand, Kallapadi, Padiri and Panakalu yielded maximum pulp per tree. The pulp : skin + stone ratio (edible to non-edible portion) was found to range from 0.65:1 in Chandrhkaran to 2.86:1 in Fazli. The total soluble ranged from 12.8° in cultivar Amini to 29.2° in cultivar Chandrhkaran. The acidity was found to be the least in cultivars Banganapalli, Imam Pasand, Lazath Baksh and Peddarasam (0.06%), whereas it was maximum in cultivar Suvarnarekha (0.65%). The total sugar content was found to range from 8.03 in Fazli to 20.41 percent in Rataul. Panakalu (17.63%), Amarapalli (17.24%), Langra (15.78%), Kallapadi (15.75%) and Dashehari (15.50%) also had high total sugar content. The sugar: acid ratio was found to range from 16.66:1 in Mohammada Vikarabad to 270.66:1 in Rataul. Cultivars Lazath Baksh (257.3:1) and Rataul (270.6:1) recorded high ratio.

M.Sc.

Title : Studies on sylleptic branching in *Zizyphus* species with special reference to productivity in ber (*Zizyphus mauritiana* Lam.) Var.Umran (1985)

Reju.M.Kuriyan, UAS, Bangalore, Guide : Dr.Y.N.Reddy

Studies on sylleptic branching of two *Zizyphus* species revealed that *Z. mauritiana* (ber) var. Umran produced lesser number of sylleptic branches than *Z. oenoplia*. In both species rhythm in the production of second order branches was noted. Various chemicals and growth regulators tried could not change the interval of sylleptic branching in ber, but BA, TIBA and morphactin increased the number of nodes and thereby sylleptic branches. Extent of shoot tip abscission was comparatively less in *Z. oenoplia*. Some of the vigorous first order branches in *Z. oenoplia* exhibited shoot tip reorganization. It was proposed that shoot apex at any given level of activity is self-regulatory, but its elevation from a lower to higher level of activity requires energy inputs from subtending structures. *Z. oenoplia* was identified to be more competitive and its use as rootstock for ber was suggested. Branch polymorphism was observed in ber. Vigorous shoots contributed 93.03% fruits on any pruned shoot; rest being from normal shoots, whereas spurs type bore no fruits. Vigorous sprouts with more basal diameter, length and nodes produced more sylleptic branches and hence more fruits. The use of branch bifurcation ratios in predicting yield was proposed based on their strong correlations with yield attributes, branch yield and ultimate tree yield. Two control points, increasing the number of vigorous sprouts and sylleptic branches, were identified to increase yield in ber. Pre-pruning spray of KNO₃ or thiourea increased the number of vigorous and total sprouts and produced the former at a lower node. Post-pruning sprays of BA, TIBA or morphactin effectively improved the second control point. Thiourea 3% + BA 100 ppm treatment was found to be the best in the simultaneous manipulation of two control points identified. The superior treatments along with appropriate cultural practices were suggested for maximizing productivity in ber.

M.Sc.

Title : **Phenotypic variability studies in F₁ grape hybrids** (1986)

B.Rangaswamy, UAS, Bangalore, Guide : Dr.Rajendra Singh

Quantitative and qualitative characters, the extent of phenotypic variability, and the relationship between characters were studied in ten F₁ grape hybrids raised at IIHR, Bangalore. The study showed significant differences indicating large phenotypic variability for 11 quantitative characters. Other 10 quantitative characters expressed non-significant differences among the hybrids. Large phenotypic variability was also evident from variations among the hybrids with respect to PCV values of the 11 quantitative characters. Phenotypic variability occurrence was also apparent from variations among the hybrids with respect to PCV values of the other 10 quantitative characters. Occurrence of a wide phenotypic variability in experimental material was evident from the quantitative characters which expressed themselves in different combinations. It was evident from the study that the F₁ grape hybrids BB x CS and BC x TS had the highest percentages of fruitful canes, BC x TS and BB x CS had the maximum number of panicles and maximum number of bunches, AES x BC and BC X TS had the maximum yields; AES x BC and CS x CLB had the maximum bunch weights: CS x CLB and AES x CLB had the highest berry weights; AK x BC and AES x BC had the highest percentage of well-developed berries; BB x CS & AK x CLB had the highest percentages of juice; BB x CS had the highest TSS percentages and BB x TS and AK x BC were earliest ripeners.

M.Sc.

Title : Effect of temperature and insoluble solids added to clarified musts on fermentation rate and wine quality (1986)

P.Saralamma, UAS, Bangalore, Guide : Dr.Rajendra Singh

The effect of suspended solids added to clarified musts on fermentation rates and qualities of wines from grape cultivars Thompson Seedless and Arka Kanchan was studied with two fermentation temperatures (13 and 18 °C) and compared with cold settled and centrifuged juice. The suspended solids such as grape solids and bentonite were added at 1% and 2% and 400 mg and 800 mg/l, respectively. In case of Thompson Seedless musts fermented at 13 °C both the maximum and overall fermentation rates were high when either grape solids or bentonite was added. When fermented at 18 °C, only bentonite addition increased the fermentation rates. However, the cold settled juice fermented faster than the juice with suspended solids at 18 °C. In case of Arka Kanchan fermented at 13 °C the maximum fermentation rates increased with higher solids contents, but overall fermentation rates didn't show much difference. At 18 °C both maximum and overall fermentation rates were higher in all the treatments except in juice with 1% solids. Varietal comparison showed that the musts of Thompson Seedless fermented faster at 13 °C while Arka Kanchan at 18 °C. The alcohol content, total acidity, pH and tannin were not affected by addition of suspended solids. Volatile acidity was in all the treatments and was within the range. Residual sugar was low in all the treatments indicating that the fermentation was complete in all the samples. Sensory evaluation of wines indicated that in case of Thompson Seedless must the quality of wine was better when fermented at low temperature with bentonite. However, at high temperature, wine from centrifuged must was better. Better quality wine obtained from Arka Kanchan, when centrifuged juice was fermented at both the temperatures.

M.Sc.

Title : **Studies on grape hybrids and their parents on different training systems (1987)**

B.Revanna, UAS, Bangalore, Guide : Dr.Rajendra Singh

Effect of different training systems on the yield and performance of some grape hybrids and their parents was investigated. Growth of the vine was more on the 'Bower' (129.18) than on the 'Head' (50.29) system of training. The number of shoots was more during April pruning in 'Anab-e-Shahi' (8.51 kg/vine) than other varieties. The weight of pruning per vine was more on 'Bower' system (6.87 kg) as compared to 'head' system (2.49 kg). Rate of shoot growth was slow in 'Arka shyam' (68.76 cm) but fast in 'Arka kanchan' (155.66 cm) on 'Head system'. It was slow in case of 'Arka hans' (82.44 cm) but steep in 'Arkavati' (158.20 cm) trained on 'Bower' system. The highest stem girth was found in 'Thompson Seedless' (7.43 cm) and least in 'Anab-e-Shahi' (3.89 cm). The training system followed did not have any effect on stem girth. The degree of apical dominance was more on 'Head' system (0.79) than on 'Bower' system of training (0.67). Among the varieties, it was highest in 'Anab-e-Shahi' (1.00) while the least was in 'Arkavati' (0.40). Although the yield per vine in 'Arka Kanchan', 'Arkavati' and 'Black Champa' was more on the 'Bower' system, even on the 'Head' system they produced 60 to 70% of the yield obtained on the 'Bower' system on unit area basis. Hence, these varieties can be recommended for growing on 'Head' system of training.

M.Sc.

Title : Studies on comparison of grape hybrids and their parents for qualitative characters (1987)

Vijayakumar Kanamadi, UAS, Bangalore, Guide : Dr.Rajendra Singh

With an objective of identifying the superior grape hybrids in respect of different qualitative and quantitative parameters, studies were carried out on the comparison of parents comprising of twenty promising hybrids with ten parental varieties in a replicated trial in a completely randomized design at the Indian Institute of Horticultural Research, Hessaraghatta, Bangalore, during 1986-87. The ten varieties used either as female or male parents were; (1) Anab-e-Shahi, (2) Angur Kalan, (3) Bangalore Blue, (4) Bangalore Purple, (5) Black Champa, (6) Cheema Sahebi, (7) Convent Large Black, (8) Gulabi, (9) Queen of the Vineyards and (10) Thompson Seedless. Hybrids were evaluated against their parents in respect of vine growth parameters, yield attributes and quality components. Salient findings of the study are summarised below; 1. Significantly differences were observed among the parents and hybrids in respect of stem girth in June and October, and October prunings weight. Significantly differences were also observed in respect of the number of days taken for bud burst, shoot length, leaf number/shoot specific weight, leaf area during the fruiting season and leaf dry matter content, Chlorophyll 'b' and total chlorophyll (a+b) content during the fruiting season, yield attributes such as number of bunches/vine, mean bunch weight, bunch length and breadth, number of berries/bunch, 50-berry weight and the yield/vine. Quality components such as juice, total soluble solids and seed (number) content also varied significantly among the parents and the hybrids. Shoot length at 60, 75 and 90 days after budbreak during the growth season was negatively correlated with yield/vine. Reduction in the yield on account of increased shoot length seems to have mediated through the number of berries/bunch. Dry matter content, area and specific weight of leaf during the growth season were positively correlated with yield/vine. Anab-e-Shahi hybrids 4/15 (Anab-e-Shahi x Bangalore Purple) and 5/17 (Anab-e-Shahi x Black Champa) which had less shoot length after 60, 75 and 90 days of April pruning than Anab-e-Shahi seemed to be promising for yield. The same Anab-e-Shahi hybrids viz., 4/15 and 5/17 had more leaf dry matter content during the growth season, adding to their promise in respect of yield. 5/17 also holds promise for yield over Black Champa in view of higher leaf dry matter content. Anab-e-Shahi hybrids, 4/15 (Anab-e-Shahi x Bangalore Purple), 5/13 (Anab-e-

Shahi x Black Champa), 5/17 (Anab-e-Shahi x Black Champa), F-13/20 (Anab-e-Shahi x Gulabi) and F-12/29 (Anab-e-Shahi x Gulabi); Thompson Seedless hybrids 29/6 (Black Champa x Thompson Seedless) and 30/16 (Black Champa x Thompson Seedless); Gulabi hybrids F-13/20 (Anab-e-Shahi x Gulabi) and F-12/29 (Anab-e-Shahi x Gulabi) and Bangalore Purple hybrid 4/15 (Anab-e-Shahi x Bangalore Purple) excelled their respective parents in yield/vine. Based on the observations made on the vine growth parameters, yield and quality, it can be concluded that Anab-e-Shahi hybrid 5/17 (Anab-e-Shahi x Black Champa), Thompson Seedless hybrids 29/6 (Black Champa x Thompson Seedless) were improvements over their respective parents for yield and quality, Anab-e-Shahi hybrids, 4/15 (Anab-e-Shahi x Bangalore Purple) was improvement over Anab-e-Shahi for yield.

M.Sc.

Title : Effect of urea and GA sprays on shoot growth and bunch characters in grape (*Vitis vinifera* L.) variety Arka kanchan (1988)

N.M.Poonacha, UAS, Bangalore, Guide : Dr.S.D.Shikhamany

A field trial was carried out during 1987-88 on 'Arka Kanchan' grape with an aim to increase the berry and bunch size. Effect of 16 treatment combinations of four foliar sprays of urea (during the growth season, fruiting season, during both the seasons and unsprayed control) and four of GA sprays (at pre-anthesis, full bloom, 10 days after fruit set and unsprayed control) on berry and bunch size was studied in grape 'Arka Kanchan'. Urea sprays during both the seasons increased only the vigour of the shoots in vines without any favourable effect on the bunch or berry weight. Urea sprays during fruiting season coupled with GA sprays on the 10th day after fruit set increased the mean berry weight. Urea sprays (0.5%) at fortnightly intervals commencing from 30th days after October pruning coupled with GA sprays on the 10th day after fruit-set may be favourable for increasing the bunch weight of this variety. These investigations also suggested that berry and bunch weight in var. Arka kachan is more dependent on the metabolites during the fruiting season than on the reserves in the canes. In view of the fact GA sprays on the 10th day after fruit set increased the length of berries but not the diameter, with no exchange in the mean berry weight, there is scope to increase the diameter of the berries and there by, the mean berry weight by application of auxin or cytokinin in addition to gibberellic acid.

M.Sc.

Title : Phenotypic variability for qualitative and quantitative attributes of certain grape hybrids (1989)

S.Venkataram Prasad, UAS, Bangalore, Guide : Dr.Rajendra Singh

The present investigation was carried out during 1986 and 1987 at IIHR, Bangalore, to evaluate the hybrids of the crosses Anab-e-Shahi, Angurb Kalan, Bangalore Blue, Black Champa, Convent Large Black, Thompson Seedless and Queen of the Vineyard, with respect to growth, fruitfulness, yield, quality, petiole nutrient contents and resistance to diseases. The salient findings of these investigations were seen as considerable variations in stem girth observed among the hybrids and parents. The hybrids 5/12 and 4/30 from the cross Anab-e-Shahi x Black Champa, hybrids 9/3 from the cross Anab-e-Shahi x Queen of the Vineyard and hybrids 29/4 and 29/5 from the cross Black Champa x Thompson Seedless had more trunk girth than rest of the hybrids. The hybrids 8/29, 29/4 and 29/5 appeared to be highly vigorous, while rest of the hybrids had low vigour. The hybrids 26/8 registered the minimum pruning weight. The percentage of increase in pruning weight of the hybrids was from 88.68% to 153.26% over the best parent, indicating for the tendency of the hybrids vigour. The parent Black Champa as a seed parent and Queen of the Vineyard as a pollen parent appeared to be best combiner for imparting high vigour to the progeny. The hybrids 4/30 had highest number of shoots. The hybrids 7/12 and 8/24 had minimum number of shoots. The hybrids which recorded the lowest angle of the shoot was 7/12 and 8/24. The hybrid 4/30 recorded the lowest shoot length in the both season, while the hybrid 29/5 recorded the highest shoot length in growth season and the hybrid 5/12 in fruiting season. Cane diameter increased invariably in hybrids compared to their parents. The genotypes with high number of shoots had less percentage of cane maturity. The hybrids 29/4 and 29/5 from the crosses Black Champa x Thompson Seedless had invariably number of leaves the better parent Bangalore Blue had the highest tolerance to all the diseases. While Anab-e-Shahi and Thompson Seedless appeared to be highly susceptible. The hybrid 30/40 had the least incident of anthracnose, while the hybrid 29/5 was highly susceptible. The hybrid 21/28 had higher downy mildew disease tolerance among all the progenies, while the hybrid 5/12, 7/12 and 26/8 were moderately tolerant. Hybrids 4/30, 8/24, 29/3 and 29/4 were highly susceptible.

M.Sc.

Title : Studies on shoot growth and berry development in different genotypes of grape (1991)

Kulapati Hipparagi, UAS, Bangalore, Guide : Dr.Rajendra Singh

Shoot growth and berry development pattern in different genotypes of grape was studied in five promising hybrids with five parental cultivars in a replicated trial. The five cultivars used as female or male parents were; Anab-e-Shahi, Angurb Kalan, Black Champa, Thompson Seedless and Queen of the Vineyard. Hybrids were studied against their parents in respect of vine growth parameters, yield attributes and quality components. Shoot length and leaf number per shoot at 90 and 105 days after budbreak during the fruiting season were positively correlated with total soluble solids. Fresh weight of berries at 30, 45, 60, 75 and 90 days after fruit set was positively correlated with Brix-yield/15 berries and 50 berries weight at harvest. All the five hybrids had more shoot length and leaf number than their parents. The study has shown that Anab-e-Shahi hybrids E-5/12 and E-9/3 and Black Champa hybrids E-29/4 were improvements over their respective parents with respect to yield and quality attributes, while Black Champa hybrid E-29/4 were improvements over its parents with respect to yield and quality attributes, while Black Champa hybrid E-29/5 and Angurb Kalan hybrid F-5/4 were improvements over their respective parents with respect to quality.

M.Sc.

Title : Studies on shoot growth and bunch development as influenced by the time of pruning and hydrogen cyanamide application in Thompson Seedless grape (*Vitis vinifera* L.) (1991)

G.C.Manjunatha, UAS, Bangalore, Guide : Dr.S.D.Shikhamany

Influence of different concentrations of cyanamide (0,1,2 and 3% a.i.) at different dates of pruning (5th October, 26th October and 16th November, 1989) on budbreak and the consequential effect of variation in budbreak on different dates shoot growth, bunch development and berry quality was studied in Thompson Seedless grape under the mild tropical climatic conditions of South interior Karnataka. Budbreak at all nodal positions, except the terminal two nodes was influenced by the dates of pruning as well as the cyanamide concentration. Irrespective of the concentration, cyanamide treatment increased the budbreak, which in turn was associated with increased yield, brix-yield/cane and increase in the proportion of water berries. Cyanamide treatment hastened budbreak by about 6 days in vines pruned on 5th October and about 4 days in vines pruned on 26th October for 50% budbreak to occur. Vines pruned on 16th November and not treated with cyanamide did not show even 50% budbreak. Mean shoot length was reduced by delayed pruning and cyanamide treatment. Total shoot length/cane decreased with delay pruning but was unaffected by cyanamide treatments. Reduced total shoot length/cane was associated with reduced yield and brix-yield/cane and mean bunch and berry weights. Vines pruned on 5th October resulted in higher yield than those pruned later. Higher yield was mediated through higher weight of berries and bunch and increase in the number of clusters/cane. Cyanamide treatment did not increase the yield/cane. Proportion of water berries in a bunch decreased with delayed pruning. This however, was not affected by cyanamide treatment. Cyanamide treatment did not have any influence on the quality parameters. This study has thus shown that cyanamide can be used to hasten and increase budbreak in Thompson Seedless vines pruned as late as 16th November under the agro-climatic conditions of Bangalore. Cyanamide at 1% a.i. was found to be the optimum. For achieving increase in yield through budbreak by cyanamide, fruitfulness of buds on the cane should be improved.

M.Sc.

Title : **Micropropagation of salt tolerant grape rootstock variety 'Ramsey' (1997)**

K.T.Bollamma, UAS, Bangalore, Guide : Dr.I.S.Yadav

Micropropagation is a technique for rapid multiplication of plant *in vitro*. The present investigation was carried out to develop a protocol for micropropagation of salt tolerant grape rootstock variety 'Ramsey'. The experiments were conducted at the plant Tissue Culture Laboratory – I of the Division of Biotechnology, Indian Institute of Horticultural Research, Hesaraghatta, Bangalore. Various experiments were conducted and result were analysed and discussed. Decontamination of 'Ramsey' nodal cutting were best achieved when they were pretreated for 1 hour or 4 hour and surface sterilized for 10 minutes. With this treatment the percent survival was higher when compared to other treatments *viz.*, the contamination rate was lower in the above treatments. Softwood nodal cuttings gave lower contamination rate. Induction of multiple shoots from nodal explants was best achieved with modified MS medium supplemented with 3 ppm BA. At this rate of BA maximum number of leaves and nodes also were obtained. At a concentration of 5 ppm BA in MS basal medium callus with pink colour pigmentation was obtained. Further, it was found that half strength MS was a better basal medium with 3 ppm BA for induction multiple shoot. Half strength MS gave rise to a sturdy plantlet with a good shoot and root system which could be directly acclimatized. Hardening was done using the closed sachet method with a very high survival percent.

M.Sc.

Title : Growth and productivity of Robusta banana under nitrogen and potassium fertigation (1998)

S.S.Chandra Kumar, UAS, Bangalore, Guide : Dr.K.Srinivas

A field experiment was conducted at IIHR, Bangalore to study the growth and productivity of banana cv. Robusta under nitrogen and potassium fertigation. The findings are summarized hereunder. The fruit yield of 88.46 t/ha was obtained with 200 g of N and K and was on par with 150 g of N and K (85.66 t/ha). The lower yield of 78.19 t/ha and 56.39 t/ha were obtained with 100 g N and K and 50 g of N and K respectively. The yield attributing parameters like hand per bunch (7.43), fingers per bunch (96.02), average finger weight (207.37 g) and average bunch weight (19.90 kg) were higher with 200 g of N and K. The maximum leaf dry matter (1258 g), pseudostem dry matter (1122 g), fruit dry matter (2010 g) and total dry matter (4390 g) were obtained with 200 g of N and K. The leaf dry matter (1207 g) and pseudostem dry matter (1031 g) were higher with 150 g of N and K which were on par with 200 g of N and K. However, leaf dry matter, pseudostem dry matter and total dry matter were not influenced much by N and K ratios. But 1:2 N and K ratio recorded maximum leaf dry matter (1116 g), pseudostem dry matter (974 g), fruit dry matter (1780 g) and total dry matter (3859 g). The bunch dry matter ($r=0.995^{**}$), total dry matter ($r=0.937^{**}$), stem dry matter ($r=0.833^{**}$) and leaf dry matter ($r=0.722^{**}$) were highly correlated with fruit yield. The quality parameters such as total soluble solids (TSS) and pulp to peel ratio were improved by N and K fertigation. Higher total soluble solids (24.01%) was recorded with 200 g of N and K which was on par with 150 g of N and K (24%). Whereas 23.25% and 22.50% TSS were recorded with 100 g of N and K and 50 g of N and K. application of 1:2 N and K ratio recorded higher TSS (24.4%) in fruit compared to 1:1 N and K ratio (23.68%). Higher net returns (Rs.3,88,568.00 per ha) was recorded with 200 g of N and K, while higher profit per rupee invested (Rs. 2.82) was with 150 g of N and K. Further, 1:2 N and K ratio obtained higher net returns (Rs. 3, 43,551.00 per ha) and profit per rupee invested (Rs. 2.59).

M.Sc.

Title : Studies on the response of grape genotypes in relation to different levels of moisture stress (1999)

H.K.Narendra Babu, UAS, Bangalore, Guide : Dr.G.S.Prakash

A pot trial experiment was conducted on six grape genotypes (Dogridge, Saltcreek, 1613, St. George, *Vitis champini* clone and cultivar Thompson Seedless) with three levels of moisture stress for a period of 14 days.

Of the six grape genotypes studied, the rootstocks, 1613, St. George, *Vitis champini* clone along with cultivar Thompson Seedless did not survive the stress under 100 per cent moisture stress condition. However, all of them survived under 50 per cent stress condition. Under 100 per cent stress, all the genotypes showed general reduction in Relative Water Content (RWC), Osmotic Potential (OP), Leaf Water Potential (LWP), Transpiration rate (AE), Net Photosynthetic Rate (Pn) and Stomatal Conductance (Gs). Under 50 per cent moisture stress RWC, AE, Pn, Gs, reduced in all the genotypes. Whereas, they were on par with the OP and LWP. Leaf temperature (LT) increased in all the genotypes at both the stress levels. The N, P and K content reduced in all the genotypes as a result of moisture stress. However, in Dogridge the N content in the leaves of stressed plants was almost on par with the well watered plants.

Another experiment conducted on the diurnal variation of leaf RWC, OP and LWP were maximum in the morning in all the three genotypes (Dogridge, Saltcreek and Thompson Seedless) studied and reduced considerably by noon and slightly recovered in the afternoon under complete moisture stress. Soil moisture content was reduced in all the genotypes due to moisture stress.

In the root development studies with six grape genotypes the highest root dry weight among all the categories of roots was found in Dogridge. Similarly, the dry weight of the shoot as well as the plant height were maximum in the rootstock Dogridge.

M.Sc.

Title : Response of grapes to micro-irrigation under different evaporation replenishment rates (2001)

B.Boraiah, UAS, Bangalore, Guide : Dr.K.Srinivas

The field experiment was conducted at the Indian Institute of Horticultural Research, Hessaraghatta, Bangalore during 1999-2000 to study the “Response of grapes to micro-irrigation under different evaporation replenishment rates”.

The fruit yield of grape was higher with drip irrigation (30.20 t ha⁻¹) compared to microjet irrigation (29.94 t ha⁻¹). The yield attributing parameters like number of branches per plant (90.75), average bunch weight (473.33 g), 100 berry weight (380.99 g), berry diameter (22.23 cm²) and berry length (31.30 cm²) were higher with drip irrigation.

Increasing the evaporation replenishment increased the fruit yield and other yield parameters like, the fruit yield was higher with 100 per cent evaporation replenishment (31.98 t ha⁻¹) which was on par with 75 per cent evaporation replenishment (31.53 t ha⁻¹), but it was lower with 50 per cent evaporation replenishment (26.69 t ha⁻¹).

Evaporation replenishment rates did not influence the growth parameters like leaf area of index leaf, fresh weight of index leaf, dry weight of index leaf, dry matter content of index leaf and pruning weight although they were higher with 100 per cent evaporation replenishment.

The total soluble solids was marginally higher with drip irrigation (15.43%) compared to microjet irrigation (15.37%), but the titrable acidity did not vary with the method of irrigation (0.34%). The sugar : acid was higher with drip irrigation (45.11) compared to microjet irrigation (44.86).

Irrigation scheduled with an evaporation replenishment rate of 75 per cent either with microjet or drip irrigation resulted in higher yields. The water use with 75 per cent evaporation replenishment was 945.75 mm.

M.Sc.

Title : **Variability and hybrid evaluation studies in papaya (*Carica papaya* L.)** (2001)

Sukhen Chandra Das, UAS, Bangalore, Guide : Dr.M.R.Dinesh

In an experiment conducted at Indian Institute of Horticultural Research, Bangalore, half-sib analysis was carried out in papaya (*Carica papaya* L.) using twelve varieties and hybrids namely Coorg Honey Dew, Pink Flesh Sweet, Sunrise Solo, Waimanalo, Pant-2, Washington, Red Gold, Pusa Dwarf; PAU Selection, CO-4, H-39 and H-57. The objective of the study was to derive information on genetic advance and genetic advance over per cent mean, physic-chemical characteristics, which could be used in breeding programme and performance of new hybrids in comparison with their parents. In addition to the above, a study was conducted to see the seed setting pattern and to study the suitable flower type for seed production two varieties of *Carica papaya*, Sunrise Solo (Gynodioecious) and Washington (Dioecious). All the plant and fruit characters studied showed higher phenotypic variance than the genotypic variance which indicated the importance of environment in the manifestation of these characters. The heritability estimates were high for the characters fruit length, pulp thickness, plant height, total carotenoids, ascorbic acid, fruit breadth and TSS, indicating that these characters are amenable for improvement through selection. Fruit length, fruit volume fruit cavity index, fruit weight, total carotenoids and ascorbic acid had high heritability and genetic advance indicating additive gene action, which showed that selection can be made easily based on parental performance. For most of the characters, the genotypic correlation values were more than the phenotypic correlation values indicating of influence of environment. With regard to the seed setting pattern, the study showed that the variety Sunrise Solo comparatively matures earlier than Washington, early germination of seed was also seen in this variety. The percentage of fruit set and germination percentage in seeds was more in case of the variety Sunrise Solo than in the variety Washington.

M.Sc.

Title : **Irrigation and fertigation studies in high-density mango (*Mangifera indica* L.)**
(2002)

Hanamanth.Y.Asangi, UAS, Bangalore, Guide : Dr.K.Srinivas

The investigation on Irrigation and fertigation studies in high-density mango (*Mangifera indica* L.) var. “Arka Anmol” was carried out at Indian Institute of Horticultural Research, Hesarghatta, Bangalore during the year 2001-2002.

Seven year old mango plants of Arka Anmol was grafted and dwarfing rootstock Vellaikulamban and planted at a spacing of 5 m x 5 m, gives a plant density of 400 plants per hectare. The mango plants were subjected to two levels of irrigation (40% and 80% evaporation replenishment rate) and three level of fertigations (100%, 75% and 50% recommended dose of fertilizer) applied through drip irrigation system.

Fruit yield (9.50 t/ha.), number of fruits per plant (99.92) and fruit volume (259 cc) were higher with 80% of evaporation replenishment rate as compared to 40% of evaporation replenishment rate {(fruit yield (7.06 t/ha.) number of fruits per plant (63.58), and fruit volume (232.20 cc)}.

The higher fruit yield (10.65 t/ha.) and number of fruits per plant (97.88) at 100% recommended dose of fertilizer, fruit yield (7.92 t/ha.), number of fruits per plant (64.38) were lower under 50% recommended dose of fertilizer. However, the interaction effect of 80% evaporation replenishment rate and 100% of recommended dose of fertilizer reported highest fruit yield (12.50 t/ha.), number of fruits per plant 9113) as compared to other interactions.

The acidity (0.40%), peel weight (48.42 g), pulp weight (178.89 g), stone weight (38.05 g), peel to pulp ratio (3.84) and pulp to stone ratio (3.63) were higher at 80% evaporation replenishment rate as compared to 40% of evaporation replenishment rate. Whereas, higher TSS was reported at 40% of evaporation replenishment rate (18.58 °Brix). Similarly, TSS (18.20 °Brix), peel weight (48.18 g), pulp weight (182.83 g), stone weight (49.06 g), peel to pulp ratio (3.84) and pulp to stone ratio (3.63) were higher at 100% RDF as compared to 50% of RDF.

M.Sc.

Title : Interspecific hybridization and mutagenic studies in papaya (*Carica papaya* L.) (2002)

L.C.Santosh, UAS, Bangalore, Guide : Dr.M.R.Dinesh

Interspecific hybridization was carried out using *Carica papaya* var. Surya as female parent and *C. cauliflora* as male parent. The study was aimed at creating variability and to fix LD₅₀ value for the variety Surya. The experiment was conducted in experimental plots of India Institute of Horticultural Research, Bangalore during 2001-2002. Maximum fruit set was recorded at 5 per cent among the different levels of sucrose concentrations used. Maximum percent response was obtained from embryos inoculated on both MS medium supplemented with IBA 5 mg l⁻¹. MS basal medium was ideal for germination of embryos producing maximum shoot length, number of nodes, internodal length, root length and number of roots. Maximum percent germination was recorded in control followed 0.1 per cent EMS concentration. Maximum percent response was observed in control whereas maximum number of multiple shoots was recorded from the embryos inoculated onto 0.005% EMS treatment.

M.Sc.

Title : Studies on nursery and propagation techniques in polyembryonic rootstocks of mango (*Mangifera indica* L.) (2002)

Venkata Rao, UAS, Bangalore, Guide : Dr.Y.T.N.Reddy

The investigation on “Studies on nursery and propagation techniques in polyembryonic rootstocks of mango (*Mangifera indica* L.)” was carried out at the Indian Institute of Horticultural Research, Hessaraghatta, Bangalore-89 during the period 2001-2002.

Fourteen polyembryonic varieties along with one monoembryonic Alphonso studied for seedling attributes related to germination, growth and vigour. Earliest germination was noticed in Muvandan and whereas the maximum germination percent and rate of germination was in Muvandan and Olour respectively. With regard to seedling growth characters like, seedling height, number of leaves and leaf area was maximum in Alphonso.

In osmopriming treatments, the variety Alphonso recorded the maximum seedling height, girth, number of leaves and leaf area in treatment GA₃ at 100 ppm concentration. Bark and stem percent was maximum in varieties Vellaikolumban and Bappakai in treatment GA₃ at 100 ppm concentration.

In media and biofertilizer experiment, the seedling height, girth and number of leaves were maximum in variety Alphonso and Muvandan in treatment comprising of potting mixture (1:2:1 proportion) + cocopeat + VAM.

The bark inverted variety Olour recorded the minimum graft height and sprout length whereas the seedling girth was maximum in variety Alphonso where bark inversion was carried out.

Thus based on the different seedling growth and vigour characters, the monoembryonic varieties Alphonso, Totapuri and polyembryonic varieties Muvandan, Bappakai, E.C-95862 and Mylepelian were highly vigorous, where as Kurukkan, Nekkare, Chandrakaran, Olour, Peach and Kensington varieties as vigorous and the Kitchner, Starch, Prior and Vellaikolumban varieties could be placed under less vigorous group.

M.Sc.

Title : Studies on pre and post pruning growth regulator treatments on yield and quality of seedless grapes (*Vitis vinifera* L. cv. Sonaka) (2003)

B.Manjunatha, UAS, Bangalore, Guide : Dr.G.S.Prakash

Good quality grapes invariably fetches premium price in the market. Apart from good variety, agro-climatic conditions, cultural and canopy management practices greatly influence the fruit quality. Other factors like crop regulation and use of plant regulator play very important role. An attempt was made in the present studies to reduce the pronounced influence of apical dominance in seedless grapes cv. Sonaka by adopting different levels of sub cane system coupled with growth regulator treatments after October pruning. The results revealed the importance of various growth regulators tested. Biozyme (0.25 ml/litre) + GA3 (25 ppm) was found to be most effective in increasing the bunch size, berry weight than Quantum and BR. It increased the berry diameter up to 17 mm. Among the various sub canes tested, developing sub canes by pinching at five bud levels was found to be more effective than pinching at four and six bud level.

M.Sc.

Title : Varietal evaluation, ploidy manipulation and biotechnological studies in papaya (*Carica papaya* L.) (2003)

Sameer Gururaj Joshi, UAS, Bangalore, Guide : Dr.M.R.Dinesh

Investigation on “Varietal evaluation ploidy manipulation and biotechnological studies in papaya” was carried out at Indian Institute of Horticultural Research, Bangalore from June, 2002 to July, 2003. Varietal evaluation was carried out using eighteen *C. papaya* genotypes and two wild species viz., *C. cauliflora* and *C. goudotiana*. In the evaluation process significant differences were observed among the genotypes for the vegetative characters such as plant height, stem girth, number of leaves and plant spread and fruit characters such as fruit weight, fruit volume, fruit length, fruit width, pulp thickness, cavity index, total soluble solids, pulp colour and hundred seed weight. Cluster Analysis and Principal Component Analysis were carried out for the genotypes. Cluster analysis constructed a dendrogram, which grouped genotypes into three clusters. Cluster I comprised of Nigeria, PAU Sel, Coorg Honey Dew, Red Indian, Thailand, Madhubala, Pusa Nanha, Shillong and CO-5. Cluster II comprised of Pink Flesh Sweet, Co2, Dwarf, Pant-2, Waimanalo, Surya and Mauritius. Cluster III comprised of Sunrise Solo, Sunset Solo, *Carica cauliflora* and *Carica goudotiana*. The varieties Sunrise Solo and Sunset Solo got grouped with the wild species, mainly because of the fruit size. Genetic diversity and hybridity testing was also carried out using Randomly Amplified Polymorphic DNA markers. In the present investigation nineteen varieties and two species were selected.

M.Sc.

Title : Comparison of micropropagation efficacy among different grape hybrids with special reference to Shweta Seedless (2004)

Smita.R.Verghese, UAS, Bangalore, Guide : Dr.B.N.S.Murthy

Among the six grape varieties Black Champa, Arka Neelamani, Anab-e-Shahi, Shweta Seedless and Arka Krishna taken up in the study Black Champa variety of grape responded the best to *in vitro* culture while Arka Krishna was the least responsive on MS medium supplemented with various levels of growth regulators; IBA and NAA. IBA supplemented to medium was found to be better for *in vitro* culture establishment compared to the one supplemented with NAA. Rooting, sprouting and growth response obtained varied with the variety. All the six varieties showed better rooting response in MS medium supplemented with IBA compared to those cultured on MS medium supplemented with NAA. Black Champa, Arka Neelamani, Anab-e-Shahi, Shweta Seedless and Thompson Seedless gave higher root number and root length at higher concentrations of IBA tried (3 μ M) compared to the lower concentrations. Arka Krishna showed the lowest root number and root length, which was observed at a lower concentration of IBA. All the varieties except Arka Krishna showed the maximum root weight at higher concentrations of IBA. Black Champa variety showed maximum rooting, sprouting and growth response at higher level of IBA (3 μ M). In general it gave the highest root number, root length, sprout height, root weight, node number and leaf number when compared to the other varieties. This shows that *in vitro* culture can be taken up successfully for Black Champa variety of grapes. It was found that in Thompson Seedless higher IBA levels favoured rooting response, growth response and sprout weight while lower IBA concentration favoured better sprout height. Arka Neelamani resembled its paternal parent Thompson Seedless in rooting requirements (root number, root length and root weight) while shooting was better at a lower concentration of IBA. Anab-e-Shahi showed variable response at different levels of IBA. It gave the highest root number, root length, and sprouts height and root weight at higher concentration of IBA while the sprout weight was observed to be maximum at lower level of IBA. The growth variables leaf number and node number were maximum at higher levels of IBA. It was observed that Shweta Seedless variety resembled its parent Anab-e-Shahi in its rooting response and sprout height; while on the other hand, for higher sprout weight it needed a higher concentration of IBA than Anab-e-Shahi. Further, it was observed that in Shweta Seedless

and its parents (Anab-e-Shahi and Thompson Seedless), the growth response (leaf number, node number) and sprout height were better on full-strength MS media compared to half MS medium. On the other hand the rooting response and sprout height was better on full MS medium. *In vitro* culture of Shweta Seedless single nodal cuttings on a combined 2 μ M BA and 2 μ M IBA supplemented media gave the best shoot and root system without any callusing. Nearly 80 per cent survival was obtained when *in vitro* derived plantlets of representative samples transplanted into polybags using the closed sachet method.

M.Sc.

Title : Studies on drought and heat tolerance at seedling stage in varieties and hybrids of pomegranate (*Punica granatum* L.) (2004)

K.C.Jayesh, UAS, Bangalore, Guide : Dr.S.H.Jalikop

In the recent times pomegranate has become a commercially important fruit crop due to wide consumer preference, and has attracted many growers especially for its wider adaptability, relatively low cultivation cost, good yields, excellent shelf life and export potential of fruits, apart from its in built drought and heat tolerance. To understand genetic variation for drought and heat tolerance a study was undertaken. Hybridization was done from August to February employing 80 genotypes grown in Indian Institute of Horticultural Research. The varieties/hybrids involved in crossing and selfing were Ganesh, Ruby, Ornamental, Daru, Double flower, Amblidana, Kabul yellow, (Ganesh x Ornamental), (Ganesh x Daru). A total of 6 selfing, 25 single cross hybrids and 14 three ways cross hybrids were made. More number of fruit set was observed in selfing followed by in single cross and three way cross hybrids. Crosses involving Ganesh, Ruby and Daru produced more number of fruits, whereas crosses using Kabul yellow produced less number of fruits. Seeds of Yercaud, Kandhari, P-26, Jodhpur red, G-137, Jodhpur collection, Muscut, Dholka, P-23, H4, Jaloore seedless, P5/02 were used to raise seedlings and observations like Seedling height, primary root length, number of secondary roots, specific leaf area, cell membrane stability and chlorophyll content were measured after 105 days of sowing. Analysis of variance revealed significant differences for all the 8 characters studied among the 25 genotypes, which included 15 hybrids and 10 varieties. Phenotypic coefficient of variation values was higher than genotypic coefficient of variation values but difference between phenotypic coefficient of variation and genotypic coefficient of variation was not high. Heritability values in broad sense were high for all characters studied except for primary root length. High genetic advance as percentage of mean was observed for all 8 characters studied. Yercaud was found to have high heat and drought tolerance as measured by CMS (27.5%) and chlorophyll after stress. The 2 popular varieties Ruby and Ganesh showed no significant difference for plant height, number of secondary roots, specific leaf area, chlorophyll before and after stress. Hybrid double flower x Daru was found to be heat tolerant due to its low solute leakage while hybrid (Ganesh x Kabul yellow) x Ganesh showed high drought tolerance among the hybrids studied due to high chlorophyll content. The field studies at Hiriyr

involving 10 multiple cross hybrids and 2 varieties indicated that there was a positive association of chlorophyll and fruit yield. Further, high chlorophyll content was also associated with drought tolerance at seedling stage. Correlation studies revealed that heat tolerance was positively associated with plant height, primary root length and negatively associated with number of secondary roots, root to shoot ratio, specific leaf area and chlorophyll before and after stress. This indicated that, genotypes with higher plant height and primary root length possessed better heat tolerance. Chlorophyll after stress is positively correlated with all the 7 characters indicating decrease in temperature tolerance and leaf thickness will improve the drought tolerant hybrids.

M.Sc.

Title : **Interspecific hybrid progeny evaluation in papaya(*Carica papaya* L.)** (2005)

K.S.Praveen, UAS, Bangalore, Guide : Dr.M.R.Dinesh

Investigation on “Interspecific hybrid progeny evaluation in papaya (*Carica papaya* L)” was carried out at Indian Institute of Horticulture Research, Bangalore from June, 2004 to July, 2005. The main objectives of this investigation were to evaluate and establish *in vitro* culture of selected hybrids and to confirm the hybridity of interspecific hybrids by using ISSR markers. The hybrids that were found to be resistant to PRSV were assorted for *in vitro* propagation as conventional seed propagation may result in loss of fixed character. An effective establishment of explants was noticed when they were treated with fungicide (Bavistin 0.2%) and bactericide (Streptocyclin 0.1 per cent) along with surface sterililant mercuric chloride (0.1%) for 3 minutes. Molecular characterization to confirm the hybridity was done with ISSR marker as ISSR marker is known to overcome the disadvantages encountered in using SSR marker. It also known to give clear and reproducible banding pattern which helps in differentiating the parents and to confirm the hybridity and it is known to be a better market then other dominant markers such as RAPD.

M.Sc.

Title : Intergeneric crossing, intervarietal progeny evaluation and mutagenic studies in papaya (*Carica papaya* L.) (2011)

Bharathi Nirujogi, UAS, Bangalore, Guide : Dr.M.R.Dinesh

The investigation on “Intergeneric crossing, inter-varietal progeny evaluation and mutagenic studies in papaya (*Carica papaya* L.)” was conducted at Division of Fruit crops, Indian Institute of Horticulture Research, Bangalore during 2010-2011. A breeding programme was undertaken using *Carica papaya* var. Arka Surya and *Vasconcellea cauliflora* with a view to raise progenies resistant to Papaya ring spot virus (PRSV). An attempt was made to break the barrier using different chemicals like (sucrose 5% + boric acid 0.5% + calcium chloride 0.1%). Among the different chemicals used, boric acid 0.5% resulted in good fruit set (96.2%). Final fruit retention till harvest (42.8) and seed recovered per fruit (178.6) were maximum in the case of sucrose 5%. Germination was recorded for the seeds treated with boric acid 0.5% (1.2%). Selfed progenies of gynodioecious hybrids Arka Surya and Arka Prabhath were evaluated for morphological and fruit traits. Variability was found within the progenies due to different genetic constitution of female and hermaphrodite plants in the population. However, quality of the fruits did not differ much. To create variability for plant height and other characters in the varieties Arka Surya and Arka Prabhath chemical mutagen, EMS was used along with KNO_3 to increase the mutagen. LD 50 was observed at 0.3 per cent EMS. Early germination and maximum germination per cent were observed in control. EMS at 0.2 per cent along with KNO_3 can bring about dwarf statured plants. In the M_0 generation, many morphological abnormalities were observed which shows the possibility of excellent variability in advanced generations.

M.Sc.

Title : Study of intergeneric, mutagenic progenies and validation of intergeneric hybridity using markers in papaya (*Carica papaya* L.) (2012)

G.L.Veena, UAS, Bangalore, Guide : Dr.M.R.Dinesh

Papaya is one of the most important fruit crops valued for its rich nutrient content mainly vitamin A and C. Papaya Ringspot Virus (PRSV) is the major impediment in the commercial cultivation. The present investigation on “Study of intergeneric, mutagenic progenies and validation of intergeneric hybridity using markers in papaya (*Carica papaya* L.)” was carried out at the Division of Fruit crops, Indian Institute of Horticulture Research, Hesaraghatta, Bengaluru during 2011-2012. The experiment on mutation was carried out using Ethyl Methane Sulphonate (EMS), along with KNO_3 to increase the efficacy of the mutagen. EMS was used to induce variability in the variety Arka Prabhath with the objective of inducing variability for plant height. The LD_{50} was observed to be at 0.3 per cent EMS concentration. The observations were recorded at first harvest in M_0 generation progenies and the selected progenies were raised for M_1 generation. In M_0 generation, many morphological abnormalities were observed, which showed the possibility of large variability in M_1 generation. Population derived by selfing a hermaphrodite tolerant plant for ‘PRSV-p’ from the intergeneric cross of *Carica papaya* var. ‘Arka Surya’ x *Vasconcellea cauliflora* was evaluated for morphological characteristics. Molecular characterization to confirm the hybridity was done with ISSR and SSR markers. The primers UBC-841, UBC-836, UBC- 815 and SSR primer P8K72CCF/R showed clear bands, which confirm the hybridity of intergeneric progenies. In the present investigation regular pairing of homologous chromosomes was observed in *Carica papaya*, *Vasconcellea cauliflora* and their intergeneric hybrids. There was no heteromorphic chromosomal distribution in hybrids. The intergeneric hybrids, which were found to be tolerant to ‘PRSV-p’ were assorted for *in vitro* propagation as conventional seed propagation may result in loss of fixed attributes, effective establishment of explant was noticed when they were treated with fungicide (Bavistin 0.2%) and bactericide (Streptocyclin 0.1%) along with surface sterilant mercuric chloride (0.1%) for 4 min. The explants cultured on MS medium supplemented with BAP (0.5 mg/L), and NAA (0.1 mg/L) and GA3 (1 mg/L) recorded good elongation of shootlets.

M.Sc.

Title : Role of B-genome in evolution of Banana (*Musa spp*) cultivars and spread of Banana Streak Virus (BSV) (2012)

M.Kishor Kumar, UAS, Bangalore, Guide : Dr.A.Rekha

Plantains and bananas originated from intra and inter specific hybridization between two wild species. *M. acuminata* Colla. and *M. balbisiana* Colla., which contributed A and B genomes respectively. B genome is very important as it is associated with resistance to pests, diseases and drought tolerance, determination of the starch type. Although integration of BSV DNA into the host's genome is not required for viral replication, the genome of banana contains numerous endogenous BSV (eBSV) sequences of banana B genome. With this background investigation on "Role of B-genome in evolution of Banana (*Musa spp*) cultivars and spread of Banana Streak Virus (BSV)" was carried out. Results revealed that *Musa* F₁ hybrids displayed a wide segregation in all selected morphological characteristics, floral characters such as male bud shape, bract apex shape, wax on the bract, compound tepal basic color, stigma color, lobe color of compound tepal *etc* showed highest segregation compared to other morphological traits. Sample of 50 accessions of natural hybrids representing various genome combinations were tested with the SSR marker (Ma_gSS8) amplified an allele of 733 bp in the accessions with exclusively AA genome, 652 bp in accessions having only the BB genome and both the alleles in the interspecific hybrids, which revealed the use of this marker in distinguishing the genomes. And using degenerate conserved primer specific for RT/RNase H regions of ORF-III of BSV amplified eBSVs from two parents *i.e.* Calcutta-4 and Beeheekela, 20 from out of 82 F₁ hybrids and in few natural hybrids, Multiple alignments of these sequences with already known sequences of eBSV present in the NCBI data base indicated that natural hybrid (BB), male parent Beeheekela (BB) and F₁ hybrids (AAXBB) sequences showed 91.32-96.4% nucleotide identity, indicating the BSV genome is passed on from male parent to the hybrids, whereas female parent (Calcutta-4) eBSV has nucleotide homology of only 63% which indicates this eBSV of AA genome has not passed on to the hybrids, however this has 90.3% homology with natural hybrid of ABB group indicating the fact that in nature it might be transferred or integrated in to the BB genome.

DIVISION OF VEGETABLE CROPS.

Ph.D

Title : Studies on gene-action, combining ability and heterosis of some economically important characters in tomato (*Lycopersicon esculantum*) with particular reference to processing (1982)

Tikoo, UAS, Bangalore, Guide : Dr.A.B.Pal

The possibility of breeding tomato genotypes with high soluble solids-an important trait for both fresh market and processing varieties-large fruit weight, heterosis, gene-action and combining ability of some physiological, biochemical and morphological components of yield and/or quality with particular reference to processing were studied. Although total soluble solids (TSS) and fruit weight were negatively correlated, simultaneous selection for both traits from F₂ onwards in the crosses involving 249-2 (TSS 8.5%) and low solid parents (TSS 4%) helped in breaking the correlation. By F₆ many genotypes with high solids of above 6% and fruit weight of above 60 g were obtained. Relatively lower coefficient of variation for TSS and fruit weight from F₂ onwards than yield and fruit number suggest these traits to be governed by fewer genes than reported earlier. The dialled analysis revealed additive and dominant genetic effects to be mainly governing most of the traits except fruit number and lycopene content. High general combining ability effects had a close correspondence with high mean expression for most of the traits. Five F₁ hybrids with semi-determinate habit were heterobeltiotic for yield per plant, highest heterosis being of the order of 47% in the cross P₁ x P₂. Crosses with the high solids parents 249-2(P₈) were observed to be superior for nutritional quality. Heterosis was observed for ascorbic acid content, indicating dominant gene action for this trait. Specific leaf area (SLA) and specific leaf dry weight (SLDW) were positively correlated with each other as also fruit weight. Small leaf area was observed to be dominant over large leaf area. Genetic divergence between parents and heterosis were not associated. Specific combining ability was a more important factor in obtaining heterosis.

Ph.D

Title : Studies on improvement of chillies for resistance to *Anthraco*se and *Cercospora* leaf spot diseases (1982)

Devinder Singh Cheema, UAS, Bangalore, Guide : Dr.D.P.Singh

Studies to locate sources of resistance to *Anthraco*se and *Cercospora* leaf spot diseases the inheritance of their resistance and to confirm the role of phenols in imparting resistance to these disease were carried out. Based on three years screening of 111 genotypes against *Anthraco*se disease and 123 genotypes against *Cercospora* leaf spot diseases, sources of resistance were located in 35 and 45 lines respectively. Inheritance of anthracnose resistance studied using five crosses involving three resistance and two susceptible parents. Five crosses involving two resistance and two susceptible parents were used for study of inheritance of resistance to *Cercospora* leaf spot. Two separate trials were laid out in *khari*f 1981 the six generations namely, P₁, P₂, F₁, F₂, B₁ and B₂ of the five crosses in each disease were planted in randomized block design with two replications each. The individual plants were visually scored for disease severity. Based on the number of spots per leaf, grading scales of 0-5 and 0-2 were used in anthracnose and *Cercospora* leaf spot diseases. The data in respect of *Cercospora* leaf spot indicated that inheritance of resistance governed by three complimentary genes. The quantitative analysis indicated that both the types of gene actions, i.e., additive (d) and dominance (h) were important. For resistance to *Anthraco*se, it is advocated to go for bi-parental crosses to exploit both types of gene actions involved. For *Cercospora* leaf spot resistance, it is advocated to resort to repeated backcrossing using the resistant parents. For simultaneous incorporation of resistance to both diseases, it is advocated to adopt recurrent selection. The role of total phenols could not be related with the resistance to both the diseases.

Ph.D

Title : Studies on important of qualitative and quantitative characters in muskmelon (*Cucumis melo* L.) (1984)

K.R.M.Swamy, UAS, Bangalore, Guide : Dr.O.P.Dutta

Investigation were undertaken to study genetic variability, correlations, gene action, combining ability and heterosis for important economic characters in muskmelon (*Cucumis melo* L.). For this purpose 45 muskmelon genotypes were evaluated in addition to a 10x10 diallel cross analysis. Among the 20 characters studied, yield per plant showed maximum variability followed by average weight per fruit, main stem length, internodal length and ascorbic acid content. High estimates of genotype coefficients of variation were observed for fruit netting, sutures and shape index. The association of yield per plant was positive with number fruits, average weight per fruit, number of nodes on main stem, main stem length, internodal length, number of primary branches and fruit shape index. But the yield was negatively correlated with TSS, ascorbic acid and dry matter which in turn were found to be positively associated among them. Narrow-sense heritability was also low to moderate for these characters. Therefore, reciprocal recurrent selection and biparental mating could be successfully used. Parents 'Arka Rajhans', 'Hara Madhu' and 'Arka Jeet' were good general combiners for most of the characters. The cross 'Arka Jeet x UFG 515' exhibited the highest percent (111.4) of heterosis over better parent. For quality characters, the range of heterosis was low. The cross, 'Main stream x Arka Rajhans' exhibited significant heterosis over mid-parental value (39.6%) and non-significant heterosis over better parent (25.2%). Both the parents of this cross carry genes for resistance to powdery mildew and in addition 'Main stream' carries genes for field tolerance to downy mildew. Hence, there is scope for further evaluation to select desirable segregants. The dominance of orange fruit colour over yellow, white flesh over orange and green, green flesh over orange and white seed coat over yellow was observed.

Ph.D

Title : **Studies on the nature and mechanisms of resistance to rust diseases in peas**
(1985)

Abu Saleha, UAS, Bangalore, Guide : Dr.A.B.Pal

The nature of rust resistance and its interrelationship with other economic characters were studied. Parental F_1 and F_2 and two back cross generations of thirteen crosses were used for the study. Chi-square method for testing the segregation ratio, generations mean method to study gene action, contingency Chi-square for association of characters were adopted. Phenols and sugars were estimated to ascertain the biochemical basis of resistance. Resistance to rust was found to be governed by a single pair of dominant genes. Plant height, pods per plant, pod weight, 100 seed weight were the important economic characters which had positive association with resistance. No linkage was found between resistance and qualitative characters like flower colour, stipule base colour, seed colour and seed shape. Dominant gene action and epistasis was observed majority of characters. However, addictiveness was also found for flowering, 100 seed weight, pod length and pods per plant. High phenols and low sugar content appeared to be responsible for resistance.

Ph.D

Title : Response of watermelon (*Citrullus lanatus thumb. Musf.*) to drip and furrow irrigation under different nitrogen and plant population levels. (1987)

K.Srinivas, UAS, Bangalore, Guide : Dr.M.Hegde

Two field experiments were conducted to study the effect of nitrogen, spacing and method of irrigation on watermelon in terms of growth, yield and water use. Growth parameters increased with increase in nitrogen levels up to 180 kg/ha. Fruit yield increased with nitrogen levels up to 120 kg N/ha (370 q/ha in 1984 and 345 q/ha in 1985) as compared to 60 kg N/ha (349 q/ha in 1984 and 308 q/ha in 1985). Reducing the row spacing from 300 cm to 200 cm increased the fruit yield from 336 q/ha to 389 q/ha in 1984 and from 303 q/ha to 336 q/ha in 1985. Fruit yield was higher under drip irrigation (418 q/ha in 1984 and 379 q/ha in 1985) as compared to furrow irrigation (307 q/ha in 1984 and 287 q/ha in 1985). Fruit yield was highest with irrigation at 1.00 IW/CPE ratio (338 q/ha in 1984 and 310 q/ha in 1985) and the lowest with irrigation at 0.25 IW/CPE ratio (327 q/ha in 1984 and 252 q/ha in 1985). Drip irrigation with one emitter per two plants recorded higher yields (367 q/ha in 1984 and 314 q/ha in 1985) than irrigation at 5.0 cm depth (269 q/ha in 1984 and 227 q/ha in 1985) in furrows. Nitrogen level of 120 to 140 kg/ha was found to be optimum for obtaining high yields in watermelon. A plant population of 16,666 plants/ha (200 cm x 60 cm) was found to be ideal for yield maximization. Drip irrigation with daily application of water at the rate of 25% pan evaporation is suitable for realizing higher yields. Furrow irrigation at 0.50 or 0.75 IW/CPE ratio with 2.5 cm depth of water can be adopted for watermelon for higher yields. Thus, nearly 50% saving in water was possible under drip irrigation, as compared to furrow irrigation.

Ph.D

Title : Studies on genetic resistance to bacterial wilt (*Pseudomonas solanacearum* e.f. Smith) and root-knot nematode (*Meloidogyne incognita* Kofold and White, 1919; Chitwood, 1949) in tomato (*Lycopersicon esculentum* Mill.) (1987)

S.Nirmala Devi, UAS, Bangalore, Guide : Dr.S.K.Tikoo

Present study was undertaken to study the inheritance of combined resistance to bacterial wilt and root-knot nematode in tomato, to study the interaction of these soil borne pathogens on the resistant genes present in the host genotype and to identify a broad spectrum resistant source of wilt amongst known lines/varieties. The results showed that F₁s of parents having dominant sources of resistance to wilt and root-knot nematode were resistant to both the diseases in the field. The combined resistance to both the diseases was inherited digenically in 'BWR-1' crosses. The interaction between the pathogens had modified the genetic ratio in the crosses. The sequential inoculation (N+B and B+N) of both pathogens, in the pots, showed that the digenic ratio was modified to 9:3:4 irrespective of the sequence. The interaction between the pathogens was more severe in 'BWR-1' hybrids as a result of simultaneous inoculation. On the other hand, 'CRA-66-Sel-A' hybrids could withstand the interaction because at the seeding stage partial dominance to wilt was operational in them. The significant correlation between ooze index and gall index proved that the nematodes predisposed the plants to bacterial wilt. The lines selected for resistance to bacterial wilt in Hessaraghatta showed differential response to isolates of *P. solanacearum* from Maharashtra, Kerala and Chethalli. The best F₁ hybrids for fresh market were 'BWR-1' x 'Rossol', '83 BWR 12-2' x 'IHR-998', '83 BWR-120' x 'Patriot' and 'MITA-668' x '83 BWR-120'.

Ph.D

Title : Genetics of resistance to yellow vein mosaic virus, yield and yield components in okra (*Abelmoschus esculentus* L. Moench) (1988)

A.T.Sadashiva, UAS, Bangalore, Guide : Dr.O.P.Dutta

Screening of thirteen inbred lines of okra under field as well as under artificial controlled conditions indicated that all the inbred lines of okra were completely resistant to YVMV but the resistance was of symptomless carrier type. Segregation pattern for disease reaction in F₂ generation of two crosses revealed seven (resistant): four (intermediate) and five susceptible. This segregation pattern can be explained assuming existence of two genes *viz.*, YV₁ and YV₂ at two separate loci determining resistance. While their recessive alleles determine the susceptibility, this model entails that the resistance was imparted only when at least one of the genes was in homozygous dominant condition i.e., either YV₁YV₁-or-YV₂ YV₂ genotype. While the intermediate expression was seen when both genes are in heterozygous condition (YV₁, YV₁-YV₂ YV₂). Combining ability studies indicated that both GCA and SCA effects were important for all the characters. However GCA variances were higher than SCA variances suggesting predominance of additive genetic variances for all characters.

Ph.D

Title : Studies on the genetics of yield and quality characters in bulb and seed crop of onion (*Allium cepa* L.) (1988)

R.Veere Gowda, UAS, Bangalore, Guide : Dr.C.S.Pathak

The main objectives of the investigation were to study extent of heterosis, combining ability and nature of gene action in respect of twenty five characters in bulb crop and nine characters in seed crop of onion using the diallel technique. The variance due to treatments were significant at one percent level for all the traits in both bulb and seed crop. Variance due to parents were highly significant in respect of height of the plant, earliness, split bulbs, dry weight of leaves, fresh and dry weight of the bulb, ten bulb weight, marketable and total bulb yield, double centres, rings per bulb, TSS, storage rot, sprouts and storage loss in weight for the bulb crop. In seed crop, variance were highly significant for days to flower initiation, height of umbel stalk, diameter of umbel, seed yield per plant and seed yield per hectare, however, percent dry matter content was significant at five percent level only. The variance due to hybrids was highly significant for height of the plant, earliness, split bulbs, dry weight of leaves, fresh and dry weight of the bulbs, ten bulb-weight, marketable and total bulb yield, double centres, firmness of the bulb, storage rot, sprouts and loss in the bulb crop where as in seed crop there were significant difference for days to flower initiation, height of umbel stalk, diameter of umbel, seed yield per plant and seed yield per hectare. The extent of heterosis estimated over mid, better and best parents revealed superiority of some outstanding F_1 s over best parent; for the number of leaves per plant, three hybrids i.e., 2x5, 2x7 and 3x7 were best. For the equatorial diameter of the bulb, the crosses 1x4, 5x 9,6x7, 6x8 and 9x10 were significantly superior over the best parent; for the polar diameter of the bulb, crosses 2x5 2x7, 2x10, 3x10, 4x9, 4x10, 8x10, 8x11 and 9x10 were significant over the best parent. The crosses 1x8, 1x9, 2x9 and 10x11 showed significant heterotic effects over the best parent for dry weight of leaves, the crosses that expressed superiority over best parent for fresh weight of bulb were 4x9 and 4x11. In seed crop the outstanding F_1 s over best parent were seen in the cross 2x10, for diameter of umbel stalk; 5x6 and 5x11 for diameter of umbel, the crosses 2x8, 3x10, 5x9, 6x7, 8x11, 9x10 and 2x10 followed by several other crosses for seed yield per umbel; 2x8 and 2x9 for seed yield per plant: 2x8, 2x9, 9x11, 2x10 and 4x7 for yield per hectare and none of the crosses were significantly superior for rest of the characters. The variances due to GCA were greater than SCA for all characters

in bulb in seed crop; except for the character seed yield per umbel where in SCA variance was greater. A comparison of gca effects revealed that none of the parents were good in respect of all the characters. However, parent 1 (IHR 52-80) was found to have best performance as it has significant gca effects for 12 characters followed by parent 6 (IHR-68) for 10 characters, parent 2 (IHR-60-94), 4 (IHR-400), 5(IHR 121-26), 7(IHR 399), and 8 (IHR-6). Best parental combination i.e., parent 2 (IHR-60-94) and 8 (IHR-6) were found to be top combiners for most of the characters (14) followed by the combination, parent 1(IHR 52-80) and parent 11(IHR56-198) for 11 traits each. All these parents have additive genetic variance for these traits which could be utilized for improving these characters through selection. For the exploitation of heterosis; the specific combining ability is important.

On the whole in most of the characters studies, all the three types of generation were observed. Under such situation, improvement in such characters may be expected through standard selection procedures which may first exploit additive genetic variance simultaneously the dominance variance should be concentrated. For this, reciprocal recurrent selection breeding procedures seem to be the best method to meet the requirements as it will utilize simultaneously all the 3 kinds of gene effects.

Ph.D

Title : Exploitation of residual heterosis in F_2 for better performance and fruit rot (*Colletotrichum capsici*(syd.) Butler and Bisby) resistance in chillies (*Capsicum annum* L.) (1991)

H.B.Patil, UAS, Bangalore, Guide : Dr.N.Anand

Selection of parents to produce heterotic F_1 s and choice of F_1 s for advancing to obtain heterotic F_2 s besides adaptability of a parent, F_1 s and F_2 s populations for fruit yield and fruit rot resistance. While studying F_2 population from a 8x8 diallel, it was observed that the parents IHR 328-9 and IHR 309-3-18 possessed high general combining ability in most environments. F_2 s of 384 x 328-9, 309-3-18 x 472-12-6-4 exhibited high degree of heterotics. In unfavorable environments additive gene effects and in favorable environments non-additive gene effects were important for yield and its components. The overall means of F_1 s and F_2 s excelled the parental mean in all four environments tested, while means of F_1 s and F_2 s were identical in unfavorable environment. Maximum heterotic in F_2 was exhibited by 328-9 x 473-11-3-1 in unfavorable and by 328-9 309-3-18 in favorable environments. Heterotics in F_2 s was attributed to near complete additivity and accumulation of transgressive segregants. Co-efficient of variation for fruit traits was less than 20%. In the other set of diallels with 5 fruit rot resistant parents and two susceptible, it was found that F_1 s and F_2 s of all resistant x resistant were resistant indicating the alleles confirming resistance to be at the same loci. Resistance was shown to be governed by a single recessive gene with modifiers, in all such parents. The F_2 hybrids have the advantage of yield and adaptability besides resistance to fruit rot, and the cost of their seed production was comparable with open pollinated varieties.

Ph.D

Title : Genetics of resistance to bacterial soft rot (*Erwinia carotovora* John), root-knot nematode (*Meloidogyne incognita*), yield and yield contributing characters in carrot (*Daucus carota* L.). (1997)

T.V.Narayana Murthy, UAS, Bangalore, Guide : Dr.O.P.Dutta

Bacterial soft rot and root-knot nematodes cause great loss in yield and quality of the carrot root. The development of varieties resistant to bacterial soft rot and root-knot nematode is one of the ways to overcome these diseases. The present investigation was carried out i) to locate the source of resistance to bacterial soft rot and root-knot nematode ii) to locate the source of combined resistance to bacterial soft rot and root-knot nematodes and iii) to study the genetics of resistance to bacterial soft rot and root-knot nematode and yield contributing characters. Ten genotypes including 5 resistant and 5 susceptible lines each for soft rot and root-knot nematodes were selected by screening under natural epiphytotic and pot conditions. These lines were crossed in a diallel manner (excluding reciprocals). The data were collected for nine quantitative traits each for soft rot and root-knot nematodes. Ten lines exhibited resistance to soft rot *viz.*, IHR 174-2, IHR-89, IHR 37-B-III, A+-PHG, IHR 64-89-HC-1, IHR 308 X PP-A, HYDC-4, IHR 309 and IHR 190 and ten genotypes for root-knot nematodes *viz.*, HYDC-4, PKR, IHR 310, IHR 174-1, IHR 308, IHR 181, Danvers Half Long, Nantes, PYD-III AND Avenger and also combined resistance in two genotypes HYDC-4 and IHR 308. The heterosis over mid parental value indicated non-additive gene action for all the characters. Combining ability analysis revealed higher *gca* to *sca* variance for all the characters except for percent disease index suggesting predominance of additive genetic variance for these characters. Dominant gene action was more involved than additive gene action for all the characters except PDI and PGI for which additive gene action was found to be operating. The hybrids IHR174-2 x Desi Red, IHR 37-B-III x Sersa local, PPA x Sersa local, PP-A x IHR 21, IHR 64 x LL-2 and the crosses IHR 174-1 x IHR 301, IHR 301 x IHR 174-2, IHR 301 x IHR 300 and IHR301 x IHR 181-2 could be used in recurrent selection for *sca* and heterosis over mid parent to bring about desirable improvement in terms of high root weight, and resistance to bacterial soft rot and root-knot nematode, respectively.

Ph.D

Title : **Genetical studies on leaf curl virus resistance in tomato (*Lycopersicon esculentum* Mill.).** (1998)

M.Jagadish, UAS, Bangalore, Guide : Dr.A.A.Deshpande

An investigation was carried out in tomato to study the genetics of TLCV resistance and yield attributes, establish strainal differences in TLCV if any identify/confirm tomato leaf curl virus resistance through graft transmission. The salient findings of the present investigation are given below: TLCV resistance is governed by two complementary genes in the resistance parent RP₁ (4-1/3) and it is controlled by recessive gene in the parent RP₂ (55-3/7). The artificial whitefly inoculation is advantageous once field screening as it advances the expression of TLCV symptoms by weeks. Major contribution of dominance x dominance epistasis was observed for the inheritance of number of fruits, average fruit weight and fruit yield per plant in all the three crosses studied (SP₁ x RP₁, SP₁ x RP₂, SP₂ x RP₂). High magnitude of phenotypic coefficient of variation coupled with high genetic advance as percent of mean and low heritability (narrow sense) was observed for all the characters studied viz., number of fruits, average fruit weight and fruit yield per plant in all three crosses. Maximum frequency of transgressive segregants with TLCV resistance and fruit size (70 g and above) were observed in the crosses SP₁ x RP₁ compared to the other crosses viz., SP₁ x RP₂ and SP₂ x RP₂. Four different types of leaf curl symptoms could be differentiated based on symptom expression on a common genotype Arka Saurabh. They are termed as TLCV group A, TLCV group B, TLCV group C and TLCV group D. these were considered to be due to distinct TLCV strains. Five accession of *L. Peruvianum* (EC 251615, LA 1954, LA 2151, LA 2959 and PA 128659), two accessions of *L. Chelense* (LA 2729 and LA 1969) and three interspecific derivatives (4-1/3), RP₂ (55-3/7) and 73-1/3) were found to be persistently resistant to TLCV.

Ph.D

Title : Identification of molecular marker linked to purple blotch disease resistance in onion (*Allium cepa* L.) (2003)

C.T.Ganesh, UAS, Bangalore, Guide : Dr.R.Veere Gowda

Investigations entitled “Identification of molecular marker linked to purple blotch disease resistance in onion (*Allium cepa* L)” was conducted at the Division of vegetable crops, Indian Institute of Horticultural Research, Hessaraghatta, Bangalore and at the Plant Molecular Biology Laboratory, Division of Horticulture, University of Agricultural Sciences, Bangalore. The salient achievement of the investigation is summarized. RAPD markers were used in onion due to the advantages over other kinds of markers to study its association with resistance. Identification of molecular linked to disease resistance included selection of resistance and susceptible parents, primer screening to identify the polymorphism between the parents and analysis of the mapping population segregating for resistance to associate DNA marker linked to resistance. Screening of onion germplasm for purple blotch disease resistance under natural and artificial epiphytotic conditions resulted in identification of one resistant genotype PBR 287(PDI 4.85) and other two moderately resistant genotypes viz., Arka Kalyan 704 (12.12) and MS-65-268(14.91). These three resistant genotypes were utilized as source of resistance to purple blotch disease. Studies on growth, yield and quality parameters on these identified resistant genotypes revealed the similarities in plant growth and bulb qualities and they were also found superior over other genotypes. The three purple blotch resistant genotypes viz., PBR 287, Arka Kalyan 704 and MS 65-268 were fingerprinted using 20 selected arbitrary primers, which could effectively distinguish the resistant and susceptible genotypes. Further, genetic analysis of the four genotypes using RAPD markers revealed high polymorphism among the genotypes confirming the high heterozygous nature of the population due to its highly cross pollinated breeding behavior. Dendrogram analysis of three genotypes revealed the existence of high genetic similarity between MS-65-268 and PBR 287(40% dissimilarity). Further dendrogram also clustered Arka Kalyan 704 and Arka Niketan 709(65% dissimilarity) together but with comparatively lesser genetic similarity.

Results revealed that the inheritance of resistance in PBR 287 was governed by single dominant gene and segregated according to classical Mendalian ratio 3:1 in F₂ population derived out of cross between PBR 287(resistant) and Arka Niketan 709

(highly susceptible). A RAPD marker OPC12 900 was found closely linked to purple blotch disease resistance as indicated by bulked segregant analysis and analysis of F₂ individuals. This marker could be effectively employed for MAS of large population for purple blotch disease resistance even in the absence of the pathogen and at the early stage of the life cycle of onion crop.

Ph.D

Title : **Genetics of yield and yield components in muskmelon (*Cucumis melo* L.)**
(2005)

J.S.Aravinda Kumar, UAS, Bangalore, Guide : Dr.M.Prabhakar

An investigation was carried out to find out the combining ability, heterosis, heritability and genetic advance and gene effects of fifteen quantitative traits in muskmelon during 2003-2004. The study involved the evaluation of 49 hybrids along with their 14 parents to assess combining ability and estimation of heterosis over mid parent, better parent and commercial check. The combining ability studies indicated that the parents Punjab Sunheri, IIHR-615-5-2 and IIHR-616-2-3 could be utilized in breeding programme since they expressed highly significant and positive GCA effects for total fruit yield per vine. Evaluation of F₁s hybrids indicated that the Kajri x IIHR-615-5-2, Pusa Madhuras x Durgapura Madhu, RM-43 x Durgapura Madhu and Kajri x Durgapura Madhu were found promising and these could be exploited for commercial purpose. Studies on heritability and genetic advance indicated the presence of non additive gene action for days to first male and female flower opening, days to first fruit harvest, vine length, number of branches per vine, TSS and total yield per vine, where heterosis can be exploited. Whereas other traits were under the control of additive gene action. Where simple selection can be done. To understand the nature and magnitude of gene effects six crosses were analyzed through generation mean analysis for 15 characters. The study indicated that traits such as days to first male and female flower opening, node at first female flower appeared, vine length, number of branches per vine, fruit length, TSS, number of fruits per vine and fruit yield were under the control of non additive gene effects. In order to exploit non additive gene effects development of hybrid is suggested involving the parents having high fruit quality traits. Among the hybrids Kajri x IIHR-615-5-2 showed high *per se* performance with high heterotic effect which can be exploited for commercial purpose.

Ph.D

Title : Development of molecular markers linked to moisture stress tolerance in onion (*Allium cepa* L.) (2006)

M.Sangeetha Kutty, UAS, Bangalore, Guide : Dr.R.Veere Gowda

Onion is an important vegetable crop in India, having great demand in the domestic and international market. However, onion productivity in tropical countries is strikingly low. Onion is predominantly grown as a rain fed crop hence exposed to moisture stress during different stages of crop growth, resulting in heavy yield losses. At present there is no onion varieties suited for cultivation under rain fed condition. Hence there is need for development of varieties suitable for rain fed conditions. There are several physiological, morphological, biochemical and molecular mechanisms which jointly influence the moisture stress tolerance mechanism operative in a particular crop species. Exploiting the existing genetic variability for WUE is the preliminary step towards breeding for moisture stress tolerance. Screening of large germplasm collections for moisture stress tolerance employing conventional techniques would be cumbersome and time consuming. Therefore, a more accurate and easy alternative is marker assisted selection. A wide array of molecular markers have been discovered which could be employed for developing markers associated with moisture stress tolerance. Twenty four onion genotypes were screened during *kharif* and *rabi* seasons under field and pot conditions to identify the moisture stress tolerant and susceptible genotypes. The phenotypically extreme genotypes were used as parents for developing molecular markers associated with moisture stress tolerance. The cDNA from onion leaves were used to isolate some of the major genes and regulatory elements associated with drought tolerance. Significant genetic variability was observed among the genotypes for indicators of plant water status (relative water content, osmotic potential and water potential). All these parameters reduced significantly under stress. The genotypes AFLR, AK-649, S.Local, PBR-140 and hybrid H-1 maintained higher plant water status even under moisture stress. Although all the genotypes showed an increase in WUE (instantaneous, intrinsic) under stress, the highest WUE was recorded in AK-649 and the lowest in Sel-11. ABA plays a major role in moisture stress tolerance through stomatal regulation. A three fold increase in leaf ABA was observed as a result of stress. The genotype AK-649 and hybrid H-1 showed highest increase in leaf ABA in response to moisture stress. ABA accumulation has been depicted as an important trait of adaptation to drought, thus the genotype accumulating more ABA is expected to perform

better under water deficit. A strong negative correlation between ABA and genotypes was suggestive of the role of ABA in regulation of stomata. The genotypes Sel-11 and AN-650 showed lowest leaf ABA under stress indicating their susceptibility to moisture stress.

Significant differences were observed for CID among the onion genotypes. In all the genotypes the CID was reduced under stress. The genotype AK-649 had lowest CID coupled with highest WUE while AN-650 had the highest CID with lowest WUE. The strong inverse relationship between CID and WUE suggested that CID could be used as a potential tool to identify the genotypes with higher WUE. One hundred and thirty seven RAPD markers generated by 15 primers were used for estimating the genetic diversity among 24 onion genotypes. Dendrogram based on Squared Euclidian distance grouped the onion genotypes into two major clusters (northern and southern India). The maximum distance was between genotypes PBR-139 and AK-649 and the minimum between AFLR and PBR-140. The Squared Euclidian distance values indicated high genetic diversity among the genotypes. PCA also differentiated genotypes of northern region from those of southern region. The tolerant lines were placed close to each other forming a subgroup, while the susceptible lines were placed together in the adjacent subgroup, indicating that the tolerant and susceptible lines were not very distant genetically. However, these were selected for BSA as the approach depends on divergence between parents in the target region and not at the whole genome level. F₂ population of the cross AN-650 x AK-649 was phenotyped based on morphological and physiological parameters and phenotypically extreme plants were identified. BSA was carried out using DNA from ten tolerant and ten susceptible F₂ plants. Three hundred RAPD and 22 SSR primers were used to screen the tolerant and susceptible bulks along with parents. Amplification with RAPD primers resulted in four markers 750bp (OPV-4), 1300bp (OPV-4), 900bp (OPAN-18) and 1200bp (OPAO-15) associated with moisture stress tolerance. Fifty one primer pairs specific to selected genes were designed and used to amplify complementary sequences from onion leaf cDNA. The amplified fragments were sequenced and characterized using BLAST programme of the NCBI. Significant homology was obtained for HSP, DREB, Aquaporin, Calcium Sensor homologue, Catalase, CDPK, Ubiquitin, Hexose transporter and SAPK. These genes have a crucial role to play in moisture stress tolerance.

Ph.D

Title : Studies on genetics of resistance to purple blotch disease, yield, yield components and quality traits in onion (*Allium cepa* L.) (2007)

Shashikanthevoor, UAS, Bangalore, Guide : Dr.R.Veere Gowda

The studies on genetics of resistance to purple blotch, yield, yield components and quality traits in onion was taken up during 2002-2004 at the Division of Vegetable Crops, Indian Institute of Horticultural Research, Hessaraghatta, Bangalore. The material for the heterosis study comprised of five lines (resistant to purple blotch) and six testers (susceptible to purple blotch) which were crossed to get 30 hybrids. The crosses PBR 139 x AN 184 and PBR 140 x AN 187 were found promising over standard check for higher total bulb yield along with purple blotch resistance. Inheritance of resistance to purple blotch disease in four crosses PBR 138 X AN 187, PBR 139 X AN 184, PBR 139 X AP 195 and PBR 140 X AN 184 indicated the presence of both additive and non-additive gene effects. However, dominance and dominance x dominance gene actions were more predominant than other gene actions with duplicate type of epistasis. So it is suggested to go for heterosis breeding to exploit dominant gene action. Joint scaling test suggested the presence epistasis in all the yield and quality traits except days to maturity (dominance), neck thickness (additive), unmarketable bulb yield (additive), and per cent loss due to sprouting (additive). Hence, it is suggested to follow simple selection for the characters neck thickness, unmarketable bulb yield, and per cent loss due to sprouting and heterosis breeding for the character days to maturity. The other characters which were governed by all the gene effects and their interactions, it is suggested to follow reciprocal recurrent selection to improve those traits.

The heritability and genetic advance as per cent over mean ranged from -10.0 (total soluble solids) to 130.55 (per cent dry matter and bulb) and 0.49 (ten bulb weight) to 432.64 (neck thickness of bulb), respectively. Most of the traits under study showed high heritability and genetic advance. So, improvement of these traits would be easy in reciprocal recurrent selection method.

M.Sc.

Title : Correlation and path coefficient analysis in capsicum (*Capsicum annum* L. var. *Grassum Saddt.*) (1981)

D.N.Narasimha Raju, UAS, Bangalore, Guide : Dr.D.P.Singh

Seventeen pure lines of capsicum were laid out in two randomized block design with three replications each under two spacing's of 50 cm x 40 cm and 50 cm x 30 cm, with a view to obtain information on variability, heritability, correlation among different traits and their contribution to trait yield. Moderate coefficients of variability (genotypic and phenotypic) were obtaining for early fruit number, plant height, number of secondary branches and number of seeds under both the spacing's. The traits such as early fruit yield, total fruit yield and total fruit number under closer spacing and fruit breadth under normal spacing exhibited moderate coefficients of variability. The path analysis revealed that early fruit yield had the highest direct effect on total fruit yield. Fruit number (early and total) had positive direct and indirect effects on total fruit yield. The direct effect of days to flowering was low but indirect effects through early fruit yield and total fruit number were moderate and negative. Indirect effect of plain height and plant spread through early fruit yield and total fruit number were also moderate and positive. The study indicated that the ideotype of capsicum should be early flowering and should have more height, spread and number of fruits per plant.

M.Sc.

Title : Varietal differences in chillies for pungency, pigmentation and ascorbic acid contents (1981)

P.Usha Rani, UAS, Bangalore, Guide : Dr.D.P.Singh

Significant differences were observed among 73 chilli genotypes for twenty traits except stem height. The maximum phenotypic and genotypic coefficients of variability were found for capsaicin content. The differences between PCV and GCV were narrow for ascorbic acid content, fruit length, plant height, pedicel length, stem diameter, plant spread, fruit diameter and 1000-seed weight indicating very little environmental influence. Heritability estimates were high for fruit length, ascorbic acid content and plant height. The maximum genetic advance was estimated for capsaicin content. Combination of high heritability and high genetic advance was obtained for fruit length and ascorbic acid indicating additive gene effects. Dry fruit yield was positively correlated with number of fruits, stem diameter, plant spread, plant height, number of primary and secondary branches, root dry weight, root volume and 50-fruit seed weight; capsaicin content had negative correlations with 50-fruit dry weight and fruit length. Capsanthin content had positive correlations with stem height, ascorbic acid and 50-fruit stalk weight. Ascorbic acid was correlated positively with capsanthin content, fruit length, pedicel length, 50-fruit stalk weight, 1000-seed weight and negatively with number of fruits and fruit length to such an extent that the fruit yield and pungency on one hand and the quality factors like ascorbic acid and pigment contents on the other could be improved simultaneously. Path coefficient analysis revealed that fruit number, stem diameter and 50-fruit seed weight were the major factors influencing dry fruit yield directly and positively while 50-fruit dry weight exhibited a negative direct effect on pungency. Stem height, ascorbic acid and 50-fruit stalk weight had positive direct effects on pigmentation. Ascorbic acid was positively and directly influenced by capsanthin content and 1000-seed weight.

M.Sc.

Title : **Genetical studies in chillies (*Capsicum annum* L.)** (1981)

M.B.Sontake, UAS, Bangalore, Guide : Dr.D.P.Singh

An investigation was undertaken to study heterosis, heterobeltiosis, combining ability and gene action of ten important characters in chillies (*Capsicum annum*) through a 9-parent full diallel analysis. The investigation was carried out at the Division of Vegetable Crops, IIHR, Bangalore. The heterosis percent of F₁ hybrids over all the parents was maximum for yield (24.63) followed by the number of secondary branches (24.42) number of primary branches (19.59) days to flower (13.52) and plant height (10.55). For other five parameters, it ranged between four to nine percent only. The maximum heterobeltiosis was expressed in terms of ascorbic acid in cross P₇xP₉ by 116.04% and minimum of 16.17% for plant height in cross P₇xP₆. For yield, it was 61.40% in cross P₂xP₅. In number of fruits per plant, none of the F₁ hybrids exhibited significant heterobeltiosis. There was not even a single heterobeltiotic F₁ hybrid for fruit diameter, fruit length, and number of fruits and yield which exceeded the top parent. The present investigation revealed the presence of additive dominant and epistatic gene-action in varying proportions. Single plant selection is suggested for fixing and improving characters like number of fruits, where gene action is mainly additive. For characters like fruit diameter and fruit length having major role of additive gene action and very little of non- additive component, initially single plant selection and later recurrent selection may be followed. Over dominance coupled with epistasis and to some extent additive gene action appeared to influence the number of primary and secondary branches, ascorbic acid and total carotenoids. Reciprocal recurrent selection and heterosis breeding can bring about improvement in those characters.

M.Sc.

Title : **Studies on improvement of bottlegourd** (1982)

K.T.Shivanandappa, UAS, Bangalore, Guide : Dr.A.B.Pal

A study was taken up to observe the expression of heterosis in the intervarietal hybrids of bottlegourd and scope of improvement by this method. Two round fruited varieties No.7 (Saharanpur, UP) and Karnataka Local as well as two long fruited varieties long Dhavidar and Jhalarwali together with a collection No.45-1-1- from South Africa were used for hybridization. The F₁ hybrids exhibited vigour in the form of early seed germination (by 4 days) and early fruit maturity (6 to 15 days). The flesh thickness of hybrid fruits was higher by 16-27%. Yield recorded 10-48% over the better parents. Spread of harvesting period was greater in hybrids.

M.Sc.

Title : **Studies on hybrid seed production in brinjal (*Solanum melongena* L.)** (1982)

N.Basavaraju, UAS, Bangalore, Guide : Dr.O.P.Dutta

Anthesis in brinjal line 22-1 commenced at 4.30 a.m and another dehiscence was complete by 7.45 a.m. the stigma was maximum (90%) on the day of anthesis pollination a day prior to anthesis gave 80% fruit set and was best suited for hybrids seed production. Pollen grains of brinjal variety supreme germinated best in 28% sucrose with 0.01% boric acid *in vitro*. Pollen grains can be stored for 3 days at 90% relative humidity without much loss of viability. Pollination operation, using glass-rod and match stick as pollination tools and butter paper bag as covering material were most suitable and gave the highest number of seeds (1304 to 13170) and maximum seed weight (6.67 to 6.9 g) per fruit. There are two flowering flushes of good fruit set in brinjal line 22-1. To get maximum seed number and seed weight, bud pollination during first 30 days is recommended. Brinjal seeds stored for two months period under room temperature gave 72.66 to 81.33% germination. However, two year old seeds gave 40 to 44% germination. Seeds stored for 6 years failed to germinate. For producing one kilogram hybrid seed in brinjal economically it took 17.36 hours to complete the operations like emasculation, pollination and flower covering in 809.0 flowers using glass rod as a pollination tool and cotton capsule as a covering material.

M.Sc.

Title : Inter-relationship between powdery mildew resistance to other economic traits in pea (*Pisum sativum* L.) (1983)

R.Krishna Manohara, UAS, Bangalore, Guide : Dr.A.B.Pal

An investigation was carried out to study the influence of the disease powdery mildew on growth and yield characters in pea (*Pisum sativum* L.). Eight parents with different reactions to the disease as resistant, tolerant and susceptible and six segregating populations (F_2) resulting from the crosses between different categories of the above parents were used. To have a better picture of the effect of the disease to different degrees of infestation the study was conducted under two sets of conditions. The first set of the crop (3 replications) was sprayed with fungicides to control the disease and the second set crop (3 replications) was not sprayed to enable disease infestation. The influence of disease on growth in terms of plant height was observed only during the later stage i.e., after infestation occurred which was further substantiated by negative correlation. The resistant and tolerant lines maintained superiority over susceptible varieties with regard to green pod yield. The general reduction in green pod yield of unsprayed plants as a result of disease infection was to the tune of 57% in the most susceptible variety. The difference in yield between resistance and susceptible was 34% during the fourth picking which was the peak period of production. The effect of the disease on green seed yield was similar to that observed in case of green pod yield, which was also shown by a negative correlation. There was increase in both pod size as well as seed number per pod up to the middle of harvesting period and then a gradual decrease which was also observed by negative correlation. Under both conditions resistant varieties were stable and under unprotected conditions the tolerant varieties suffered to some extent because of the disease with regard to number of pods per plant. In one particular F_2 significant and positive correlation was observed which could be due to a higher frequency of tolerant segregants. The seed number per plant was found to be always superior in case of resistant and tolerant varieties compared to susceptible ones. The growth of stems as measured by thickness (diameter) was found to be unrelated to disease incidence, but the variance seen in this character could be attributed to genetic or varietal characters.

M.Sc.

Title : **Crossability behavior and inter-relationship among nine different species of *Capsicum* (1983)**

Anil Kumar.S.Patil, UAS, Bangalore, Guide : Dr.D.P.Singh

Cytomorphological studies in 9 capsicum species (*C. pendulum*, *C. praetermissum*, *C. chacoensa*, *C. sinense*, *C. microcarpum*, *C. fasciculatum*, *C. baccatum*, *C. frutescens* and *C. annuum*) and their 17 F₁ hybrids were conducted at IIHR, Bangalore. High crossability, high pollen fertility and low meiotic irregularities were observed in the following F₁ hybrids which can be used successfully in a breeding programme for disease resistance.

Sl.No. Successful hybrids

C. praetermissum x *C. baccatum*

C. praetermissum x *C. annuum*

C. microcarpum x *C. pendulum*

C. fasciculatum x *C. praetermissum*

C. fasciculatum x *C. annuum*

C. baccatum x *C. praetermissum*

C. fasciculatum x *C. annuum*

C. annuum x *C. praetermissum*

C. fasciculatum x *C. baccatum*

The above cross combinations indicate their close relationship with each other genetically.

M.Sc.

Title : **Genetic evolution of morphological, physiological and biochemical traits tomato (*Lycopersicon esculentum* Mill.) (1985)**

B.K.Nandeesh, UAS, Bangalore, Guide : Dr.S.K.Tikoo

Seven high yielding cultivars from each growth habit, viz., indeterminate (ID), semi-determinate (SD) and determinate(D), randomly representing releases from USA and India since 1952 to date, were grown along with two accessions of *Lycopersicon cerasiforme*, and one accession of *L.pimpinellifolium*. The cultivated varieties were superior to the related wild species for yield, average fruit weight, locule number, and fruits per plant. All major yield components were observed to be independent of growth habit. Physiological parameters were monitored at 4 stages of crop growth. The differences between the growth habits were distinct 60 days after sowing. Leaf size was observed to be smaller in the wild types. Both leaf dry weight and leaf area (5th leaf) were correlated with fruit size, indicating that increased leaf size may have evolved with large fruits. Stem dry weight was highest in wild genotypes followed by ID, SD and cultivars. Harvest index (HI) was observed to be 65 to 70% in the determinate cultivars. SD had HI of 55% followed by ID with around 50% and wild types with 48%. The recent varieties thus are more efficient in mobilizing available resources towards economic yield. Total biomass was highest in the wild types followed by ID, SD and types. The wild genotypes were superior in TSS., ascorbic acid, acidity and also sugar: acid ratio. A progressive decline in these traits was observed from ID to D cultivars indicating that yield increase may have been at the expense of quality. Lycopene content was observed to be independent of growth habit.

M.Sc.

Title : Studies on breeding tomatoes (*Lycopersicon esculentum* Mill.) for tolerance to moisture stress (1985)

N.Sudarsana Reddy, UAS, Bangalore, Guide : Dr.N.Anand

Studies were carried out using seven F_{10} , $9F_2$ populations and their 14 parents under intermittent moisture stress conditions during *kharif* season. F_1 's as a group were superior to the parents for plant height, number of primary branches, number of flowers per cluster, percentage of fruiting clusters, root length, harvest index besides yield per plant. F_2 as a group exceeded the parental means for yield and harvest index. The F_2 of 554 x 707 exhibited the highest mean yield of 1.218 kg/plant. Eight parents, four F_1 's and six F_2 's exceeded Pusa Ruby for yield indicating the distinct possibility of replacing 'Pusa Ruby' with more efficient genotypes under moisture stress conditions. All the F_2 's and five of the F_1 's besides 10 of the parents exceeded Pusa Ruby for harvest index. Heterosis was observed in 2 F_1 's and 4 F_2 's for yield. Correlations differed between the different F_2 populations, F_1 's and parents. Number of fruiting clusters and number of primary and secondary branches were consistently correlated with yields. Plasticity inherent in the characters, number of branches and number of fruiting clusters, is through to have influenced yields under moisture stress. Semi-determinate growth habit was suggested as ideal for stress conditions. A scheme of recurrent selection was envisaged for further yield improvement under moisture stress, low input conditions.

M.Sc.

Title : Heterosis and combining ability studies in onion (*Allium cepa* L.) using line x tester analysis (1985)

T.S.Aghora, UAS, Bangalore, Guide : Dr.C.S.Pathak

The study on heterosis and combining ability for 16 important characters was carried out using Line x Tester analysis involving 20 inbreds as lines and 3 male sterile lines as testers. Heterosis over the best parent was observed for all the characters except dry weight of leaves. Thirty five hybrids were heterobeltiotic for total bulb yield, highest heterosis being of the order of 89.56% in the cross MS 39 x IHR 78. The crosses with high heterosis for plant height and number of leaves expressed positive heterosis for bulb yield. The studies on combining ability indicated the predominance of additive effects for most of the characters except average dry weight of the bulb. The tester MS1 and MS8 were found to be best general combiners for yield, whereas, among the lines Arka Kalyan, Arka Niketan, IHR-21 and N-53; selections were found to be better combiners. The lines IHR-52, Sel-1, Ihr-123 and SL.95 were the best combiners for three important quality characters, viz., total soluble solids, ascorbic acid and dry matter. Five hybrid combinations were identified for commercial exploitation of heterosis using male sterile lines.

M.Sc.

Title : Comparative study of pea lines with variable resistance to powdery mildew (*Erysiphe polygoni* DC) and rust (*Uromyces fabae* (Pers) de Bary) diseases (1986)

V.Nagaraju, UAS, Bangalore, Guide : Dr.A.B.Pal

A comparative study of pea lines with variable resistance to powdery mildew as well as rust diseases and their influence on yield components was carried out. Sixteen lines having different categories of resistance were used in the experiment laid out in a randomized block design with three replications. The observations were recorded on various growth and yield parameters. It was observed that the incidence of powdery mildew and rust diseases were negatively associated with the yield components. The resistant lines maintained superiority over susceptible lines with pods per plant, green pod yield per plant and number of seeds per plant. About 44.11% reduction in pod yield was recorded in susceptible lines. Yield per plant and yield per pods was negatively correlated with the disease incidence. Resistant lines were stable with regard to pods per plant. However, susceptible lines were adversely affected with regard to this trait. The qualitative characters such as sweetness were not much associated with disease intensity. Shelling percentage was found to be superior in case of pea line resistant to either of the diseases. In general, the characters like number of pods per plant, number of seeds per pod and number of seeds per plants were adversely affected by the two diseases. Pod yield per plant was affected more due to rust disease than powdery mildew as the correlation was negative and significant.

M.Sc.

Title : Genetics and variability studies in first segregating generation of bell pepper x chilli crosses (1986)

S.M.Gopal, UAS, Bangalore, Guide : Dr.N.Anand

Five F₂ populations of bell pepper x chilli crosses were studied for frequency distribution interrelationship of quantitative characters besides heritability, genetic advance and coheritability for 15 characters. Normal distribution was observed in the F₂'s for plant height and fruit length. The distribution for number of primary branches, fruit per plant and average fruit weight were positively skewed. Other characters had varied responses in different populations. Green fruit yield was negatively skewed. Transgressive segregants were observed for all characters except average fruit weight. Plant height, spread primary and secondary branches, fruit length, early yield and fruit number showed positive influence with green fruit yield. Average fruit weight was negatively correlated with green fruit yield. Green fruit yield, average fruit weight and fruit number had high estimates of heritability and genetic advance. Strategies to obtain large fruited high yielding bell pepper types from bell x chilli crosses have been suggested.

M.Sc.

Title : Studies on biometric characters, nutritional and pre-processing qualities in garden pea lines (1987)

S.N.Jayasimha, UAS, Bangalore, Guide : Dr.A.B.Pal

Investigation to study the important morphological characters, nutritional constituents, pre-processing qualities and the inter-relationship among these characters were carried out utilizing 24 breeding lines of garden pea (*Pisum sativum* L.). Data on morphological characters indicated that the lines used were either early or midseason and short or medium tall in stature. These showed wide variability for characters like the number of reproductive nodes (7.5-13.50, total number of pods/plant (4.13-10.10), pod length (4.03-7.57 cm), 100 green pod weights (66.25-421.50 g), number of seeds/pod (4.52-7.33) and 100 green seed weight (9.25-40.9 g). Observations on green pod yield/plot indicated that the lines 'RPH 68', and 'BK 12-SB' were high yielders compared to the rest. Correlations worked out at the phenotype level among 20 characters indicated that pod length correlated significantly and positively with 100 green pod weight, 100 green seed weight, phosphorous and ascorbic acid contents. Total number of pods/plant correlated significantly and negatively with crude protein content. Green pod yield/plot had positive correlation with iron content. Iron had highly significant and positive correlation with phosphorous content. Combined assessment of parameters indicated that the line 'RPD 12-SB', 'RPA 9-5-3 Nm', 'RPH 68 BK', 'FC 1-32-1-2-SB (19)' and 'Bonneville' were promising for yield parameters. 'FC 1-32-1-2-SB (19)', 'RPG 1-11-GMS', 'RPB-12-3-BK 8' and 'Bonneville' were ideal for quality parameters. The lines 'FC 1-32-1-2-SB (19)' and 'RPC 13-3-7-6' were found to be most suitable for yield and processing quality.

M.Sc.

Title : Studies on the potential ripening mutants to extend shelf life in tomato (*Lycopersicon esculentum* Mill.) (1987)

Mahanth Gowda Patil, UAS, Bangalore, Guide : Dr.S.K.Tikoo

Studies on potential ripening mutants to extend shelf life in tomato were undertaken with a view to compare shelf life, lycopene, firmness, and other attributes of ripening mutants, with normal ripening cultivars including firm fruited ones and F₁ hybrids using normal ripening lines in crosses with nor and alc. shelf life (50% fruits turned soft) of the alc lines IHR 1137 and 1313 was 30 and 37 days, respectively, compared to 37 days in nor at room temperature. Their corresponding values at 20 °C temperature were 44.67 and 70 days. Shelf life differed between the normal ripening varieties scope for isolating better keepers within the available tomato lines, (2) nor and alc. shelf life was much superior. The better colour development in alc lines could make them more suitable as parents in a breeding programme for extending shelf life. Mean shelf life of F₁ was significantly superior to their normal parents but lower than nor and alc genotypes under ambient and constant temperature (20 °C). Highest mean Shelf life observed was 21.6 days and 51.0 days at ambient and constant temperature (20 °C) respectively in Floradade x nor. The corresponding values were 20 and 30 days in Floradade x 1137, Floradade x nor had the most delayed initiation of softening (21 days) followed by Floradade x 1137 (16.5 days). There was correspondence of lycopene content in normal parents and lycopene in F₁s. F₁s with nor had low lycopene content at various stages of ripening compared to F₁s with alc. The crosses of nor and alc with the high pigmented (hp) line IHR 1143 had significantly higher lycopene. There was an apparent correlation between firmness and shelf life, among normal ripening lines Floradade had maximum firmness value of 5.15 and 4.3 kg at B and D stages, respectively. IHR 709, IHR 674 and Se1-4 were next best for firmness. Significant differences were not observed between mutants normal ripening lines for yield, but highly significant differences were observed between parents and F₁ hybrids.

M.Sc.

Title : **Mutation breeding in cauliflower (*Brassica oleracea* L.)** (1987)

M.Narayanaswamy, UAS, Bangalore, Guide : Dr.S.C.Pandey

Two varieties of cauliflower namely Pusa Deepali and Early Kunwari were treated with ethyl methane sulphonate to study the effects on various parameters. The 0.4% EMS treatment created maximum variability. Percentage disease intensity and disease index indicated that in all the treatments plants were susceptible, whereas 0.4% EMS treatments produced resistant plants at seeding stage. The germination and survival percentage decreased with increased EMS concentrations. High Genotypic and phenotypes variances were recorded for all the characters. High variability and genetic advance were recorded for whole plant weight, curd weight, leaf weight, harvest index, leaf area, germination and survival percentage. Positive and significant character association was recorded for fresh weight curd with leaf area, harvest index, whole plant weight and fresh weight of leaves. Path coefficient analysis revealed that whole plant weight had high direct effect on fresh weight of curds in positive direction.

M.Sc.

Title : Studies on genetics and combining ability in Cauliflower (*Brassica oleracea*. L. var. Botrytis) (1988)

B.M.Shivalingappa, UAS, Bangalore, Guide : Dr.S.C.Pandey

A 5 x 5 complete diallel analysis was carried out to study the genetics and combining ability in cauliflower. Both additive and non-additive genetic variances were involved in all the characters. Preponderance of additive genetic variances was recorded for all except vitamin C content. The parent lines 'Early Dawn' and 'Early Cauliflower' was found to be the best general combiners for days to curd initiation, days to curd maturity, plant weight and curd weight. Maximum heterotic and best specific combinations involved at least one good general combiner. High heritability was observed for days to curd initiation and maturity, plant height and plant weight and curd size index, whereas remaining characters had medium to low heritability. The ratio of degree of dominance revealed partial dominance for days to curd initiation and maturity, plant height and plant weight and curd size index, and curd to plant ratio. Positive and significant genotypic and phenotypic characters, association of curd weight was recorded with number of leaves, plant weight and curd size index and vitamin C content. Selection of parents for hybrids and population improvement programme was advised on the basis of per se performance and combining ability.

M.Sc.

Title : **Studies on genotype – environmental interaction in onion (*Allium cepa* L.)**
(1988)

B.Nagarjuna Gowda, UAS, Bangalore, Guide : Dr.C.S.Pathak

Fifteen onion genotypes comprising nine varieties and six elite genotypes were tested under twelve environments generated by the manipulation of nutrition and different sowing seasons. Nineteen characters which involved yield and yield components were studied for stability. The genotypes and environments differed significantly for all the nineteen characters, where as genotype environment interaction was significant for most of the characters except fresh weight of bulb per plant, number of leaves per plant, firmness of bulb, undersized bulb percentage, TSS percent and neck thickness. These characters remained unaffected with the change in environment and can be grouped as most stable characters. On the basis of stability statistics, mean (μ_i), regression coefficient (b_i), deviation from regression ($S^2 d_i$), UD-103 was identified as a stable genotype for estimated bulb yield, total bulb yield, marketable bulb yield per plot, split bulb percentage, bolting percentage & polar bulb diameter. Arka Niketan was stable for estimated bulb yield, total bulb yield per plot, bolting percentage, split bulb percentage, marketable & unmarketable bulb yield per plot, per cent dry matter, rotten bulb percentage, single centered bulb percentage & equatorial bulb diameter. Among other varieties IHR-396 was stable for 12 characters & N-2-4-1 was stable for 10 characters including bulb yield. These four genotypes were well adapted to all the environments with above average estimated bulb yield.

M.Sc.

Title : Variability, heritability, correlations and path analysis in carrot (*Daucus carota* L.) (1988)

B.N.Nagaraja, UAS, Bangalore, Guide : Dr.C.S.Pathak

Thirty nine genotypes of carrot representing the collections from diverse geographic area of the world were studied for variability, heritability, correlations and path analysis. Significant differences were observed for all the 17 characters studied. The PVC and GCV values were larger for specific leaf area, specific leaf dry weight, fresh weight of leaves, dry weight of leaves, fresh weight of roots, carotene content, percent forked roots and undersized roots. However, these PVC and GCV values were lower for rest of the traits. High heritability values associated with high genetic advance was observed for carotene content, root yield, fresh leaf weight, dry leaf weight, fresh weight of roots and specific leaf area, which indicated that selection for these characters will be effective. Rest of the characters had moderate or low heritability. The genotypes IHR 3, IHR 75, IHR 128 and IHR 205 exhibited deep orange colour of roots and these had high carotene content. Root yield was positively correlated with root length, root diameter, top length, fresh weight of roots, number of leaves, fresh weight of leaves, dry weight of leaves, specific leaf area and carotene content. Path analysis studies revealed that among the components characters, diameter of root exerted maximum positive effect on root yield both directly and also indirectly through traits like top length, specific leaf area and number of leaves.

M.Sc.

Title : **Studies on heat tolerance in garden pea (*Pisum sativum* L.)** (1991)

Oinam Kumar Singh, UAS, Bangalore, Guide : Dr.A.B.Pal

Twelve garden pea lines viz., UN-5-29(P), IHR575, UN-5-29(S), RPN-34, IHR-544, RPD-9-1 (P), UN-57(G),RPD-9-1(S) (early lines), IHR-476, Bonneville, FC-1-32-1-1-40 and IHR-570 (mid season lines) were evaluated for growth and yield parameters during *rabi* and summer seasons and the relative performance of the lines at high temperature, its effect on yield and yield components and the role of chemical constituents in offering heat tolerance were studied. High temperature was found to affect the growth and consequently the yield during the summer season. All the growth and yield parameters decreased drastically when the growing temperature reached 35 °C at maximum and 17 °C at minimum. At this temperature shelling percentage increased in the case of early lines but decreased in the mid season lines. Number of days taken for 1st flowering was reduced in the early lines whereas it increased in the mid season lines at high temperatures. Chemical constituents such as starch, protein and sugar also decreased during summer to the extent of 2.02 to 48.09%. Both positive as well as negative significant correlations were found among many of the characters during summer than *rabi*. In general, there was genotypic variation in heat tolerance in garden pea lines. Lines with long duration had less tolerance to heat as compared to short duration lines. Chemical constituents of the plants were also altered by temperature with wide variations among the lines. Among the lines tested, IHR-544 and IHR-575 were found to be the most heat tolerant lines and were most suitable for cultivation during the summer season.

M.Sc.

Title : Identification of tomato (*Lycopersicon esculentum* Mill.) F₁ hybrids with potential for yield, quality and resistance to bacterial wilt(*Pseudomonas solanacearum* E.F.Smit) (1991)

H.V.Sathyanarayana, UAS, Bangalore, Guide : Dr.N.Anand

Attempts were made to identify potential F₁ hybrids in tomato resistant to bacterial wilt suitable for fresh market and/or processing. A line x tester analysis was carried out with five lines carrying dominant gene for resistance to bacterial wilt, two of them (Sl.6 and Sl.11) additionally being resistant to nematodes. The testers involved (6) were endowed with good horticultural qualities and high yield but susceptible to bacterial wilt. The hybrids and parents were evaluated in wilt sick soil (10⁸ cfu/g soil), with inoculation (10⁷ cfu/ml) as well as in wilt free soil under staked conditions. F₁ hybrids obtained from all the resistant parents exhibited very high degree of resistance to bacterial wilt (100% survival). Combining ability analysis revealed that the bacterial wilt resistant lines, BWR 5 followed by BWR resistant 15 and among testers IHR 1614 and IHR 858 were good general combiners. The highest yielder among the 12 fresh market hybrids was BWR 5 x IHR 858 IHR 858 IHR 858 (estimated yield 71.75t/ha). Based on fruit quality analysis for lycopene, TSS, acidity and pH, seven F₁ hybrids were found suitable for processing, best among them being BWR 15 x IHR 1614 (estimated yield 76.3t/ha). Among the 11 dual purpose F₁ hybrids, BWR 5 x 1032-1 was the best (estimated yield 68.87t/ha).

M.Sc.

Title : **Inheritance and incrossability studies in papaya** (1996)

S.Meenakshi, UAS, Bangalore, Guide : Dr.I.S.Yadav

All the plant and fruit characters studies showed higher phenotypic variance than genotypic variation which indicated the importance of environment in the manifestation of these characters. The phenotypic and genotypic variance were higher for plant height, fruit weight and fruit cavity index, it was moderate for plant spread, fruit length and low for stem diameter, fruit breadth, pulp thickness, TSS, total carotenoids and total sugars. The phenotypic coefficient of variation was higher than the genotypic coefficient of variation for all the characters. The coefficient of variation was high for fruit weight, fruit volume, fruit cavity index, fruit length and medium for fruit height, stem diameter, fruit breadth and total carotenoids. Plant spread, pulp thickness, TSS and total sugars had low coefficient of variation. Maximum fruit set was noticed when 3% sucrose was used irrespective of then cross combinations involving papaya varieties as female parents. However, among the cross combinations maximum fruit set was noticed in Pusa Dwarf x *Carica cauliflora*. In all cross combinations where *Carica cauliflora* was the female parent, the average fruit set was maximum with the use of 3% sucrose and among the cross combinations maximum fruit set was recorded in the cross *Carica cauliflora* x Lucknow Collection. Average number of seeds set was maximum under 5% sucrose level in crosses where *Carica papaya* was used as female parents. Maximum number of seeds set was recorded in the cross Washington x *Carica cauliflora* at 5% sucrose level. percentage of variable seeds was maximum 2% sucrose level in all the cross combinations studies. percentage of variable seeds was highest in the cross combination Pusa Dwarf x *Carica cauliflora* at 5% sucrose level. Cross combinations involving *Carica cauliflora* as female parent did not yield any viable seed. Varietal differences were observed in the crossability of *Carica papaya* with *Carica cauliflora*. The cultivar Pusa Dwarf was found to be the best as female parent in crosses with *Carica cauliflora*.

M.Sc.

Title : **Genetic transformation of watermelon (*Citrallous lanatus*) by electroporation (1997)**

M.V.Hema, UAS, Bangalore, Guide : Dr.O.P.Dutta

Experiment was conducted at IIHR, Bangalore to optimize the parameters for watermelon transformation using the *Gus* reporter gene by electroporation. The gene transfer was done *in vitro* using seed-derived embryos and *in vivo* using nodal meristem of watermelon variety Arka Manik. The uptake and expression of the said gene in the embryos was confirmed by histochemical staining with X-glue showing blue coloured cells. Further, the higher *gus* activity was observed by a higher staining pattern and intensity in the embryos electroporated with plasmid PB 1121 as compared to the plasmid P353G4INT. Higher *Gus* expression with both the plasmid was observed by using ten pulses from an experimental decay pulse of 400V over duration of 99 MSEC as compared with 5 pulses. Higher transformation frequencies (48.83%) were achieved by electroporation of watermelon nodal buds *in vivo* using dot blot analysis of R1 plants. Southern transfer and hybridization of the restriction digested R1 genomic DNA samples confirmed the stable integration of the gene/DNA fragments in the watermelon genome.

M.Sc.

Title : **Ploidy manipulation and mutation studies in papaya (*Carica papaya* L.)**
(1997)

M.Mahadevamma, UAS, Bangalore, Guide : Dr.I.S.Yadav

Ploidy manipulation has been used in fruit crops to advantage by getting better sized fruits. In case of papaya with its chromosome number being $2n=18$, there is good scope for making heading in breeding. In case of variety Sunrise Solo, the fruits are quite small, but the quality is good. The variety Coorg Honey Dew has big sized fruits with poor keeping quality. Hence these two varieties were selected for mutagenic treatment to create variability. In this experiment GA was used as a pretreatment chemical for seed material before mutagenic treatment to study the effect of various mutagens *viz.*, gamma rays, EMS and colchicine on various growth parameters, mitosis and fix LD₅₀ dosage, Seedlings, callus and shoot tips of Coorg Honey Dew were also used to know their response and to find LD₅₀ dosage. Germination and survival percent was the highest (85.16 and 80.16) in control and the lowest (22.00 and 12.99) in 20 kR respectively. A dosage of 30 kR and above were found to be lethal. Germination and survival percent was the higher in Sunrise solo (53.67 and 44.22) than in Coorg Honey Dew (45.33 and 36.11). LD₅₀ dose for Germination percent and survival percent for pretreated seeds with gibberellic acid was 9.5 kR and 7 kR for Sunrise solo and 7.5 kR and 4.5 kR for Coorg Honey Dew respectively. For seeds without pretreatment the LD₅₀ dose for Germination percent was 39 kR for Sunrise solo and 27 kR for Coorg Honey Dew.

Gamma rays significantly influenced the seedling height both at and 30 days after Germination which decreased with increase in gamma rays dosage and was minimum (5.68 cm and 9.44 cm) with 20 kR maximum (7.15 cm and 11.93 cm) with control. Total chlorophyll content decreased with increase in gamma rays dosage and was the lowest (1.54 mg/g tissue) at 20 kR and the highest (2.15 mg/g tissue) with control. Both stomatal length and breadth increased with increased in concentration of EMS but decreased with increase in duration of treatment. The maximum stomatal length (15.55 μ and 13.61 μ) and breadth (7.86 μ and 7.86 μ) were observed at 0.3% EMS and 8h duration treatment respectively compared to control which recorded minimum stomatal length (10.41 μ) and breadth (5.75 μ). EMS treatment significantly reduced the plant height, plant spread, plant girth and intermodal length at the time of first flowering in Sunrise Solo variety. EMS treatment 0.3% recorded minimum plant spread at North-South (72.46 cm) and East-West

(71.52 cm) direction, Plant girth (3.130 and intermodal length (3.59 cm) while control plants recorded maximum. Ovules excised 60 days after pollination continued growth on half strength MS media supplemented with 60 g sucrose, 400 mg glutamine and 20% coconut water which recorded the maximum ovule length (3.43 mm) and breadth (2.08 mm) after 60 days in culture compared to ovules excised 90 days after pollination which recorded maximum ovule length (2.77 mm) and breadth (1.85 mm). Sixty days upon culture, the highest percent of green and enlarged ovules (29.00) was also noticed from ovules excised of sixty days after pollination while it was lowest (10.5) from ovules excised 90 days after pollination.

M.Sc.

Title : Evaluation of paprika (*Capsicum annum* L.) lines and hybrids for yield and colour (1998)

Chandrashekar Achar, UAS, Bangalore, Guide : Dr.A.A.Deshpande

An investigation was carried out in paprika (*Capsicum annum*) to study the extent of heterosis, combining ability and thereby to locate high yielding paprika hybrids with high colour and ascorbic acid. Data obtained from 21 hybrids of 7 lines x 3 testers were subjected to RBD and Line x Tester analysis. The mean performance of hybrids was superior over their parents for most of the yield and quality parameters. Non-additive gene effects were predominant for fruit length, fruit number; dry fruit, yield, percent pedicel, ascorbic acid and capsaicin content whereas additive genes were found to be predominant for pericarp, seed and capsanthin content. However, involvement of additive and non-additive gene effects were observed for fruit width. Among female parents L₁ showed significant gca effects for 7 out of 10 characters studied, excluding number of fruits per plant, dry fruit yield and ascorbic acid content; L₂ showed significant gca effects for the similar characters as L₁ except fruit length. Among male parents T₁ had significant gca effects for quality parameters and pericarp yield. The data on magnitude of heterosis over better parent, best parent and commercial check revealed the superiority of some outstanding cross combinations. Considering total yield, yield of pericarp and quality parameters like capsanthin, capsaicin and ascorbic acid content, two hybrids of paprika type and are comparable with best parent L₁ for capsanthin and parent L₂ for capsanthin content. They have fairly high ascorbic acid content and suitable for paprika Oleoresin industry.

M.Sc.

Title : Studies on heterosis in chillies (*Capsicum annum* L.) using genicytoplasmic male sterility (1998)

S.Thippeswamy, UAS, Bangalore, Guide : Dr.A.A.Deshpande

The studies on heterosis in chillies (*Capsicum annum* L.) using genicytoplasmic male sterility were carried out. Three male sterile lines and 10 male parents drawn from breeding lines resistant to different diseases and germplasm selections were crossed in Line x tester fashion to get 30 F₁ hybrids. These hybrids were compared with 13 commercial F₁ hybrids for 20 growth, yield and quality parameters. Mean performance of hybrids was superior than mean performance of parents for majority of characters viz., plant spread, number of tertiary branches, number of laterals, days taken from flowering to fruit ripening, first and second harvest, fruit length, percent pedicle, percent seed content, first harvest and total number of fruits, first harvest and total dry fruit yield per plant and capsaicin content (%). For total dry fruit yield per plant maximum of 54.85% heterosis over better parent and 20.21% over best commercial F₁ hybrid was recorded. Combining ability studies have shown the predominance of additive gene action over non-additive effects for majority of characters except plant spread, days from flowering to fruit ripening, fruit length (I harvest), percent pedicel capsaicin and capsanthin content. However, involving of both additive and non-additive gene effects were noticed for number of laterals first harvest fruit length and width, first harvest fruit number and first fruit yield per plant. Cytoplasmic effects on expression of characters revealed no cytoplasmic differences for majority of characters. However, these differences indicted that the differences is not only due cytoplasmic alone but to genome x cytoplasmic interactions. In the present study, when comparison was made between the male sterile lines and their respective maintained lines, the maintainer lines had higher number of seed per fruit under open set.

M.Sc.

Title : Studies on F₁ hybrids tomato for long shelf life developed using slow ripening mutants (*Alcobaca* and ripening inhibitor) (1998)

L.Roopa, UAS, Bangalore, Guide : Dr.A.T.Sadashiva

The objective of the study was to study the potential of *Alcobaca* (alc) and ripening inhibitor (rin) for their combining ability, heterosis for yield, quality and shelf life and to identify F₁ hybrids tomato with long shelf life. The experimental material consisting five lines (4 alc and 1 rin), six testers, 30 F₁ hybrids obtained from line x tester fashion and four commercial checks (Avinash-2, To-230, Arka Shreshta, Arka Abhijit) were evaluated. The GCA effects were significant for the characters shelf life, yield and fruit firmness for the lines 2052 (alc) and 2053 (alc). While for the testers (IIHR cultivars) the gca effect was significant in 858 for shelf life, 1614 for pericarp thickness, firmness and shelf life and Flora-Dade (FD) for fruit weight and shelf life. The data on magnitude of heterosis over better parent and standard check revealed the superiority of some outstanding cross combinations. Four hybrids expressed significant heterosis over best parent for number of fruits per cluster, six hybrids for pericarp thickness, four hybrids for fruits for fruit firmness and twelve hybrids for yield per plant. Fifteen hybrids expressed standard heterosis for pericarp thickness, four for fruit firmness, fifteen for life at different stages. Two hybrids, namely 2052 x 858 and 2053 x FD were found to be outstanding. These hybrids had firm fruits, the firmness values being 5.53 and 4.95 kg/cm². The fruits stored for 22.26 and 33 days, till 50% softening at room temperature. The fruits of these mutant heterozygotes developed red colour upon ripening similar to the normal ripening fruits. They yielded 56.59 and 58.96 t/ha.

M.Sc.

Title : Development of F₁ hybrids with resistance to bacterial wilt in tomato (*Lycopersicon esculentum* Mill.) (2000)

R.Prashanth, UAS, Bangalore, Guide : Dr.A.T.Sadashiva

Fifty F₁ hybrids obtained by crossing 10 lines and 5 testers in a line x tester mating design were evaluated along with their parents in both wilt infested and wilt free soil to know their reaction to the bacterial wilt and their performance for yield and yield components. The hybrids were highly resistant to infestation of bacterial wilt ranging from 91-100% whereas the check Pusa Ruby was found to be 100% susceptible. The F₁'s expressed superior heterosis and heterobeltiosis for characters like yield, days to first fruit maturity, days to 50% flowering and fruit quality parameters. Combining ability analysis revealed predominance of non-additive gene action for parameters like yield, number of fruiting clusters, fruit per cluster and quality parameter while additive gene action was observed in plant height, days to 50% flowering and TSS. The line IIHR 2038, IIHR 2042 and NOR-1 were found to be good combiners and crosses such as BWRsx2038, BR11x2038, BWRIx2042, 15SBSBx2042 and BR11xNOR-1 were outstanding in respect of yield, firmness and early bearing. These hybrids also recorded hundred percent survival to bacterial wilt and further can be commercially exploited.

M.Sc.

Title : **Combining ability studies in virus resistant Capsicum lines** (2000)

B.C.Narasimha Prasad, UAS, Bangalore, Guide : Dr.A.T.Sadashiva

The investigation was undertaken to assess the combining ability of virus resistant chilli lines, to study the extent of heterosis of their hybrids for different characters and to locate resistant parents and hybrids for virus with special reference to cucumber mosaic virus. Combining ability studies have shown the predominance of additive gene action for fruit maturity, fruit length, fruit width, plant spread, primary branches, secondary branches, percent pericarp, percent seed content, number of fruits per plant and dry fruit yield per plant and non-additive gene action for days to 50% flowering and tertiary branches. The data on magnitude of heterosis over mid-parent, better parent, best parent and standard check revealed that the hybrid VR-42 x VR-55 was found superior over mid-parent, better parent, best parent and standard check dry fruit yield per plant. When the parents and their hybrids were screened for virus resistance under field conditions, it was seen that six parents *viz.*, VR-42, VR-14, VR-47 and VR-55 exhibited some degree of resistance. In an experiment conducted to study resistance to cucumber mosaic virus, parents VR-42 and VR-55 were found completely free from infection. This was also confirmed by ELISA test.

M.Sc.

Title : Isolation of sources of combined resistance to purple blotch, basal rot and white rot in onion (*Allium cepa* L.) (2001)

Somanna Chittiappa, UAS, Bangalore, Guide : Dr.R.Veere Gowda

Study was conducted to identify sources of multiple resistance to purple blotch, basal rot and white rot diseases in onion by screening 50 genotypes using seed, bulb and seedling inoculation methods both under natural and artificial epiphytotic conditions, and to evaluate biochemical and morphological factors responsible for disease resistance. The lines YL-58.WPL-95, 73, Pusa Red-135, Kalipathia Local-303, MS-48-26 and MS11-36 showed multiple resistances for purple blotch, basal rot and white rot diseases. Moderate resistance to purple blotch and white rot was noticed in Sel 14-2, YL-61, WPL-95, MS65-11, MS-65XPBR-415 and MS11XPBR-409. Screening at seed stage revealed that 19 genotypes were resistant (81-100%) to purple blotch, 13 moderately resistant to (61-80%) basal rot and only one genotype YL-68 moderately susceptible (41-60%) to white rot. Screening at bulb stage the genotypes Sel 14-5, Sel 13-26, WPL-158, 165, 169, PWO-1-PAU-309, MS-48-25 were found to have moderate multiple resistance to basal rot and white rot. However, five genotypes each for basal rot and white rot were found resistant (Rose-69, WPL-95, 169, PBR-5PAU-306 and AK-IIHR-307) and (WPL-69, PBR-5-PAU-306, Pusa Red-135, MS(YL) Pure(s)-414, respectively). Screening at seedling stage in open field revealed that the lines Sel 11-34, MS65-8,9, and MS65XPBR-415 to had multiple resistance to purple blotch and basal rot, and lines WPL-158, 169, 73, AK-IIHR-307 and MS48-100 were moderately resistant. Plant screening in polyhouse revealed that none of the onion genotypes were resistant to purple blotch, basal rot and white rot. However, moderate resistant was observed in seven genotypes (WPL-169, 158, 165, MS48-25, PWO-1-PAU-309, Sel13-26 and Sel 14-5). The biochemical studies indicated that the resistant varieties recorded high reducing sugars and phenols as compared to susceptible ones. Onion plants with tubular (erect) leaves were found to be moderately resistant to purple blotch.

M.Sc.

Title : **Genetic analysis of yield and yield components in cucumber (*Cucumis sativus* L.) (2001)**

G.D.Dinesh Kumar, UAS, Bangalore, Guide : Dr.M.Pitchaimuthu

On study was carried out, to estimate heterosis, heritability, genetic advance, gene action, gene action and study the inheritance pattern of qualitative characters in cucumber. Among the F₁ hybrids evaluated, IIHR-101 X IIHR-34 exhibited an appreciable amount of desirable heterotic effects for most of the yield contributing characters *viz.*, total yield per plant, average fruit weight, fruit number per vine, fruit length, fruit girth, flesh thickness and number of branches per plant. Hybrid IIHR-81 x IIHR-82 showed positive heterotic effects for only fruit length and flesh thickness. Whereas negative heterotic effect was observed for days to first female flower opening, days to first fruit harvest and nodal position of first female flower. Both highest heritability and genetic advance were observed in hybrid IIHR-101 x IIHR -34 for flesh thickness and vine length whereas, IIHR-81 x IIHR-82 cross combination was observed for total yield per plant., number of fruits per vine and average fruit weight. Most of the yield contributing traits in hybrid IIHR-101 x IIHR -34 was under the control of dominance gene action hence, it would be beneficial to emphasize heterosis breeding. In cross IIHR-81 x IIHR-82 most of the traits were under the influences of both additive and non additive gene action hence, reciprocal recurrent selection would be beneficial. In the cross IIHR-82 X *C. sativus* var. *C. hardiwickii*, it has been conspicuous that bitter principle was under the control of single dominant gene and one can isolate non bitter plant from segregating generation as a inbred line to utilize in the hybridization.

M.Sc.

Title : Line X tester analysis for heterosis and combining ability using male sterility in okra (*Abelmoschus esculentus* L. Moench) (2001)

S.Thippeswamy, UAS, Bangalore, Guide : Dr.M.Pitchaimuthu

Thirty F₁ hybrids obtained from crossing five lines and six testers in a line x tester mating design were evaluated along with their parents and their performance for yield and yield components along with Yellow Vein mosaic virus resistance in Okra. The estimation of gca effects of all 11 parents revealed that IIHR-MS-5 and IIHR-MS-2 showed the highest positive significant effects and were good combiner for plant height, number of fruits per plants, marketable yield, total yield per plant and fruit weight. IIHR-MS-5 had highest gca for number of branches per plant, fruit length and fruit girth. Among the testers the magnitude of gca effects for high marketable yield, total yield per plant, plant height, node at which first flower appearance and fruit girth was high in the Arka Anamika. Parbhani Kranti had high gca for fruit weight, fruit length and number of ridges. Significant sca effect in desirable direction was noticed in the cross combinations in IIHR- MS- 5 X 120-11-8-1 for days to first flower appearance and the cross IIHR-MS-1 X 116-12-23-6 for days to first fruit picking. In cross IIHR-MS-2 X Arka Anamika had significant sca effect for number of branches per plant. The per se performance of IIHR-MS-2 X Arka Anamika showed higher magnitude of sca with 313.7 g marketable yield per plant. Thus, cross having high per se performance for marketable yield and highly significant sca effect. Therefore, sca effect for marketable yield could consider the basis for selection of crosses. All the crosses with significant sca effect for different characters had positive heterosis. In majority of crosses, high sky effect was due to high X high and high X or low X high cross combinations, indicating the importance of additive X additive and additive X dominance or dominance X additive type of interaction. The hybrid IIHR-MS-2 X Arka Anamika and IIHR-MS-5 X Parbhani Kranti can be exploited commercially for marketable yield, more number of fruits per plant and earliness.

M.Sc.

Title : **Genetic variability studies in cauliflower** (2001)

Prasanna, UAS, Bangalore, Guide : Dr.B.Varalakshmi

A study was undertaken to estimate the genetic variability, heritability for yield and its components and their association with yield in early cauliflower. Twenty five genotypes of cauliflower were evaluated in randomized block design with two replications. Genotypic coefficient of variation (GCV) was found to be less than the phenotypic coefficient of variation (PCV) with respect to all the characters studied. High GCV and PCV were observed for characters like yield per hectare, blindness, buttons and leafy curds. Narrow differences between GCV and PCV were seen in character like days to curd initiation, days to curd maturity, curd size, net plot yield, yield per hectare, vitamin C content and buttons indicating that there is no environmental influence in the expression of these parameters. It was observed that high heritability associated with moderate values of genetic gain as percent of mean for petiole length, curd size, net plot yield, yield per hectare and vitamin C content, indicating that these characters are governed by additive gene action and so direct selection will be effective to improve the genotypes for these characters.

The character association revealed high significant positive association of curd diameter on curd yield at both phenotypic and genotypic level only. Therefore for, genetic improvement in cauliflower it is better to adopt direct selection through curd diameter, fresh leaf weight, number of leaves and leaf area index and indirect selection through plant weight, curd size and plant height. Among plant characters it is suggested to select semi erect leaf orientation plants with white or cream colour and full compact curds to improve yield in early cauliflower.

M.Sc.

Title : **Studies on male sterility in onion (*Allium cepa* L.)** (2002)

K.M.Saraswati, UAS, Bangalore, Guide : Dr.R.Veere Gowda

The main objectives of the investigation were to study, “Development and morphological analysis of flowers, Micro-sporogenesis and Micro-gametogenesis; seed set and seed yielding abilities of male fertile and male sterile lines. The salient achievements are summarized below. Developmental and morphological analysis of male sterile and male fertile plants: The flower buds of male sterile and male fertile lines took 97.3 and 105.5 days respectively from the time of visible initiation to complete withering of filaments. The male sterile line had flower bud size 0.6 x 0.6 Sq.cm. This was comparatively less than that of male fertile line 0.8 x 0.9 Sq.cm. The total flowering period observed in both sterile and fertile lines was 22.3 and 24 days respectively. Peak flowering was observed on 15th day in sterile whereas on 17th day in fertile line from the visible flower initiation. Majority of the flower buds (22-34%) opened between 7 a.m. and 10 a.m. in male sterile line. Whereas in fertile line between 7a.m. and 4a.m. Peak period of anthesis was observed at 7 a.m. in both male sterile (34%) and male fertile (16%) lines. Maximum anther dehiscence was at 11 a.m. (100%). The lines MS11,MS48 and Arka Kalyan were more receptive on 3rd day of crossing with 96,93 and 91% seed set respectively whereas, MS39 and MS65 were receptive till 5th day of crossing after opening, with 100% and 97% seed set respectively. Arka Kalyan recorded the highest pollen germination (50-75%) with the lowest pollen absorption (21.76%). Studies on micro-sporogenesis and micro-gametogenesis in onion flower: Studies showed that the tapetum in male fertile lines was essentially peripheral type. Following the release of microspores from tetrads, radial and inner tangential walls of the tapetum broke down and the tapetal protoplast released into the locular cavity and engorged the developing microspores. Whereas the sterile lines used in the present investigation exhibited abnormalities. Soon after the formation of microspores. Investigation on seed set and seed yielding abilities of male sterile and male fertile lines revealed that the Pusa Red (42), Arka Pragathi (42.97), MS 48(38.57) and MS39 (40.37) recorded lower number of days for flower stalk emergence. Arka Pithamber (84.43) and MS48 (98.5) were found to had highest percent flowering. Arka Niketan recorded highest seed weight per plant (3.28g). Arka Pithamber had highest umbel weight (12.03g). The parental lines did not show significant differences for number of flowers per umbel, number of seeds per umbel percent recovery of seeds per umbel and

seed set percentage. The crosses which had significant differences for different characters were plant height MS11 x Arka Bindu (68.28 cm); number of days for stalk emergence MS48 x Arka Bindu (98.50); highest percent flowering MS11 x PBR-2(96); number of flower stalks MS39 x Arka Kalyan (6); highest length and diameter of the scape MS39 x PBR-1(707.27 x 1.47 Sq.cm); highest umbel size index MS65 x Arka Kalyan (25.19); number of seeds per flower MS48 x PBR-2(42); highest seed weight per umbel MS39 x Arka Bindu (1.33 g); seed weight per plant MS11 x Arka Pithamber (7.27 g); umbel weight MS11 x PBR-1 (6.23 g); 1000 seed weight MS65 x Arka Niketan. Correlation studies for different characters among parental lines and crosses Study revealed that the strong positive correlation for umbel diameter and umbel weight ($r=0.967$), seed weight per umbel were recorded between seed weight per plant ($r=0.788$) and umbel size index ($r=0.657$). Umbel weight recorded positive correlation between seed weight per umbel($r=0.776$), seed weight per plant ($r=0.632$) and umbel size index ($r=0.816$). Strong correlation among the crosses were observed between percent flowering and plant height ($r=0.51$) and umbel diameter ($r=0.515$). Between number of days for stalk emergence and umbel index ($r=0.512$), seed weight per umbel ($r=0.381$), umbel equatorial diameter ($r=0.722$) and umbel weight. Seed weight per umbel had significant correlation for seed weight per plant ($r=0.592$) and umbel weight ($r=0.444$) in turn seed weight per plant recorded positive correlation for number of flower stalks per plant ($r=0.529$).

M.Sc.

Title : Isolation of resistance source for combined diseases viz., purple blotch, basal rot and white rot in onion (*Allium cepa* L.) by saprophytic and gametophytic screening (2002)

A.U.Subbaiah, UAS, Bangalore, Guide : Dr.R.Veere Gowda

With plant pathogens and the insects that spread them are exploding worldwide, finding new ways to fight diseases has become an absolute necessity. The first line of defense against plant diseases is natural resistance, which can often be transferred between and among the species by cross breeding for which resistance sources must exist. Evaluation of resistance for long has been done by sporophytic screening which is time consuming and laborious. Hence, it would be desirable to use strategies that allow an early selection of resistant genotypes, male gametophytic screening is one of them. Apparently, pathogenesis-related mechanisms involved in disease resistance are expressed in both vegetative (sporophytic) and generative (gametophytic) tissues.

The primary objective of our study was to develop and evaluate screening methodologies for identifying genotypes within heterogeneous populations that have resistance (Multiple resistances) to purple blotch, basal rot and white rot diseases of the onion caused by *Alternaria porri*, *Fusarium oxysporum* f.sp.*cepae* and *Sclerothium cepivorum* respectively. Our selection procedures were developed initially with the sporophytic generation where sixteen genotypes were evaluated under field condition, polyhouse condition where the seedlings were subjected to different concentrations of the pathogens (4×10^4 Conidia ml⁻¹, and 1×10^4 spores ml⁻¹ and 1-2 Sclerotia per seedling for purple blotch, basal rot and white rot respectively) and then tested the bulbs under storage conditions for the storage diseases namely basal rot and white rot at 45×10^4 spores ml⁻¹ and 6-7 sclerotia per bulb respectively. And in the gametophytic generation the pollens of eight male fertile genotypes were subjected to the crude culture filtrates of the above said diseases in accordance with the proposal that a possible overlap between generations might result from selection of genes expressed in both stages.

Considering the economics losses caused by these three important diseases of Onion, the importance of the work carried out is of significance to Indian agriculture, as some promising results were obtained in accordance with our objective.

M.Sc.

Title : **Heterosis and combining ability studies in cauliflower** (2002)

Deepa Singh, UAS, Bangalore, Guide : Dr.B.Varalakshmi

Line X tester analysis involving six lines and six testers was carried out in early cauliflower (*Brassica oleracea* var. Botrytis) at IIHR, Hessaraghatta, Bangalore during 2000-2001. Thirty-six hybrids along with twelve parents and a check hybrid (NS-60) were evaluated in a randomized complete block design with three replications. The heterosis over mid parent was significant in majority of the F₁ hybrids tested for days taken for 50% curd initiation, days taken for 50% curd maturity, stem weight, stem length and curd diameter indicating the pre-dominance of dominant type of gene action for these traits. Number of crosses showing significant heterosis over mid-parent was very less for number of leaves, leaf weight, leaf area, plant height, plant weight, curd weight and pronounced for the expression of these traits.

Two hybrids *viz.*, Katki x IIHR-263 (-3.50%) and First Early x IIHR-263 (-8.00%) exhibited lowest negative standard heterosis and the curd weight of these hybrids were on par with the curd weight of the standard check hybrid, NS-60. Significant GCA effects were observed in First Early, IIHR-217-1-4-6 and IIHR-263 for 50% of curd initiation whereas IIHR-Sel 3, IIHR-217-1-4-6, IIHR-302 and IIHR-305 for 50% curd maturity indicating that these were the best general combiners for earliness. Four hybrids, IIHR-Sel. 3 x IIHR-250-4-1-11, IIHR-73-24 x IIHR-302, IIHR-73-24 x IIHR-305 and Arka Kanti x IIHR-217-1-4-6 were good specific combiners for earliness. Four hybrids *viz.*, IIHR-Sel. 3 x IIHR-302, Arka Kanti x IIHR-302, Early Kunwari x IIHR-250-4-1-11 and Early Kunwari x IIHR-217-1-4-6 were the best specific combiners for curd weight. The ratio of GCA and SCA variance reveals the dominant gene action to be predominant for all the characters. Thus, the present investigation reveals that these characters can be improved by heterosis breeding.

M.Sc.

Title : **Development of F₁ hybrids resistant to viruses in chilli (*Capsicum annuum* L.)**
(2002)

K.T.Shasikumar, UAS, Bangalore, Guide : Dr.K.Madhavi Reddy

Chilli is cultivated as one of the important cash crops throughout India, grown both as vegetable and as a spice. Mixed infection of viruses in chillies is a common feature in nature, hence there is a strong need to develop multiple virus resistant variety/hybrids with desirable fruit type. In the present investigation, in order to develop chilli F₁ hybrids resistant to multiple viruses with high yielding ability, eleven lines, five testers and fifty five F₁ hybrids along with two standard checks and a susceptible check were evaluated at IIHR. Among the parental lines evaluated, P3 was found earlier for the characters like days to 50% flowering and days to first fruit maturity; P1 showed highest mean plant height; P5 showed highest mean for plant spread and dry fruit yield per plant. P6 was the best among the lines for fruit length, and P4 for fruit width and P8 showed highest mean number of fruits per plant. Significant negative heterosis was noticed in the cross P3 x P16 for 50% flowering and P2 x P12 for days to first fruit maturity. Out of 55 hybrids developed, 19 expressed resistance to PVBV, PVY & ChiVMV; and 18 hybrids expressed resistance to CMV individually. However, two hybrid combinations *viz.*, PMR69 x Perennial and PMR69 x Punjab Gucchedhar showed multiple resistance to all four viruses with an yield potential of 86.8 and 84.0 g dry yield/plant.

M.Sc.

Title : **Diallel studies in chilli (*Capsicum annuum* L.)** (2002)

C.Venkata Ramana, UAS, Bangalore, Guide : Dr.K.Madhavi Reddy

Combining ability analysis of 8 x 8 diallel cross (including reciprocals) was carried out in chilli, involving cucumber mosaic virus (CMV) resistant and susceptible lines. The variances for general combining ability (gca) and specific combining ability (sca) were highly significant for all the characters, suggesting the importance of both additive and non-additive gene action. The sca variance played an important role in the genetic control of days to 50% flowering, days to 50% ripening, fruit width, plant height, plant spread, number of fruits per plant, green fruit yield per plant and per cent CMV incidence. On the contrary additive gene action was observed for fruit length. The genotype VR-27 was judged to be the best general combiner for fruit yield per plant and Perennial, Punjab Lal, Punjab Gucchedar and Pant C-1 proved to be good general combiners for per cent CMV incidence. The crosses Punjab Gucchedar x Pant C-1 and Tiwari x EG-174 have greater sca effect for fruit yield. These two crosses may directly be used for commercial cultivation after further testing over a range of environments. Fifteen of the twenty eight crosses had significant reciprocal effect for green fruit yield per plant. Hence, the influence of maternal effect on the economic traits is evident in the present material.

M.Sc.

Title : **Genetic variability studies in french bean (*Phaseolus vulgaris* L.)** (2003)

Saiyad Mansur Basha, UAS, Bangalore, Guide : Dr.T.S.Aghora

Investigations on genetic variability studies in 47 genotypes of french bean (*Phaseolus vulgaris* L.) were carried out at Indian Institute of Horticulture Research, Hessaraghatta, Bangalore. Wide range of variability was observed for most of the characters studied. The analysis of variance revealed significant differences among the genotypes for all the characters studied. Phenotypic coefficient of variability was found to be higher than the genotypic coefficient of variability. The estimates of phenotypic and genotypic coefficient and variability were high for green pods per plant, number of pods per plant, plant height and 100 seed weight; moderate for number of branches per plant, number of inflorescence per plant, number of seeds per pod, pod length, pod width, pod weight and low values were observed for days to first flowering, days to 50 per cent flowering and days to pod maturity. Heritability estimates in broad sense were very high for pod length, green pod weight per plant, pod length, pod width, number of pods per plant, plant height, number of branches per plant, number of inflorescence per plant, days to first flowering, days to 50 per cent flowering, days to pod maturity, 100seed weight, pod weight and number seeds per pod. The genetic advance as per cent mean was high for green pod yield, plant height, number of pods per plant, number of inflorescence per plant and 100 seed weight number of branches per plant, pod length, pod width and number of seeds per pod have showed moderate genetic advance over mean. While other characters had low genetic advance over mean values. The path coefficient analysis revealed highest positive direct effect of number of pods per plant and pod length. The indirect contribution of component characters on green pod yield was high through number of pods per plant, number of branches per plant, number of inflorescence per plant and 100 seed weight. In D2 analysis 11 clusters were formed, out of which cluster I with 17 genotypes was the biggest followed by cluster II consisting of 12 entries and cluster III and V had 5, 2 and 4 entries respectively, cluster VI and X had 2 entries and all the other remaining cluster were solitary. The intra-cluster distance was maximum for cluster III. The highest inter duster distance was recorded between cluster V and VI while the cluster VII and VIII were the least divergent. The investigation revealed that the cluster V (Arka Anoop, AFAI0, PNK 30, PNK34) and VI ((AKx220) 12-3 IPS1) possess the potential

genotypes that can be chosen for hybridization programme to develop varieties with high green pod yield.

M.Sc.

Title : **Genetics of yield and yield components in cauliflower** (2003)

Devaraju, UAS, Bangalore, Guide : Dr.B.Varalakshmi

An investigation on generation mean analysis in cauliflower was carried out at Indian Institute of Horticultural Research, Hesaraghatta, Bangalore, during 2002-2003. The objective was to estimate heterosis, heritability and genetic advance and gene action for various quantitative characters. The parents, hybrids and segregating generations were evaluated in RCBD with 3 replications. The salient features of the present investigation are summarized here under. All the crosses exhibited earliness for curd initiation and curd maturity over the parental population mean except IIHR Sel-5 x First Early. Significant heterosis observed for days taken for curd initiation, curd maturity, total plant weight stalk length and yield per plant in the cross IIHR 223 x IIHR 302, either in positive or negative direction. In cross IIHR 223 x IIHR 217-1-4-6-12, significant heterosis was observed for days taken for curd initiation, curd maturity, total plant weight, stalk weight and curd yield per plant, whereas in IIHR 217-1-4-6-12 x IIHR 73-24 for the character days taken for curd initiation, leaf number and leaf weight. The heterosis was significant for all the characters except for stalk length in the cross IIHR Sel-5 x First Early. In the F₁ hybrid of IIHR 217-1-4-6-12 x IIHR 73-24 desirable negative heterosis for days taken for curd initiation was noticed.

Highest heritability and genetic advance was observed for the characters curd yield per plant, stalk weight, leaf weight and total plant weight in cross IIHR 223 x IIHR 30. The cross IIHR Sel-5 x First Early recorded the highest heritability and genetic advance for the characters like curd yield per plant, stalk weight and total plant weight. Majority of yield contributing characters in IIHR 223 x IIHR 302 and IIHR 223 x IIHR 217-1-4-6-12 controlled by non-additive gene action where the hybrid vigour was exhibited. Hence it is beneficial to emphasize on heterosis breeding on these crosses. In IIHR 217-1-4-6-12 x IIHR 73-24 most of the characters were under the operation of additive gene action. It could be fixed by simple selection in segregating generations. Most of the characters of the cross IIHR Sel-5 x First Early were under the influence non-additive gene action, so it is wise to go for heterosis breeding to exploit the hybrid vigor.

M.Sc.

Title : Genetic analysis of yield and yield components in okra (*Abelmoschus esculentus* L. Moench) (2004)

Y.C.Chandrashekar, UAS, Bangalore, Guide : Dr.M.Pitchaimuthu

An investigation was carried out, to estimate heterosis, heritability, genetic advance, gene action, gene action and study the incidences of YVMV in okra. Among the F₁ hybrids evaluated, P7 X BO-13 exhibited an appreciable amount of heterotic effect or hybrid vigor for most of the yield contributing characters *viz.*, total yield per plant, marketable yield per plant, fruit weight, number of fruits per plant, fruit length and fruit girth. The same hybrid also exhibited heterosis effect on earliness, days to first fruiting and days to first picking. The heritability and genetic advance as percent mean ranged from 1.0% (days to 50% flowering) to 87.06% (days to flowering) and 107% number of branches per plant in the cross Arka Anamika x BO-13. The F₁ hybrid Arka Anamika x BO-13 most of the traits were under the influences of both additive and non- additive gene action. In order to use of these both gene action reciprocal recurrent selections would be beneficial. The other F₁ hybrids Parbhani Kranti X VRO-6 and P. Kranti x BO-13 much of the yield contributing traits were under the influences of dominant gene action where the hybrid vigor was exhibited. The incidence of yellow vein mosaic virus disease was found to be very low in BO-13 (0%) and VRO-6 (3.33%) among the parents. Among the hybrids. Arka Anamika x BO-13, P. Kranti X BO-13 and P7 x BO-13 were found to be resistant to YVMV under field condition.

M.Sc.

Title : **Pollination and variability studies in cauliflower** (2004)

T.R.Vinay, UAS, Bangalore, Guide : Dr.B.Varalakshmi

The present investigation was taken up to study the level of self-incompatibility and genetic variability among the selected fifteen genotypes of early cauliflower. Fertility index was estimated by seed set as well as fluorescence microscopic methods. By seed set method, out of 15 genotypes, seven genotypes namely IIHR-223, IIHR-217-19-6-12, IIHR-263, IIHR-73-5, IIHR-318, IIHR-351 and IIHR-266-16 were found to be self-incompatible as the fertility index was very high and more than one. This high fertility index might be due to the fact that self-incompatible genotypes possess highly expressive S-alleles. Due to these S-alleles action in self-incompatible genotypes seed set was very less under self pollination (bagging and manual selfing of open flowers). Genotypes IIHR-250-4-1-11-28, IIHR-272, IIHR-217-3-14, IIHR-352, IIHR-316-17, IIHR-73-3, IIHR-305 and IIHR-73-24 were self compatible because their fertility index was less than one. The ultimate categorization of all the fifteen genotypes into self-incompatible and self-compatible based on fertility indices remained the same under both the methods.

The analysis of variance revealed highly significant differences among the genotypes for days to curd initiation, day to curd maturity, leaf number, plant weight, leaf weight and curd weight. It was observed that high heritability values were associated with moderate value of genetic advance or gain for days to curd initiation and days to curd maturity. Moderate heritability with moderate genetic advance has been observed for characters like leaf weight, curd weight, curd diameter, low heritability with low genetic advance was observed for characters like total plant weight, leaf number, curd size, stalk length and stalk weight indicating that these characters are governed by non additive gene components and the selection based on phenotypic appearance will not be effective and hence they can be exploited by heterosis breeding.

M.Sc.

Title : Characterization of chilli (*Capsicum annuum* L.) germplasm for quantitative and qualitative characters (2004)

V.T.Sreenivasa, UAS, Bangalore, Guide : Dr.K.Madhavi Reddy

A field experiment was conducted during *kharif* 2002 at Division of Vegetable Crops, Indian Institute of horticultural research, Hesaraghatta Bangalore to “Characterize the Chilli (*Capsicum annuum* L.) germplasm for quantitative and qualitative characters. The design adopted was Augmented design with four standard checks *viz.*, Arka Lohit, Pusa Jwala, G-4 and Punjab Lal. Two hundred accessions were evaluated for their variability. Phenotypic coefficient of variability was found to be higher magnitude than the genotypic coefficient of variability for all the seventeen character studied. High percentage of PCV coupled with thigh heritability and high genetic advance was observed for number of fruits per plant, fruit length, fruit width, fruit pericarp thickness, Ascorbic acid, capsaicin, capsanthin, oleoresin, fresh to dry recovery, fresh yield per plant and dry yield per plant. Correlation analysis revealed that positive significant association of fresh fruit yield per plant with number of fruits per plant (0.907,0.921), plant spread (0.443, 0.455), ascorbic acid (0.358, 0.365), plant height (0.316,0.328), oleoresin (0.237, 0.242), number of seeds per fruit (0.185, 0.1990 and capsanthin (0.183, 0.185). Path coefficient analysis for fresh fruit yield per plant indicated that number of fruits per plant (0.861), fruit length (0.175), capsanthin (0.084), fruit width (0.066) and pericarp thickness (0.0.49) are the most important characters, which can be used as selection criteria for improving yield. No parallelism was observed between genetic diversity and geographical diversity. The characters ranking indicated that, fresh fruit yield per plant followed by ascorbic acid, number of fruits per plant and capsanthin were the major contributors towards genetic divergence. None of the combinations of selection indices constituted for fresh fruit yield per plant recorded more than 100 per cent relative efficiency, which revealed that straight selection was superior to selection indices for this character.

M.Sc.

Title : **Genetic analysis for chilli veinal mottle virus resistance in chilli (*Capsicum annuum* L.)** (2004)

M.S.Adarsha, UAS, Bangalore, Guide : Dr.K.Madhavi Reddy

Though India is the largest producer of chilli in the world covering an area of 8.922 lakh ha, its production (9.213 lakh t) and productivity (1030 kg/ha dry yield) are considerably low. Among the factors that limit its production, viruses play an important role. Around 21 viruses are reported to be affecting chilli in India, of which chilli veinal mottle virus (ChiVMV) and cucumber mosaic virus (CMV) transmitted mechanically and aphids in non-persistent manner are very important. In India cultivars with good amount of potyvirus resistance coupled with high yielding potential are lacking in chilli. A few varieties *viz.*, Pant C-1, Tiwari, Punjab Lal are developed for virus resistance, their acceptability in the country is limited. Therefore, a few experiments were conducted to confirm resistance to ChiVMV in the improved lines at IIHR, to study genetics of resistance to ChiVMV resistance; and to study heterosis, combining ability and gene action of the hybrids developed using promising ChiVMV resistant lines. Segregation patterns for disease reaction in F₁, F₂ and backcross generations along with their corresponding parents suggested monogenic recessive condition for ChiVMV resistance. Heterosis study indicated the superiority of some out standing hybrids over better parent. Combining ability studies indicated that both gca and sca effects were important for all the characters studied, however the gca variance was lesser than the sca variance expressing the non-additivity preponderance. Parents with high mean performance and significantly desired effects along with F₁s having significantly desired sca effects have been pooled. The gene action study illustrated that the characters *viz.*, number of secondary branches per primary branch, average fruit weight, stalk length, fruit width and ChiVMV resistance were under control of both additive and non-additive effects. Epistasis was operating in few traits *viz.*, early flowering, plant height, plant spread, fruit width and seed ratio per fruit. Fruit length was under the control of additive gene action.

M.Sc.

Title : **Breeding french bean (*Phaseolus vulgaris* L.) for resistance to mung bean yellow mosaic virus (2008)**

A.H.Naveen, UAS, Bangalore, Guide : Dr.T.S.Aghora

The genetic information on resistance to mung bean yellow mosaic virus (MYMV) was generated in french bean (*Phaseolus vulgaris* L.) by employing diallel analysis involving one resistant line IIHR-55 (IC 525260) and four susceptible commercial cultivars viz., Arka Komal, Arka Anoop, Arka Suvidha and IIHR-78 and their F₁ and F₂ progenies. Environmental conditions at experimental site were quite favorable for the disease development. Further, screening of F₁ and F₂ populations was also done under laboratory conditions for confirmation of resistance. The frequency distribution of resistant and susceptible grouped in the ratio of 1: 15. The χ^2 analysis results were found highly significant at $P < 0.05$ and acceptance of null hypothesis gave a good fit to duplicate gene interaction ratio 1: 15 resistant to susceptible, respectively. It was found that two recessive genes governed the resistance in donor parent. Based on the F₂ mean *per se* performances, it was concluded that plants of the crosses IIHR 55 x AK and IIHR 55 x AA were promising with high yield and resistance. The combining ability studies indicated high proportions of gca variances than sca variances for all the characters studied indicating the predominance of additive gene action. Negative association of quantitative characters with % disease incidence and coefficient of infection were significant for all the characters except days to 50 per cent flowering and days to pod maturity. The magnitude of negative correlation of PDI and CI was high for pod yield per plant and pod number per plant. It was found that none of the parental lines was superior general combiner for all the traits. Similarly none of the cross combination had SCA effects for all the characters. Among the parents, and F₁s studied, the parental line IIHR-55 (IC525260) was the best general combiner with high gca effect, the crosses IIHR 78 X AK and IIHR 78 X AA were best specific combiners with high sca values and the cross IIHR 78 X AA was best reciprocal combiner for most of the quantitative characters studied, viz., plant spread in both directions, pod yield per plant, pod number per plant, ten pod weight. The identified RAPD marker OP7₇₃₀ which is linked to MYMV resistance in french bean can be successfully used for rapid screening and identification of genotypes resistant to MYMV.

M.Sc.

Title : **Characterization and evaluation of cauliflower germplasm (2009)**

H.M.Santhosha, UAS, Bangalore, Guide : Dr.B.Varalakshmi

An investigation was carried out to study the morphological characterization; character association studies and genetic divergence in early cauliflower at IIHR during the *khariif* season of 2008-09. In the present investigation through characterization studies, out of 51 early cauliflower genotypes, IIHR-272, IIHR-263, IIHR-266 and IIHR-390 showed superior performance for high marketable curd weight and white compact curds along with resistance to biotic stresses hence these lines may be directly used for cultivation or as a source of desirable traits in a breeding programme for the improvement of curd yield in cauliflower. High genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were observed for characters like, plant weight, leaf weight, curd size, net curd weight, net plot yield, yield per hectare, protein, vitamin-C and marketable curd weight. Moderate values of GCV and PCV were observed for characters like, leaf number, curd depth and curd diameter.

It was observed that high heritability values were associated with high values of genetic gain or advance for plant weight, leaf weight, curd diameter, curd size, net curd weight, net plot yield, yield per hectare, protein, vitamin-C, marketable curd weight and high heritability values with moderate genetic advance for leaf number, indicating these characters are governed by additive gene action. Character association revealed highly significant positive association of plant weight, leaf number, leaf length, leaf breadth, leaf weight, curd depth, curd diameter, curd size, net curd weight, net plot yield and yield per hectare with marketable curd weight at both the phenotypic and genotypic levels. Path coefficient analysis also revealed that maximum direct effect of characters like, plant weight, leaf number, leaf length, curd size, net curd weight on marketable curd weight at both the levels. Therefore for, genetic improvement in cauliflower it is better to adopt direct selection through plant weight, leaf number, leaf length, curd size, net curd weight.

In genetic divergence study, fifty one genotypes differed significantly for the 16 quantitative characters considered collectively and highest diversity was found between genotypes namely, IIHR-323-13, IIHR-214-5, IIHR-277-14 and IIHR-263, IIHR-272. Hence in order to get more variability in heterosis breeding programme crossing between these genotypes is desirable. It was observed that marketable curd weight, plant weight, net plot yield and curd size had contributed predominantly towards divergence.

M.Sc.

Title : Validation of molecular markers linked to ToLCV resistance in tomato varieties/F₁ hybrids (2010)

Shamprasad Phanis, UAS, Bangalore, Guide : Dr.A.T.Sadashiva

Tomato (*Solanum lycopersicum* L.) is one of the most important and extensively grown vegetables around the world. Successful cultivation of tomato crop has been hindered due to attack by numerous pests and devastating diseases. Chiefly of these limiting factors, the tomato leaf curl disease caused by Tomato Leaf curl Virus (ToLCV) is a destructive disease of tomato in many parts of India and world. The use of molecular markers linked to genes for resistance is a tool, which can be used efficiently in plant breeding through marker assisted selection (MAS). In this study three molecular markers *Ty1*, *Ty2* and *Ty3* linked to ToLCV resistance were validated with fourteen ToLCV resistant entries after screening against ToLCV resistance under screen house. These resistant entries included four ToLCV resistant varieties (Hisar Anmol, Vyabhav, Nandhi and Sankranthi), six ToLCV resistant commercial hybrids (Abhinava, Arka Ananya, Lakshmi, NS-501, Shakthiman and US-618); three advanced breeding lines (IIHR-2611, IIHR-2822 and IIHR-2823) and a ToLCV resistant wild accession *Solanum habrochaites* LA 1777 (IIHR-2101) and Pusa Ruby was used as a susceptible check. Among these, two advanced breeding lines IIHR-2822 and IIHR-2823 showed the presence of the all three genes *TY1*, *Ty2* and *Ty3* for ToLCV resistance, the wild accession *S. habrochaites* LA 1777 (IIHR-2101) showed the presence of two genes *Ty2* and *Ty3*, Abhinava showed the presence of *Ty1* gene and Hisar Anmol (H-24), Vyabhav, Arka Ananya, Lakshmi, NS-501 showed the presence of only *Ty2* gene and none of them showed the *Ty3a* gene presence. The varieties Nandhi and Sankranthi; hybrids Shakthiman and US-618 and the advanced breeding line IIHR-2611 (TV 55) did not show any presence of the *Ty1*, *Ty2* and *Ty3* resistant genes.

M.Sc.

Title : **Identification of molecular markers linked to male sterility in onion (*Allium cepa* L.)** (2010)

V.Dhanya, UAS, Bangalore, Guide : Dr.R.Veere Gowda

Onion is one of the most important vegetable crops. Onion hybrids are very popular. Male sterility has been utilized for the production of F₁ hybrids. Molecular markers help us to identify a male sterile and maintainer line which facilitates early development of F₁ hybrids with stable male sterility system. Keeping this in view, the present study was conducted in onion. Studies on morphological and floral characters of male sterile (A), maintainer (B) and male parent (C) lines have showed significant differences for different parameters. Molecular characterization of these lines using RAPD marker could not differentiate the genotypes successfully. However Dendrogram and PCA analysis clustered the genotypes accurately. The first cluster consisting of MS-65 and MS-48 group and the second cluster consisting of MLT group. This result has also in agreement with the morphological character, as multiplier onions are different from single onions.

A marker was identified which could able to classify male sterile (A) and male fertile (B) genotypes by using ORF 725 primers. Among the male sterile and maintainer lines tested with ORF 725 marker, the lines MS-65(A and B), PBR (A and B), Rose onion (A and B) were successfully differentiated by amplifying both forward and reverse primers to produce two bands in male sterile(A) and one band in male fertile (B) lines. This marker was not able to differentiate A and B lines of Arka Pragati, MS-48 and MLT group. Among F₁ hybrids tested, the F₁ 451 (MS-65 x Sel-13) produced two bands but 394(MS-65 x PBR) and 452(MS-48 x Sel-14) produced single bands indicating these are lacking stable cytoplasmic male sterility. This is because male sterile lines used in these hybrids are not stabilized. This may be also due to the N-cytoplasmic contamination of S-cytoplasmic hybrid seed lot.

M.Sc.

Title : **Studies on genetic diversity in okra (*Abelmoschus esculentus* L. Moench)**
(2010)

Prakash Kerure, UAS, Bangalore, Guide : Dr.M.Pitchaimuthu

Okra is a popular green vegetable crop grown in India for its delicious tender pods. The extent of initial genetic variability or genetic diversity determines the level of crop improvement to large extent. Hence, the investigation on genetic variance was carried out with 44 okra genotypes. The high GCV and PCV were observed for plant height, internodal length, first flowering node, first fruit producing node, average fruit weight and number of seeds per fruit. High heritability coupled with high GAM were observed for all the characters, studied, except for days to 50% flowering and days to 80% maturity showed high heritability with low GAM. In genetic divergence study, 44 okra genotypes had differed significantly for the 12 quantitative morphological characters and grouped into 12 clusters based on D2 analysis. The cluster III was the largest with eight genotypes followed by cluster I and VIII with seven, cluster II with five, cluster XII with three genotypes while, cluster IV, V, VI, IX, X and XI were included two genotypes each. Maximum inter cluster distance was observed between the cluster VI and VIII (35.57) and inter cluster distance as in cluster XII (28.14). The characters namely days to 50% flowering (35.62%), 100 seed weight (28.44%), number of seed per fruit (17.23%) and average fruit weight (8.14%) were directly contributed towards maximum divergence. The extent of genetic diversity at molecular level was estimated for 44 okra genotypes using DNA markers (RAPD). The total genomic DNA was extracted and subjected to RAPD analysis using 14 arbitrary decamer primers, produced good polymorphic bands across the genotypes. RAPD data's were subjected to calculate a SED matrix using Wards method. It clearly showed two major groups, first consisting of three genotypes and second one further grouped into 11 sub groups included 41 genotypes. The present study also clearly grouped the six wild species in one cluster and five cultivated species in another cluster from the total of eleven okra genotypes; these results were hold good with by using ITS markers.

M.Sc.

Title : Assessment of genetic variability and identification of DNA markers linked to fruit quality traits in chilli (*Capsicum annuum* L.) (2011)

Ponnam Naresh, UAS, Bangalore, Guide : Dr.K.Madhavi Reddy

Chilli is an indispensable commodity in every Indian cuisine due to its pungency, spicy taste, appealing colour and flavour of fruits. Understanding genetic variability and population structure is of great importance and a prerequisite for association mapping to identify marker trait associations. Investigation on Genetic variance for major fruit quality traits was carried using 116 chill genotypes. The high GCV and PCV were observed for total capsaicinoids, total carotenoids, red and yellow fractions of total carotenoids and total soluble solids. High heritability coupled with high GAM was observed for all the major quality traits studied. Investigation on population structure was carried out with 100 chilli genotypes using 24 genome-wide simple sequence repeat (SSR) markers using STRUCTURE and DARwin softwares. The 100 accessions were divided into three subpopulations. The three clusters seemed to have very distinct parentages with few genotypes categorized as having admixed ancestry from at least two clusters and represented a good population structure which is amenable for association analysis. Allele mining approach was followed to see Sequence variation in candidate genes responsible for colour and pungency. Results revealed that Capsanthin capsorubin synthase gene coding region was present in yellow pepper line LCA 1068 (Aparna) with 99% similarity to sequence of Byadagi Dabbi (dark red line) except for a single nucleotide polymorphism (G935A) and an amino acid change (R312K). In case of pungency, Acyltransferase gene several single nucleotide polymorphisms (SNPs) were found scattered throughout the amplified sequence of 840bp. Phylogenetic analysis of sequences showed clear demarcation between *AT3-1* and *AT3-2* (tandem duplicates of *AT3*) and the non-pungent lines are not clustered into single cluster suggesting the existence of contrasting modes for varied level of pungency.

M.Sc.

Title : Genetic diversity and evaluation of advanced lines for resistance to downy mildew (*Pseudoperonospora cubensis*) diseases in cucumber [*Cucumis sativus*] (2011)

R.Veena, UAS, Bangalore, Guide : Dr.Amrik Singh Sidhu

An investigation was under taken to assess the genetic diversity, heritability, genetic advance, morphological and molecular characterization and screening for downy mildew disease resistance in advanced lines was conducted at IIHR, Bangalore, during 2010-2011. To assess the genetic variability and diversity of 38 genotypes of diverse origin were tested for 17 quantitative morphological traits. Genotypic and phenotypic variation was high for node at first female and male flower appear and yield per plant. High heritability coupled with genetic advance over mean was recorded for node at first female flower appears and yields per plant. Fruit yield had positive and highly significant association phenotypically and genotypically with 100 seed weight, vine length, number of fruits per plant and flesh thickness. Vine length, number of fruits per plant and flesh thickness had positive and direct genotypic and phenotypic effects on fruit yield per plant. The cucumber lines were analysed by using 13 RAPD primers those produced 103 DNA markers bands. A total of 67 polymorphic bands were obtained with a mean of 5.15 bands per primer. The cluster drawn out of the distance matrix grouped various genotypes in to two major cluster as A and B, than again major cluster A is sub divided in to A1 to A9. The highest dissimilarity percentage was between genotypes IIHR-409-2 and 595920. The genotypes Swarna Ageti, Sangeeta, Nandini, Barsati, Ajax, VR-101, VR-06-07, IIHR-405, Karur Local IIHR-407-1, and IIHR-409-2 were found to be moderately resistant and *Cucumis hardiwickii* showed highly resistant to the downy mildew disease.

M.Sc.

Title : Development and performance studies of F₁ hybrids in Manjarigota type of brinjal (*Solanum melongena* L.) (2011)

Khapte Pratapsingh, UAS, Bangalore, Guide : Dr.T.S.Singh

Brinjal is an important solanaceous vegetable crop grown in India and throughout the world. The Manjarigota type of brinjal is of purple colour with white strips and has great demand in south India due its colour and taste. Twenty one crosses resulting from a L x T design comprising of seven lines and three testers were studied to know the combining ability and magnitude of heterosis. Combining ability analysis revealed that L₃ and L₄ showed good general combiner for most of the characters. The tester T₂ were identified as good general combiner for yield and yield attributing characters. Among the 21 crosses, L₄ x T₂ was identified as best specific combiner as it showed high *sca* effect and per se performances (2.73 kg) for fruit yield per plant. For heterosis out of 21 crosses, L₄ x T₂ (69.56%) and L₃ x T₂ (49.68%) were the most heterotic and could be exploited for commercial cultivation. The cross L₄ x T₃ exhibited highest magnitude of heterosis over commercial check for average fruit weight (14.22%), L₆ x T₂ exhibited significantly heterobeltiosis (-4.89) for days for fifty per cent flowering which is desirable. The hybrid L₄ x T₂ exhibited highest magnitude of mid parent heterosis (90.74%) for number of fruits per plant and highest heterobeltiosis (98.74%) for estimated yield tonnes per hectare in desired direction. The hybrid L₄ x T₂ exhibited highest heterosis over mid parent and commercial check for fruit length. For fruit diameter L₆ X T₂ exhibited highest heterosis over mid parent and commercial check.

M.Sc.

Title: Studies on combining ability for purple blotch disease resistant, bulb yield and quality components using male sterile lines in onion (*Allium cepa* L.) (2012)

Ambresh, UHS, Bagalkot, Guide : Dr.R.Veere Gowda

Onion is an important vegetable crop grown in India and throughout the world. Purple blotch caused by *Alternaria porri* is one among serious fungal diseases that affect onion, causing heavy yield loss ranging from 2.5 to 87.8 per cent. So there is need to develop hybrids with male sterility background for resistant to purple blotch disease coupled with higher yield. Twenty eight crosses resulting from a L x T design comprising of four lines and seven testers were studied to know the combining ability and magnitude of heterosis. Combining ability analysis revealed that L₃ showed good general combiner for most of the characters. The tester T₄ and T₅ were identified as good general combiner for yield and yield attributing characters. Among the 28 crosses, L₂ x T₄ was identified as best specific combiner as it showed high *sca* effect and *per se* performance, were as cross L₃ x T₅ exhibited high *per se* performance for total and marketable bulb yield. For heterosis out of 28 crosses, L₂ x T₄ and L₃ x T₅ were the most heterotic and could be exploited for commercial cultivation. The cross L₂ x T₄ (-42.62%) had exhibited highest magnitude of heterosis over commercial check for purple blotch disease resistance in desired direction. L₂ x T₁ (-7.78%) exhibited significant stranded heterosis for days to maturity. L₃ x T₁ (36.84%) showed significant mid parent heterosis for ten bulb weight. The cross L₃ x T₅ exhibited highest magnitude of heterosis over commercial check for total bulb yield tonnes per hectare (27.44%) and for marketable bulb yield per hectare (28.65%), L₂ x T₂ (-33.33%) exhibited significant heterosis over standard check for unmarketable bulb yield per hectare.

DIVISION OF ORNAMENTAL CROPS.

Ph.D

Title : **Seed germination and tissue culture studies in orchids** (1982)

Ramachandran Nair, UAS, Bangalore, Guide : Dr.Foja Singh

Investigations were carried out to standardize *in vitro* culture techniques and find out the effect of different culture media, growth substances, and other additive on seed germination and tissue culture of orchids. Studies on cytological and histochemical changes associated with orchid seed development were also made. Comparison of five different media (Knudson, C., Murashige-Skoog, Vacin and Went, Burgeff N₃F and modified Vacin and Went) for germination and growth of seeds of six different orchid species showed that Vacin and Went medium was superior in respect of germination, growth and development of *Bletilla hyacinthine*, *Phaius wallichii* and *Epidendrum radicans*, while Murashige-Skoo medium was found superior for *Spathoglottis plicata* and *Vanda coerulea*. Burgeff N₃F medium was found suitable for different *Dendrobium* species. Histochemical studies revealed that the seeds of *Bletilla hyacinthine* contained considerable amount of lipids and proteins but no starch. The developing protocorm exhibited a decreasing gradience in the size of its cells and its nuclei. Ribonucleic acid and proteins showed an increasing gradiance in the protocorm like body from its base to apex. The peripheral cells of the callus of *Dendrobium pierardii* contained rich cytoplasmic RNA and proteins and a few starch grains. Cytological evaluation of the cultured tissue revealed the presence of chromosomal variations in different cells. This may be due to the stress caused by the unnatural environment by cell fusion.

Ph.D

Title : **Genetical investigations in china aster (*Callistephus chinensis*)** (1984)

S.P.S.Raghava, UAS, Bangalore, Guide : Dr.S.S.Negi

Studies were carried out to evaluate 12 parents on the basis of combining ability and to analyse genetic basis of inheritance of 14 quantitative characters in 12x12 diallel set of crosses in two conditions, namely, field and pot culture. Inheritance of important quantitative characters like flower colour, flower doubleness, flower type and plant type was also studied. Diallel analysis revealed involvement of both additive and non-additive gene actions in the inheritance of 14 quantitative characters under both conditions. However, additive gene action played predominant role in the inheritance of number of ray florets per flower head and flower size, while the remaining 12 characters, viz., plant height, number of main branches per plant, number of laterals per plant, plant spread, stem girth, area per leaf, days to flower, number of flowers per plant, stalk length, flower weight, duration of flowering and cut flower life were found to be governed mainly by non-additive gene action under both conditions. Dominance and epistasis of complementary type played significant role in the inheritance of all characters which were reflected in terms of better parent heterosis for almost all characters under both conditions. As regards inheritance of quantitative characters, violet colour was found to be dominant all colours, deep pink over pink and pure white and pink over light pink and pure white. Deep pink was incompletely dominant over light pink. Four independent genes, A, B R and P were found to govern different flower colours. Gene B had a dominant allele B. Doubleness (DD) was observed to be monogenically dominant over singleness (dd). Pompon type of flower was dominant over Chrysanthemum and Fluffy types. Chrysanthemum type was dominant over Fluffy type. Three independent genes Tu, D and C governed these three flower types. Drooping plant type (Dp Dp) was found to be incompletely dominant over erect plant type (dp dp).

Ph.D

Title : **Studies *in vitro* seed germination and morphogenesis in orchids** (1986)

Sangama, UAS, Bangalore, Guide : Dr.Foja Singh

Most of the orchid species are cross pollinated viability and storage of pollen seeds and protocorms for getting desired hybrids were investigated. The pollen viability of *Spethoglottis plicate* *Epidenrumradicans* and *Dendrobium* “Jaquelyn Thomas” was reduced when stored with a dehydrant (silicagel). Storage at low temperature (4 °C) enhanced pollen viability compared to that at room temperature in all the three species. Seed viability of these three species was enhanced when stored with dehydrant. Protocorn regeneration of *Dendrobium* “Jaquelyn Thomas” was better when stored with glycerol 10% as a cryoprotectant. Among three media used, *S.plicate* seeds germinated successfully in Pundson’s medium in a short time. Seed germination of *E. radicans* and *Dendrobium* “Jaquelyn Thomas” was better in MS medium. Seed germination of all three species was faster with NAA, GA and BA at 0.1 mg l⁻¹ and 1 mg l⁻¹ as compared to control. Among the three growth regulators, GA at 1 mg l⁻¹ was best as the time required for germination was half that required with control. The percent seed germination in all three species was higher with NAA, GA and BA at 0.1 mg l⁻¹ as compared to other treatments. Growth of the seedling was enhanced with growth regulators either alone or in combination than control in all the three species. Less time was required for complete growth of the seedling with IBA+GA+BA each at 5 mg l⁻¹ compared to other treatments. Histochemical and ultra structural studies revealed the utilization of metabolites for organal development. Lipids, proteins and carbohydrates were utilized in the order mentioned during seed germination.

Ph.D

Title : **Development of micropropagation systems and new *in vitro* strategies for some import ornamental plants (1993)**

M.B.Ravindra, UAS, Bangalore, Guide : Dr.Foja Singh

The present Investigations were conducted at the IIHR, Hessaraghatta, Bangalore to develop *in vitro* systems for some important ornamental plants. In *Saintpaulia ionantha*, leaf discs were found to be a superior source of explants than petiole section with respect to morphogenic responds. However, the axenic leaf explants responded at a faster rate during recurrent cultures. MS medium supplemented with NAA and BA at 0.5 mg l⁻¹ was found to be optimum for callusing and differentiation of explants during initiation of cultures. Combination of IBA and BA at 1 mg l⁻¹ resulted in maximum number of plantlets during both axenic cultures and subsequent subcultures. Higher intensity of rooting and better growth of plantlet was observed on MS medium without growth regulators. A potting mixture of soilrite + sand + compost (2:1:1 V/V) and hardening of plantlets using polythene covers for 3 weeks was found to be optimum for better establishment of plantlets. Begonia 'Lucerna' Petiole segments cultured on MS medium supplemented with NAA 1 mg l⁻¹ + BA 2 mg l⁻¹ resulted in higher intensity of callusing and differentiation. *Cymbidium aloifolium* protocorms cultured on liquid Vacin and Went medium supplemented with 0.4 mg l⁻¹ BA resulted in maximum proliferation of PLB's and multiple shoots. Similarly, the nodal segments also induced maximum number of shoots on the same medium. *Anthurium scherzerianum* leaf sections initiated callus from the veins when cultured on Vacin and Went medium supplemented with 2, 4-D and BA at 1 mg l⁻¹. The protocorms of *Cymbidium aloifolium*; callus, petiole sections and shoot buds of *Saintpaulia ionantha* were encapsulated using 2.5% sodium alginate and it was found that these encapsulated plant material could be stored at 4°C temperature. This suggested the suitability of encapsulated material for efficient delivery system, storage and effective transport under limited refrigerated condition. Another of *Saintpaulia ionantha* culture *Saintpaulia ionantha* on MS + IBA 1mg l⁻¹ + BA 1 mg l⁻¹ resulted in higher callusing and differentiation of haploid plantlets. Leaf mesophyll protoplasts of *Dendrobium* 'Jaquelyn Thomas' were isolated using 5 ml enzyme solution having 0.75% cellulose and 0.4% onozuka R-10 macerozyme and an incubation period of 16 hours.

Ph.D

Title : **Encapsulation & regeneration of protocorms in orchid (*Spathoglottis plicata*)**
(1995)

B.V.Champa, UAS, Bangalore, Guide : Dr.Foja Singh

Encapsulation is a technique, where in cultured matter like a tissue piece, or an organ, or a cell is coated with synthetic polymer which later degrades and allows the plant to establish. An investigation on Encapsulation & regeneration of protocorms from encapsulated breads was carried out in the orchid laboratory, IIHR, Hessaraghatta, Bangalore during 1993-95. Orchid seeds from matured pods of *Spathoglottis plicata* were sown on modified vaccine & Went medium, Murashige & Skoog medium & Nitsch medium by green pod culture technique to standardise the media for protocorm production. It was found that modified vaccine & Went medium; Murashige & Skoog medium gave satisfactory results & resulted in healthy protocorms. The protocorms were encapsulated using different hydrogels viz., sodium alginate, alginic acid, agar & gelrite. Among these, sodium alginate was found to be the best hydrogel for encapsulation. The encapsulated beads were stored in sterile petriplates, wrapped with parafilm & kept under storage temperatures for long term storage temperature. Beads stored at this temperature, were viable even after 12th week of storage & gave good regeneration when cultured on artificial medium. The regenerated plants, when transplanted to community pots established well with 70-80% field establishment. This technique offers a unique way for efficient delivery system, storage & efficient transport of plant material from one to another place under limited refrigeration conditions.

Ph.D

Title : **Mutation breeding in rose and pigmentation studies in rose and hibiscus**
(1997)

K.S.Shobha, UAS, Bangalore, Guide : Dr.R.N.Bhat

An investigation was carried out at IIHR, Bangalore to study the effect of gamma rays on 3 rose cultivars along with qualitative and quantitative estimation of flower pigments of rose and hibiscus cultivars. Budwoods of rose cvs. Paradise, Raja Surendra Singh of Nalagarh and Sindoor were irradiated at 3,4,5 and 6 kR gamma rays and budded on the rootstocks. Increased dosage of gamma rays reduced sprouting and survival of vegetative buds. Four induced mutants were reduced in cv. Paradise. However, the Raja Surendra Singh of Nalagarh was found to be less sensitive to higher doses of irradiation. The detailed morphological studies were carried out in the induced mutants. The morphological studies were also carried out in 6 spontaneous rose mutants developed at the institute along with their respective parents. Analysis of pigments in rose genotypes indicated that somatic flower colour is due to both qualitative and quantitative changes in pigments resulted by induced and spontaneous mutation. Paper chromatographic studies revealed that among the induced mutants, increased gamma irradiation reduced the anthocyanin contents where as the spontaneous rose mutants had higher concentration of anthocyanin than their parents exhibiting somatic flower colour change. The study of pigments was also extended to 15 hibiscus cultivars developed at the institute to understand the biochemical basis of their flower colour variation. More of anthocyanin with high concentration was observed in red and orange/orange yellow groups having darker shades as compared to yellow/yellow orange group of cultivars having lighter petal shades. Thus both in rose and hibiscus, the major pigment estimated was anthocyanin and tentatively as cyanin.

Ph.D

Title : Induction of mutation in carnation (*Dianthus caryophyllus* L.) through gamma rays and ethyl methane sulphonate. (1998)

K.Hemalatha, UAS, Bangalore, Guide : Dr.R.N.Bhat

Induction of mutation was attempted on two carnation genotypes viz., 'Sterlite Dop' and 'H-13' using gamma rays as physical mutagen and on one genotype 'Sterlite Dop' using EMS as chemical mutagen at different concentrations. The effect of mutagen treatments on various morphological and floral characters, histological and histochemical changes during rhizogenesis and organogenesis and pigment composition were studied. Increased dosage decreased sprouting and survival of cuttings. Induction of mutation reduced all the morphological characters at higher dosage of gamma rays. Some interesting leaf variegations like leaves with white and creamy yellow streaks were observed in cuttings treated at 1.5 and 2 kR gamma rays. Interesting changes were observed with respect to the floral characters. At 2 kR gamma rays, petal variegation was observed in genotype 'H-13'. Two flower colour mutants were observed in cutting treated at 1.5 kR gamma rays in genotype 'Sterlite Dop' and 1 and 2 kR gamma rays in genotype 'H-13'. A miniature mutant with reduction in flower size was also observed in genotype 'Sterlite Dop' treated at 2 kR gamma rays. Induction of mutation through EMS showed very little response. However, few plants treated with 3% EMS showed creamy yellow streaks on the leaves of cv. Sterlite dop. Correlation studies revealed that environmental and genetic factors influenced to a great extent. Meager deviation in genotype and phenotypic co-efficient indicated the reliability of variation. Histological and histochemical studies of the shoot apex revealed the stepwise development of cellular damages like suppression in the growth of dome shaped apex, vacuolation of cells, damage of the apical initial layer, total damage of a small percentage of cells and formation of dichotomy with the extent of damage increasing in the dosage of gamma rays. Exposure of cutting to different doses of gamma rays resulted in correlative inhibition of root emergence. Considerable variation was observed in the anthocyanin, chlorophyll and carotenoid content among the seven carnation genotypes studied. Quantitative and qualitative studies using paper chromatographic and thin layer chromatographic methods were undertaken. By comparing anthocyanin bands with that of authentic standards, the pigments present in carnation were tentatively identified as cyanin and pelargonidin.

M.Sc.

Title : **Propagation and cytotaxonomic studies in some Indian orchids** (1981)

S.R.Nagabhusan, UAS, Bangalore, Guide : Dr.Foja Singh

Investigations to standardize propagation techniques in some Indian orchids and cytological studies in 15 species of Indian orchids belonging to five genera were carried out. Among five basal media (K.C., V.W., BN₃F, M.S. and M) compared with regard to germination and growth of *Spathoglottis plicate* and *Phaius wallichii*. Vacin and Went's (V.W.) medium proved to be the best in which germination of seeds was faster than in the others. Pseudobulbs of *Dendrobium aggregatum* treated with IBA at 1000 and 2000 ppm put forth maximum rooting, number of roots and root length. The effect of NAA at 2000 ppm on the Pseudobulbs was similar to that of IBA at 1000 and 2000 ppm. Cytotaxonomical studies showed that among the five species of Paphiopedilum (*P.fairieanum*, *P.hirsutissimum*, *P.insigne*, *P.venustum* and *P.villosum*) four species except *P.venustum* were found to be diploids with $2n=26$. *P.venustum* possessed $2n=36$ which may be hypoploid due to centric fission. In these species the chromosomes were large. All the three species of *Cymbidium* (*C.aloifolium*, *C.giganteum*, and *C.grandflorum*) possessed a chromosome number $2n=40$ which represented a clear homogenous assemblage. In the genus *Pholidota* the species *P.imbricate* also had a chromosome number of $2n=40$. In the genus *Aerides* all the species investigated (*A.lawrence*, and *A.odorum*) possessed $2n=40$ chromosomes. In *Rhynchostylis* the only species investigated *R.retusa* possessed $2n=38$. It was concluded that both numerical and structural alteration in chromosomes have played an important part in the evolution of different orchid species, which got stabilized through the agency of vegetative reproduction.

M.Sc.

Title : Effects of gibberellic acid on growth and flowering of china aster (*Callistephus chinensis* Nees.) (1982)

R.Jayanthi, UAS, Bangalore, Guide : Dr.A.Mukhopadhyay

Gibberellic Acid at concentrations of 0 (control, spraying with distilled water), 10,25,50,100,250,500 and 1000 ppm were sprayed at 60 and 75 days after sowing on China aster cultivar 'Heart of France' to observe the effects on growth, flowering and chemical composition. The results indicated that GA3 spray at 50 ppm and above effectively increased plant height at all stages of growth, whereas 100 and 500 ppm concentrations were most effective in increasing the number of main branches. The influence of GA3 was not evident on the production of axillary branches. Flowering was accelerated considerably as a result of GA3 spray and the maximum acceleration of 52 days was obtained by 250 ppm spray. Though total flower production was not increased, the marketability of the flowers was significantly increased by GA3 sprays of 50-25 ppm as GA3 treated flowers were of better quality in terms of size (diameter), fresh weight and longevity. The total nitrogen content of leaves increased at vegetative stage in GA3 treated plants which might have contributed towards production of more branches. Similarly, sugar content in leaves at vegetative stage improved in GA3 treatments which might have helped the plants to produce better quality flowers. The flowers of the GA3 treated plants contained maximum amount of reducing and non-reducing sugars, which might have contributed towards better flower life.

M.Sc.

Title : **Studies on genetic variability and correlations in china aster (*Callistephus chinensis* Nees.)** (1982)

T.Manjunatha Rao, UAS, Bangalore, Guide : Dr.S.S.Negi

Wide and significant variations for all the 12 characters were observed among the 38 genotypes of China aster studies. The difference between phenotypic and genotypic coefficient of variation was medium for a number of laterals per plant and narrow for the remaining characters. High heritability as well as high genetic gain were observed for flower weight and number of ray florets, whereas medium heritability along with high genetic gain was observed for number of laterals per plant. High heritability accompanied by medium genetic gain was found for plant height, plant spread, stalk length and stem girth. Stalk length had positive and significant correlations with plant height, plant spread, number of laterals per plant, number of flowers per plant, days to flower, flower size, flower weight and number of ray florets per head. Positive and significant associations were observed between flower size and each of the following seven characters, viz., plant height, plant spread, stalk length, number of laterals per plant, days to flower, flower size, flower weight and number of ray florets per head. Number of flowers per plant exhibited positive and significant relationship with plant height, plant spread, stalk length, number of main branches per plant, number of laterals per plant and days to flower. Path coefficient analysis revealed that plant height and plant spread were the major factors influencing stalk length directly. Number of flowers per plant, number of ray florets per head and flower size were also important as their total indirect effect on stalk length was high. Flower size was found to be influenced directly by stalk length, number of ray florets per head and plant spread. Plant height and the maximum total indirect effect on flower size., number of laterals per plant had the maximum direct effect on number of flowers per plant. This was followed by number of main branches per plant. Selection showed that selection based on 11 characters would be more efficient than straight selection to an extent of 42.5% in stalk length and 21.5% in number of flowers per plant, but there was practically no improvement over straight selection in flower size.

M.Sc.

Title : **Cytotaxonomical studies in Indian *Dendrobiums* (Orchidaceae)** (1982)

C.T.Yeshoda, UAS, Bangalore, Guide : Dr.Foja Singh

Twenty different species of Indian *Dendrobiums* are collected from the Western Ghats and North Eastern India was evaluated cytotaxonomically. Out of the twenty species, eleven species had $2n=38$ chromosomes and nine had $2n=40$ chromosomes. All the species endemic to Western Ghat region had $2n=38$ ($n=19$) chromosomes, but the species from Eastern India had both $2n=38$ as well as $2n=40$ ($n=19, 20$) chromosomes. Chromosomes were found to be very small in size in this genus. Length of chromosomes ranged between 2.75 μm in *D.herbaceum* and 4.5 μm in *D.aggregatum*. Size of chromosomes ranged between 2.0 and 2.75 μm in other species. In this investigation karyotypes were not much helpful in delineating different species from each other. Species having close morphological similarity had very distinct unrelated karyotypes. Out of the twenty species studied, five species showed the presence of satellites, mostly one pair except in *D.nobile* which had two pairs of satellite chromosomes. The satellites were very distinct and hint towards the polyploidy origin of the species. The differentiation of *Dendrobium* species as evident by karyotypic variation may be due to the increase in telocentric chromosomes by centric fission or simple translation or inversion. However, the structural changes in chromosomes appear to have little effect on the external morphology of different species.

M.Sc.

Title : **In vitro propagation of orchids** (1984)

Sulalappa, UAS, Bangalore, Guide : Dr.Foja Singh

The major objectives of the investigations were to standardize the method for *in vitro* propagation of orchids both through seed/embryo culture and meristem culture. *Bletilla hyacinthine*, *Dendrobium phalaenopsis* were selected for the seed/embryo culture studies while *Epidendrum radicans*, *Dendrobium phalaenopsis*, *Vanda* 'Miss Joaquim' and *Cymbidium munronianum*, *C. aloifolium* were selected for tissue culture studies. Modified Vacin Went medium was found most suitable for the germination of *Bletilla hyacinthine* seeds while Burgeff N₃f medium supported the best germination in *Dendrobium phalaenopsis*, IAA (1 mg l⁻¹) when incorporated in the medium enhanced seed germination and subsequent growth in both the species. It was also observed that coconut water 15% v/v had no effect on seed germination but it was very much helpful in subsequent growth and development of seedlings. Tissue culture studies revealed that Vacin-Went medium best suited for callus formation and differentiation in all the species studied followed by MS and Kc media. IAA and NAA incorporated in the medium (1 mg l⁻¹) gave more number of plantlets compared to control in *Epidendrum radicans*, while in *Vanda* 'Miss Joaquim' the best results were obtained by incorporating coconut water 15% v/v in addition to IAA and NAA (1 mg l⁻¹). It was also observed that NAA+BA (1 mg l⁻¹) was helpful in producing multiple plantlets from the nodal sections of *Epidendrum radicans*.

M.Sc.

Title : **Morphological evaluation of some rose cultivars** (1985)

Sudeep Vyapari, UAS, Bangalore, Guide : Dr.R.N.Bhat

Investigation was carried out to study and compare the extent of morphological variability including vegetative and floral characters, pollen fertility status and disease tolerance of 50 rose cultivars. Majority of the cultivars were exotic and of recent origin. All the cultivars except 'Careless Love' had erect growth habit. Considerable variation was observed for plant height, average leaf area and density of thorns in different rose cultivars. Variability was also observed to exist for flower bud size, flower diameter, number of petals, petal length and petal breadth. Of the 50 cultivars, 14 had moderately fragrant flowers and cv. Fragrant hour was highly fragrant. The cvs. Ambassador and Ghazal had maximum and minimum stalk length. On estimating the pollen fertility using versatile stain, the cv. Ferry Porche had maximum whereas 'Yankee Doodle' had minimum pollen fertility percentage. It was also observed that 27 cultivars were highly susceptible to black spot and 34 cultivars were tolerant to powdery mildew. Based on the morphological evaluation of 50 rose cultivars, 9 were selected suitable for garden display, 7 each for cut flowers and exhibition purpose.

M.Sc.

Title : Changes in growth, flowering and chemical composition as influenced by bulb size, spacing and depth of planting in tuberose (*Polianthes tuberosa* Linn.) cv. Single (1985)

H.T.Nagaraju, UAS, Bangalore, Guide : Dr.A.Mukhopadhyay

The objectives of the study were to investigate the effects of varying bulb sizes (bulb diameter of 1 cm and 3 cm), spacing (15 x 15 cm and 30 x 30 cm and depths of planting (3 cm and 7 cm) on the nitrogen and sugar contents of bulbs, bulblets and leaves at flowering stage. By using large sized bulbs the bulb production was more, flower spike emergence was early with higher yield of spikes. Flower quality parameters like length of spike, length of rachis, number of florets per spike and longevity of spike in field improved when large sized bulbs were planted. Wider spacing resulted in earlier emergence, larger yield of flower spikes, besides improvement in length of rachis, number of florets and vase life of spikes. However, yield of spike and florets per unit area were more with closer spacing. Deeper planting improved the length of spike, number of florets per spike, length of rachis and longevity of spike in field and number of florets produced per unit area. Use of larger bulbs or narrow spacing resulted in higher total nitrogen in bulblets. Leaf nitrogen content was higher at wider spacing. Reducing and total sugar contents in leaves of plants from large bulbs were higher, whereas at closer spacing, reducing, non-reducing and total sugars of increased appreciably compared to wider spacing.

M.Sc.

Title : Studies on floral variability and sensitiveness of cutting to gamma radiations in some jasmine genotypes (1987)

K.A.Deviah, UAS, Bangalore, Guide : Dr.H.C.Srivastava

Analysis of variance showed highly significant differences among the genotypes for all the characters studied. The genotype and phenotypic coefficients of variation were found to be high for length of style, width of petal, length of anthers, weight of 100 flowers and weight of 100 flower buds. In general, phenotypic coefficients of variation (PCV) was marginally higher than genotypic coefficients of variation (GCV) except for length of flower bud, and it indicated low environmental influence on the expression of these characters. The high difference between PCV and GCV for flower bud length indicated that this character is influenced by environment. Heritability estimates were high for all the characters studied. Flower bud length revealed a comparatively lower estimate. Combination of high heritability and high estimate of length of style, width of petal, length of anthers, 100 flower weight, 100 flower bud weight, length of petal, diameter of flower, length of corolla tube, and number of petals per flower indicated additive gene action. percentage of rooting was high in all the genotypes and decreased with increase in dosage of gamma radiations. Untreated cutting (control) produced highest number of roots per cutting and the number of roots decreased with increase in the dosage of gamma radiations. Untreated cutting produced longest and thickest roots compared to irradiated cuttings. In general, there was a gradual decrease in the length and thickness in irradiation cuttings in all the genotypes studied. Thus, it can be concluded that gamma irradiation resulted in decrease in percentage of rooting, number of roots per cutting, length and thickness of roots.

M.Sc.

Title : Studies on pollen fertility, seed set and seed germination in some rose cultivars (1988)

M.G.Sandhya, UAS, Bangalore, Guide : Dr.R.N.Bhat

The investigation was on the pollen fertility status, seed setting behavior of three cultivars after natural selfing, artificial selfing and artificial cross pollination, tracing the pollen tube growth in stylar region, seed viability and seed germination in rose. The percentage of pollen fertility estimated in 48 cultivars by using versatile stain was found to vary widely with cultivars. Among the Hybrid Teas, cv. Chandrama (76.9%) had maximum pollen fertility. cvs. Aquarius (19.31%) and Roi des Rois (20.47%) had minimum pollen fertility among Hybrid Tea and Floribunda group, respectively. Seed setting was observed to vary greatly with season. High temperature (>27 °C) adversely affected the fruit and seed set. Naturally selfed flowers of cv. Happiness did not set fruit in both the seasons due to lack of pollen grains falling on the stigma whereas artificial selfing improved the fruit set in cvs. Happiness and Paradise. cv. Queen Elizabeth was found to be better seed parent followed by 'Paradise' and 'Happiness' based on the degree of fruit setting. Fruit set as well as seed set was low in case of selfed flowers when compared to crosses. Although fruit set maximum (100%) in 'Queen Elizabeth' when crossed with cvs. Happiness and Paradise seed set was maximum (23.06) in the cross between 'Paradise' x 'Queen Elizabeth' followed by 'Paradise' x 'Happiness' (17.20) during July-Nov., 1987. Seed viability test was carried out by using topographical tetrazolium test for the first time in rose. Embryo along with the cotyledon stained more than half was considered as viable. Embryos unstained and hollow inside were considered as non viable seed. As per the test, percentage of seed viability was 'Paradise' and 'Happiness' in cv. Proud Land (56%) followed by 'Cyclamen' (52%) and 'Queen Elizabeth' (51.2). open-pollinated seeds of cvs. Cyclamen, Proud Land and Queen Elizabeth were successfully germinated on moist vermiculite at a constant temperature of 4 °C. Seed germination was observed from 85-134 days in refrigerated condition. Seed germination was maximum (42.6%) in cv. Cyclamen and was poor in case of cvs. Proud Land (13.35) and Queen Elizabeth (10.6%).

M.Sc.

Title : **Studies on radiation sensitivity in some *Bougainvillea* cultivars** (1990)

P.T.Srinivas, UAS, Bangalore, Guide : Dr.R.N.Bhat

The present investigation was on relative radiation sensitivity, sprouting behavior, morphological variations, pollen fertility and finally selection of desirable mutants in three *Bougainvillea* cultivars viz., 'Dr.R.R.Pal', 'Lady Mary Baring' and 'Stanza'. The survival percentage estimated in three cultivars was found to vary widely. The LD₅₀ for 'Lady Mary Baring', it was 2.0 kR. Detailed studies on the morphological abnormalities with exposure to gamma rays revealed that the cuttings were very sensitive to radiation. The abnormalities observed in leaves include asymmetrical development of leaf blade, variation in size, notching, mottling and bilobed conditions in some of the leaves of the cuttings treated with more than 1.0 kR of gamma rays. Stimulation in plant height was observed at 1.0 kR in 'Dr.R.R Pal,' and 'Stanza' and in 'Lady Mary Baring' at 2.0 kR of gamma rays. An interesting induced somatic mutant in cv. 'Lady Mary Baring' was observed with changes in flower and bract colour in one of the well established plants at 3 kR of gamma rays. The bract colour was completely changed to light pink as compared to Indian yellow in the parent cultivar. The flower tube was changed to light green and star colour was changed to light yellowish green with the backside of star changed to pink. In 'Stanza' one of the interesting features observed was partial leaf variegation in two of the leaves at 2.kR. The mature leaves showed cream yellow variegation on one side of the margin. However, other leaves in this branch were normal. Rooting behavior varied widely in the cultivars after exposure to gamma rays. In Dr.R.R Pal, the development of adventitious and lateral roots was minimum at 1.0 kR, followed in 'Lady Mary Baring' at 1.5 kR and 'Stanza' at 2.0 kR. The pollen fertility estimated in all the three cultivars in the treatments showed that the pollen grains were shriveled and deformed and they failed to take the stain confirming sterility as in the parent cultivars.

M.Sc.

Title : ***In vitro* propagation of *Anthurium*** (1993)

L.Hemantha Kumar, UAS, Bangalore, Guide : Dr.Foja Singh

Foliage anthuriums are gaining importance as indoor plants and are highly valued in the internal market and for export. The availability of planting materials however is very limited. The present studies were conducted to standardize methods for *in vitro* propagation of two important foliage species *Anthurium bakeri* and *Anthurium magnificum*. *In vitro* germination of seeds of *A. bakeri* were best supported by Nitesh medium followed by Vacin Went medium, Murashige and Skoog medium was not found suitable for germination or subsequently growth. Among the growth of seedlings (0.5 mg l^{-1}). NAA did not promote see germination or growth but induced callusing in the seedling early germination (0.1 mg l^{-1}) and subsequent growth (0.5 mg l^{-1}). Tissue culture studies revealed that leaf segments were the best explants for callus induction and subsequent growth as compared to periole segments, Nitsch medium was found to be the best for the growth. Among the growth regulators BA (0.1 mg l^{-1}) + 2,4-D (0.1 mg l^{-1}) were found more suitable for callus induction and subsequent growth in *A. bakeri*. Nitsch medium was also found to be the best for *A. magnificum*. Explants was observed in a combination of BA (1 mg l^{-1}), however higher concentration of BA (5 mg l^{-1}) inhibited the production of callus and its further growth. It was observed during the experiments that callus formation was promoted only in dark (45-60 days). The cost of production per *in vitro* seedling was Rs. 0.67.

M.Sc.

Title : **Hybridization studies in tuberose (*Polianthes tuberosa*)** (1993)

G.K.Seetharamu, UAS, Bangalore, Guide : Dr.R.N.Bhat

The detailed hybridization studies including pollen viability, *in vitro* pollen germination, seed setting behavior in nine tuberose genotypes were conducted for the first time. The percentage of pollen viability varied considerably between genotypes. Among the double type of tuberose, maximum pollen viability was observed in IIHR-5 (89.9%) and IIHR-3 (88.3%). In single type to tuberose, maximum pollen viability as observed in IIHR-6 (89.3%). The percentage of *in vitro* pollen germination by hanging drop technique in tuberose genotypes revealed that the double types the highest percentage of pollen germination was observed in IIHR-2 (62.75%) and the lowest was in IIHR-3 (47.46%). Among the single types, maximum percentage of pollen germination was recorded in IIHR-6 (62.95%) and the minimum in cv. Single (45.92%). The fruit set by open-pollination was highest in IIHR-6 (76.0%) whereas it was lowest in IIHR-1 (18.0%). Self incompatibility was observed in tuberose genotypes. Crossing of different single type of tuberose revealed that only in crosses between cv. Single x cv. Variegated a low percentage of success (1.31%) was observed after third and fourth day of pollination. The crosses involving double type of tuberose as a pollen parent with single type, the fruit set and fruit retention was considerably improved on fourth day after anthesis followed by third and second. Day. In single type to tuberose cv. Single and IIHR-6 were found to be better as seed parents. Among the double types, IIHR-2 and IIHR-3 were found to be better as pollen parents. The crosses between IIHR-6 x IIHR-3 gave better fruit set (31.71%) followed by IIHR-1 x cv. Double (35.29%). The open-pollinated seed germination was maximum in cv. Variegated (76.0%) followed by cv. Single, (64%). In seeds obtained from artificial cross-pollination, the seed germination was maximum in crosses between IIHR-1 x cv. Double (90.0%) followed by cv. Single x IIHR-2 (88.8%).

Ph.D

Title : **Micropropagation of *Gerbera*** (1996)

S.M.Deepaja, UAS, Bangalore, Guide : Dr.C.Aswath

Gerbera is one of the popular flower crops in the world and is gaining importance in our country. Hardy upright flowers, leafless long stalks, numerous colours with long vase life have popularised gerbera. Availability of cheaper plant material is one of the major limitations in popularising this crop. The present investigations were carried out with varieties GJ-1, GJ-2 and OJ-3 to study shoot proliferation callusing and regeneration of leaf explant and rooting of *in vitro* developed shoots Half strength media of both MS and modified MS induced early shoot initiation and side shoot initiation but shoot number, shoot length and shoot weight was better in full strength media. The best treatment to produce higher shoot number with better growth was MS medium supplemented with 0.2 mg l⁻¹ IAA and 1 mg l⁻¹ BAP in OJ-1 and OJ-3. For GJ-2, MS medium supplemented with 0.1 mg l⁻¹ IAA and 2 mg l⁻¹ BAP was best. It was noticed that the MS media supplemented with BAP induced higher multiplication rate with small plants and modified MS media supplemented with kinetin induced lower multiplication rate with good plant stature. Therefore, a protocol to obtain higher multiplication for a period of six weeks and transferring to kinetin supplemented modified MS media (5 mg l⁻¹ kinetin for GJ-1 and GJ-2, 1 mg l⁻¹ kinetin for GJ-3) for a period of four weeks before rooting is suggested. Callus initiation was earlier in media supplemented with 2,4-D and BAP when compared to media supplemented with IAA and BAP in all the three varieties. (Maximum amount of callus was produced by 0.5 mg l⁻¹ 2,4-D with 4 mg l⁻¹ BAP, 1.0 mg l⁻¹ 2,4-D with 3 mg l⁻¹ BAP and 0.75 mg l⁻¹ IAA with 2 mg l⁻¹ BAP. Two distinct type of calli were produced by leaf explant. Creamy callus which was frothy in GJ-1 and GJ-2 and friable in GJ-3 was produced by 2,4-D with BAP. Green/greenish white granular callus was produced by IAA and BAP. A higher cytokinin to auxin ratio in the media (IAA at 0.25, 0.5 or 0.75 with BAP at 3 mg l⁻¹ favoured regeneration from petiole tips of young leaves. The response was better with IBA than with NAA. Both IBA and NAA induced swelling of roots in GJ-2 and NAA induced callus production in GJ-3. GJ-2 was the only variety to show good response for ex vitro rooting. Best treatment for ex vitro rooting was IBA at 1000 ppm. When varietal responses to treatments were observed, NAA at 500 ppm was best for ex vitro rooting in GJ-2 and IBA at 1000 ppm for GJ-1.

M.Sc.

Title : Cytological and pigmentation studies in certain cultivars and mutants of *Bougainvillea* (1996)

N.Anand, UAS, Bangalore, Guide : Dr.R.N.Bhat

Studies were carried out to compare the cytological pigment differences associated with varied bract colours in certain *Bougainvillea* cultivars and mutants. The *Bougainvillea* genotype including induced mutants were selected. The quantitative and qualitative status of pigments showed considerable variations. The estimated betacyanin content expressed as O.D. value was observed to be maximum in cv. Elizabeth (1.7638) followed by colchicines induced mutant 'Zakariana' (1.2007) with the lowest bract (pH 5.87). Estimated bract betaxanthin content was found to be maximum in cv. Mrs. Enid Lancaster (1.5422) followed by cv. Tomato Red (1.0922). Therefore the ratio was of bract betacyanin to betaxanthin was the highest in cv. Dr. H.B. Singh (2.4901) with highest record bract pH (6.53) and the lowest betacyanin to betaxanthin ratio was observed in cv. Lady Mary Baring (0.1497). Qualitative estimation of bract pigments by paper chromatography on the basis of Rf values were grouped. Two betaxanthin bands were observed in all the genotypes studies except in cv. Dr.H.B.Singh. this variation in pigment content seems to influence upon light and dark coloured bracts of induced mutants. Cytological studies in the cultivars and mutants indicated no loss of the chromosomes in gamma irradiated and colchicine treated mutants. Miotic behaviour varied from normal behavior showing less number of univalents and pollen mother cells having laggards. Whereas in highly abnormal behavior more number of univalents and laggards were observed in metaphase I and anaphase I and II, respectively. Among the mutants gamma rays induced mutant 'Zakariana' had less mitotic behavior than its parent. Thus the uniformity in gametic chromosome number and variations in bract colour is attributed to the effects of genes controlling the bract colour expression.

M.Sc.

Title : **Variability studies in carnation (*Dianthus caryophyllus* L.)** (1997)

K.Mahesh, UAS, Bangalore, Guide : Dr.R.N.Bhat

An investigation was undertaken to study the nature and magnitude of various genetic parameters and association among important quantitative characters in carnation at the IIHR, Bangalore. The study involved nine genotypes and variability was observed for all of the characters except for flower weight and number of flower buds per stem. Out of 25 metric characters studied, 15 characters were found to be useful for breeding programme. Heritability with higher genetic advance were exhibited by leaf area at 6th node and number of secondary branches which have no commercial value but the latter plays an important role for commercial propagation. Genotype correlation coefficients were higher than phenotypic correlation coefficients. Most of the characters exhibited significant positive correlation among themselves except for very few characters. Flower diameter had significant positive correlation with petal width, petal length, flower length, leaf area at 6th, 9th and 15th node. Path coefficient analysis was done for three most important characters, namely, flower diameter, node number at which flowering and number of primary branches. Genotypes 'White with red edge', 'Arthur Sim' and 'Scania' were found to be superior for different horticultural characters and useful in breeding superior hybrids. The genotypes such as 'Scania', 'Dusty Pink', 'Pink', 'Arthur Sim' and 'Sam's Pride' were found to be having pleasant fragrance.

M.Sc.

Title : ***In vitro* studies on *Anthurium andreanum* Lind and *A. crystallinum* Hort.**
(1997)

Mrityunjay.B.Angadi, UAS, Bangalore, Guide : Dr.Devinder Prakash

The investigations were conducted on *Anthurium andreanum* and *A.crystallinum* at IIHR, Bangalore, for standardizing the best nutrient medium and to supplement adjuvants for *in vitro* seed germination and subsequent seedling growth, callusing, differentiation and acclimation. In vitro seed germination was rapid (7 days) on Morels medium, followed by half strength Nitsch, Nitsch, MS, Vacin and Went and Knudson-C media. Nitsch medium was the best to promote subsequent seedling growth parameters like root length (9.70 cm), number of roots (3.30), shoot length (3.24 cm), fresh weight (498.70 mg), dry weight (50.60 mg) and FW/DW x 100 index (985.20). Nitsch medium supplemented with coconut water supported the early seed germination (100 days) while the early seedling growth (fourth leaf) was promoted by banana pulp (100 days). However, ragi and wheat malt were inhibitory. MS medium containing 1 ppm each of BAP and 2,4-D was effective in inducing callus and further growth. Higher concentration of 2,4-D (6 ppm inhibited the callus growth in both the species. Lower concentration of BAP (1 ppm) induced more number of shoots per flask (36), root length (9.98 cm), number of roots(8.90), leaf length (1.84 cm) and the leaf breadth (1.22 cm) but higher concentrations (2.5 and 5.0 ppm) reduced the number of shoots and also inhibited the rooting. NAA(1 ppm)induced more number of roots (12.55) with higher root length (1.45 cm). All the plantlets were survived completely under mist chamber, green house and laboratory conditions. However, seedlings grown under mist chamber were superior for shoot length (6.49 cm), root length (10.29 cm), leaf length (3.66 cm) and leaf breadth (2.33 cm) in both the species.

M.Sc.

Title : **Embryo culture of certain economically important Orchids** (1998)

Shakeel Ahmed, UAS, Bangalore, Guide : Dr.Devinder Prakash

The *in vitro* studies conducted in *Cymbidium aloifolium* Sw., *Dendrobium nobile* Lind and *D. pierardii* Roxb. revealed that, Vacin and Went medium was best for early (6.33 weeks) and highest germination (48.33%) in *C. aloifolium*, while Knudson C medium was best for *D. nobile* and *D. pierardii* with 100% germination. Nitsch medium was also equally effective as that of Knudson C in case of *D. nobile*. Coconut water increased leaf length (1.23 cm) and stem thickness (0.17 cm) in *in vitro* plantlets of *D. pierardii*. Banana pulp increased leaf number (4.0) and leaf length (1.37 cm) in *D. nobile*. Wheat and sago were better alternatives to agar as they promoted growth. Wheat malt increased shoot length in *C. aloifolium* (1.74 cm) and *D. nobile* (0.94 cm). It also promoted leaf length (1.30 and 1.13 cm) and stem thickness (0.23 and 0.17 cm,) in *D. nobile* and *D. pierardii*. Sago increased leaf number in *C. aloifolium* (3.85) and *D. pierardii* (3.65), shoot length (3.13 cm) in *C. aloifolium*,s leaf length (1.12 cm) and stem thickness (0.18 cm) in *D. pierardii*. Even in *D. nobile* it could replace agar with slight beneficial effects. BAP (1 ppm) had a growth promotive effect in *D. nobile*. In *Dendrobium* species 2,4-D (1 to 6 ppm) with BAP(1 ppm) induced callus. 2,4-D and BAP (1 ppm each) were found best for early induction of callus (65.63 days), higher callus intensity, better callus size (5.31 mm), weight (30.85 mg) and with very quality. But, 2,4-D (1 to 6 ppm) was inhibitory for *C. aloifolium* protocorms. Polyhouse with higher relative humidity (80.85%) was better than Green house for hardening of *Dendrobium* hybrid 'Sonia', since survival percentage was highest (66.25%), as compared with green house (56.88%).

M.Sc.

Title : Studies on microsporogenesis and mega sporogenesis in hybrids of tuberose (*Polianthes tuberosa* L.) (1998)

K.C.Satisha, UAS, Bangalore, Guide : Dr.Meenakshi Srinivas

Floral biology, histological and histochemical studies of the reproductive structures of tuberose cvs. Shringar and Suvasini were studied. In 'Shringar' and 'Suvasini' an average of 17.76 and 26.86 days were required for anthesis from the stage of visible initiation. The anther dehiscence started at 6 pm and 6.20 p.m in 'Shringar' and 'Suvasini' respectively. The maximum anther dehiscence was observed around 6.20 pm in 'Shringar' and 'Suvasini' it was 7.00 p.m. histological and histochemical changes in anthers of 'Shringar' revealed that, during early stages of development, sporogenous cells had intense polysaccharide, protein and rich polysaccharides, proteins and RNA. The tapetum started degenerating, thus assisting nutrition of developing microspores. This was followed by the development of pollen wall with exine and intine around the mature spores. In 'Suvasini', PMCs were intense in insoluble polysaccharides, RNA and rich protein content. In the anthers, tapetum is not well differentiated. In the pollen sac, pollen development is incomplete because of improper differentiation of tapetum. They were exposed to malnutrition as a consequence, the pollen development is not proper. At pollen grain stage they had rich polysaccharide, protein and intense RNA content. Histological and histochemical studies conducted on the developing ovule revealed that the ovule was anatropous, crassinucellate and bitegmic. The development stages *viz.*, archesporium, megaspore mother cell, megaspore tetrad had low polysaccharides, intense proteins and RNA indicating a high rate of metabolic activity. The egg cell, synergids had rich polysaccharides proteins and RNA.

M.Sc.

Title : **Cytomorphological Studies in tuberose** (1998)

P.L.Jayasree, UAS, Bangalore, Guide : Dr.Meenakshi Srinivas

In tuberose (*Polianthes tuberosa* L.) the two high yielding F₁ hybrids viz., Shringar (single) and Suvasini (Double) were compared with their parents viz., Mexican single and Peral double for their somatic chromosome number, meiotic behavior, leaf and floral axis anatomy. Three of them except Suvasini were evaluated along with three other F₁ hybrids for the effect of tuber size (small and medium) on establishment and expression of both vegetative and floral characters. Somatic chromosome number in all four varieties was similar and was 2n=60. Five pairs of large chromosomes and 25 pair's small chromosomes were present. At diakinesis, one, two or three nucleoli were present in the four varieties. However, their frequency varied with varieties. Course of meiosis was nearly normal in all four varieties, culminating in the production of four microspores in most of the PMCs. The pollen fertility varied among the varieties. There were no differences in the leaf anatomy among the four varieties viz., Mexican single, Peral double, Shringar and Suvasini. Anatomy of floral axis is also similar in the four varieties. In the comparison of bulb size, appropriate choice of bulbs for planting based on size is variety specific in case of the three varieties studied viz., IIHR-2, IIHR-4, and Peral double.

M.Sc.

Title : Microsporogation studies on chrysanthemum (*Dendranthema grandiflora* Tvelev) (1998)

M.Viswanath, UAS, Bangalore, Guide : Dr.T.M.Rao

The investigations were conducted on chrysanthemum (*D. grandiflora* Tvelev) at IIHR, Bangalore, for optimizing the nutrient medium for multiple shoot induction, for *in vitro* rooting and to evaluate the efficacy of low cost gelling agents in chrysanthemum. Shoot tips of 5 mm and 10 mm long gave better establishment (60%0, and when cultured on various media started growing within a week after inoculation. Sterilization of chrysanthemum shoot tip explants using mercuric chloride at 0.1% for two minutes gave better survival for 'Ravikiran' (80%), 'M-14' (73.3%) and '87-17-1' (60%). For 'Yellow Gold', 0.05% mercuric chloride for three minutes was better. For nodal segment explant, mercuric chloride at 0.1% for two minutes was found to be better for all the four genotypes. After eight weeks of inoculation an average of six shoots was induced by BAP (2 mg/1) as well as kinetin (2 mg/1) when supplemented in MS basal medium. Cultivar Ravikiran produced eight shoots on BAP (2 mg/1). Maximum shoot length (3.25 cm) was obtained in cultivar Ravikiran in MS basal medium supplemented with BAP 1.5 mg/1. The medium with IBA 1mg/1 was effective in inducing maximum root length and number of roots for all the four genotypes. At four weeks the root length ranged from 2.5 cm to 3.2 cm. Cultivar Ravikiran was superior with an average of 18.8 roots having 3.28 cm root length. Gelrite and Agar as gelling agents performed better compared to Isubgol and Sago for multiplication of Chrysanthemum when nodal segments were used as explants. The shoot length was more (1.98 cm) and number of leaves was maximum (7) in gelrite. The survival of plantlets transferred to pots containing cocopeat and sand was high in cultivar Ravikiran (80%) followed by M-14 (75%).

M.Sc.

Title : Effect of coco peat media and electrical conductivity on production of *Gerbera jamesonii* (1998)

Padmanabha Pillai, Bangalore University, Guide : Dr.C.Asath

The experiment was carried out with gerbera to study the influence of coco peat based potting mixtures on production and leaf nutrient content of *Gerbera jamesonii*. The treatments include 100, 75, 50 and 25 per cent coco peat mixed with various proportion of normal growing media supplied with nutrient solutions having three different electrical conductivity 1.3 ds/m(E1), 1.8 ds/m (E2) and 2.3 ds/m (E3). The medium containing higher proportion of coco peat had good physico- chemical properties. The pH of the growing media decreased with increase in nutrient EC levels. The medium containing 100% coco peat supplied with nutrient solution having EC of 1.8 ds/m (E2) produced good quality flowers. The build up of EC was high in 100 per cent coco peat medium and low in normal growing medium. The phosphorus, potassium, calcium, magnesium, sulphur and micronutrients in leaves were determined after 4 months after planting. The leaf phosphorus, manganese, zinc, copper and sodium contents were high in 100 per cent coco peat medium while potassium and calcium contents were at optimum level. However, magnesium, sulphur and iron content were high in normal growing medium. In general, the nutrient contents increased with increased coco peat proportion.

M.Sc.

Title : **Chemical regulations of vase life of cut *Anthuriums*** (2000)

M.N.Anuradha, UAS, Bangalore, Guide : Dr.Devinder Prakash

Research was carried out to extend the vase life of cut Anthurium flowers of cv. Liver Re, Meringue and Casino by using different chemicals in combination with sucrose and germicides. The prime objective was to standardize optimum concentration of vase solution for the above cultivars by using growth regulators and metal salt in combination with sucrose and germicides. Studies include the use of growth regulators namely Triadimefon, Benzyl adinine, Mineral salts and AgNO₃. Each of these at 4 different concentrations, each in combination with two levels of sucrose, 4 & 6% and germicide 8 HqO at 400 ppm were used. It was observed that the chemicals used have shown to have maximum quantity of cumulative water uptake and higher water uptake to water loss ratio in the treated spikes. As a result there was a better water balance to maintain fresh weight which eventually leading to the increased longevity of flower. Best vase life improvement in the three cultivars was by 87%, 89%, and 93% respectively with chemical treatment over control. The period of initiation of the symptoms associated with senescence was drastically delayed by treatment with different concentrations of TAF, BA, AGNO₃ in combination with sucrose and germicides over control. Though all the chemicals used had beneficial effects in terms of better water relations to extend vase life in all 3 cultivars of anthuriums. BA was more effective followed by TAF, AGNO₃ in all three, in combination with sucrose and 8 HqO.

M.Sc.

Title : **Genetic and pollen studies in *Gladiolus* spp.** (2000)

M.V.Balaram, UAS, Bangalore, Guide : Dr.T.Janakiram

Gladiolus is one of the important bulbous ornamentals grown in many parts of the world. In India it has now gained importance as a cut flower for domestic consumption and also for export. A study was carried out at IIHR, Bangalore to generate information on genetic and pollen related characters in *Gladiolus* spp. Studies on the relative performance of India (11) and exotic (24) *Gladiolus* genotypes showed that Indian cultivars were early in spike emergence, had more florets per spike, more spikes per corm, high corm multiplication rate, larger corms, more viable pollen and short flowering duration. While, exotic genotypes had larger florets, more florets open at one time, longer spikes and high cormel multiplication rate. Since, exotic cultivars exhibited better spike/floret characters which are of economic importance they may be grown on a commercial scale. High phenotypic and genotypic co-efficient of variation, heritability and genetic advance recorded for number of shoots per plant, number of spikes per corm, number of daughter corms, number of cormels per corm, 25 cormel weight and propagation co-efficient suggests selections of genotypes based on these traits for further improvement through effective breeding programmes. Studies on the association of various morphological traits through correlation and path co-efficients analysis showed that, plant height, spike girth, number of florets open at one time, florets length, weight of daughter corm and rachis length had positive and significant correlations with maximum direct effects on number of florets per spike. While leaf number, floret diameter and spike length though had positive and significant correlations. Spike weight, and equatorial corm diameter had maximum indirect effects with significant and positive correlations. Number of daughter corms had significant positive association and direct effects on number of shoots per plant and 25 cormel weights. While, number of shoots per plant through had significant and positive correlation, it exhibited maximum indirect effect. The feasibility studies on storing pollen from five promising varieties viz., Darshan, Dhiraj, Sagar, Sapna and Shobha developed at IIHR and *G. callianthus* a wild fragrant species at sub zero temperatures of -65 °C and -196 °C (in liquid nitrogen) showed negligible loss in the viability, vigour and fertility levels of pollen (from all the genotypes) upon storage compared to fresh pollen. Hence, there are no species/variety specific pollen storage temperatures.

M.Sc.

Title : **Effect of different growing media and pH on growth and development of *Anthurium andreaeanum* L. (2000)**

R.Smitha, UAS, Bangalore, Guide : Dr.M.L.Choudhary

Anthurium is gaining importance in the global cut-flower trade because of its attractive and long lasting flowers. Commercial cultivation of this crop started recently in India and hence there is a need to standardize the growing techniques. *Anthurium* plants require a growing medium with good physical and chemical properties for their proper growth and development. In the present study coir pith, a waste product of coir industry, was tested in combination with different proportions of normal potting medium (soil, sand and FYM in 2:1:1 ratio) to find of their suitability as substrate for *Anthurium*. Coir pith and normal potting medium ratio of 100:0, 75:25, 50:50, 25:75 and 0: 100 were tried in the experiment. In each growing media three levels of pH (4.5-5.5, 5.5-6.5-7.5) were maintained to determine the optimum range of pH for *Anthurium*. The experiment was designed in a completely randomized factorial design with fifteen treatment combinations. Increased proportions of coir pith in the growing media improved the physical properties viz., maximum water holding capacity, porosity and drainage. The bulk density and particle were lowered with the addition of coir pith due to the increase in pore space and lighter weight of particle. The pH of the growing medium was decreased with increasing proportions of coir pith whereas CEC was found to be increasing with increasing amounts for coir path. The available NPK status of coir pith containing medium was higher than that of normal potting medium. The growth parameters like leaf area, number of levers, petiole length, petiole thickness and number of roots were maximum in 100% coir pith medium. The number of suckers per plant, fresh weight and dry weight were higher in T₂ (75% coir pith + 25% normal potting medium) and T₁ (100% coir pith) growing media when compared to other growing media treatments. Early flowering was also noticed in these two media where plants flowered within a period of eight months. Leaf water potential was improved by increasing amounts of coir pith in the growing media. The light of these results, it can be concluded that for better growth and development of *Anthurium* the most suitable growing medium is the one containing coir pith alone. Among the different pH levels maintained in the media, slightly acidic pH range of 5.5-6.5 was optimum for the growth of *Anthurium* plants.

M.Sc.

Title : **In vitro regeneration of chrysanthemum (*Dendranthema grandiflora* Tzvelev)**
(2000)

J.B.Noorjahan, UAS, Bangalore, Guide : Dr.M.L.Choudhary

In vitro direct regeneration without a callus intermediary is a pre-requisite for developing efficient transformation system, in ornamental crops including chrysanthemum (*Dendranthema grandiflora* Tzvelev) which is one of the popular flower crops of the world. An experiment was conducted to develop an efficient direct regeneration protocol for chrysanthemum. The surface sterilized shoot tip and leaf explants of cvs. Ravikiran and Chandrika were cultured on Murashige and Skoog medium fortified with different concentration of BAP (0.2-2.5 mg/l), Kinetin (0.2-2.5 mg/l), IAA (0.1-1.0 mg/l) and NAA (0.5-1.0 mg/l). The MS medium supplemented with 0.2 mg/l BAP or Kinetin+0.1 mg/l was found best for obtaining maximum frequency of regeneration. Puncturing the surface sterilized explants before inoculation increased the frequency of regeneration from leaf explants. The number of regenerated adventitious shoots obtained was significantly more from cv. Ravikiran when compared to cv. Chandrika. Histological studies conducted showed that direct shoot regeneration was obtained from the mesophyll cells. The histochemical studies carried out revealed that arising shoot primordial, leaf primordial and pro-vascular strands showed intense protein and nucleic acid content. Preliminary studies on *Agrobacterium* mediated genetic transformation revealed that chrysanthemum transformants with Kanamycin after a co-cultivation period of 48 hours.

M.Sc.

Title : **Performance, dormancy and disease screening studies in *Gladiolus*** (2001)

G.Shankar Murthy, UAS, Bangalore, Guide : Dr.T.Manjunatha Rao

Gladiolus is one of the most important bulbous ornamentals grown commercially for cut flower purpose. An investigation was carried out on performance of cultivars, breaking of dormancy and screening of cultivars against fusarial wilt disease at Indian Institute of Horticultural Research, Hessaraghatta, Bangalore. The performance was best adjudged in *Gladiolus* cultivars 'Sapna' for days to flower, floret diameter and florets open at one time, 'Sagar' for plant height and corms and cormels produced per corm, hybrid '87-22-1' for spike and rachis length, 'Meera' for number of florets per spike and 'Darshan' for number of marketable spikes per corm. High phenotypic and genotypic co-efficient of variation, heritability and genetic advance were found for the characters *viz.*, rachis length, number of side spikes per corm, duration of flowering, cormels produced per corm, cormel size and cormel weight. Marketable spikes per corm had significant and positive genotypic correlation co-efficients with number of side spikes per corm and cormel size. It also had positive direct effects with rachis length, number of florets per spike, vase life and corms produced per corm. Treatment of small sized corms of *Gladiolus* hybrid '87-22-1' with ethrel at 250 ppm for 48 hours reduced the days to sprout, while treatment with ethrel at 1000 ppm resulted in maximum sprouting percentage. Whereas, the treatment of medium sized corms of *Gladiolus* hybrid '87-22-1' when treated with thiourea at 500 ppm resulted in early sprouting, while the maximum sprouting percentage was recorded from the corms treated with 50 ppm BA for 48 hours. Pollen from the second basal floret collected after one day of tying and incubated for 3½ hours showed maximum pollen germination. Fresh pollen had maximum germination than room temperature and cold stored (-65 °C) pollen. Pollen of all the cultivars germinated well in the absence of fusaric acid, while with the addition of fusaric acid there was drastic reduction in germination and there was complete inhibition of pollen germination at higher levels of fusaric acid.

M.Sc.

Title : **Genetic studies in tuberose (*Polianthes tuberosa* L.)** (2002)

K.N.Radhakrishna, UAS, Bangalore, Guide : Dr.Meenakshi Srinivas

A study was undertaken to evaluate tuberose genotypes for qualitative and quantitative characteristics and to understand the variability and heritability of different morphological traits. Fourteen genotypes of tuberose were evaluated. Hybrids Prajwal, 1x6 (T) and Shringar exhibited superior performance for loose flower yield while Vaibhav and Suvasini recorded higher spike yield. Hybrids IIHR-2, 1x6 (T) and Shringar exhibited good multiplication of bulbs.

M.Sc.

Title : Investigations on varietal response to dormancy in Gladiolus (*Gladiolus grandiflorus*) (2011)

Varun.S.Amingad, UAS, Bangalore, Guide : Dr.T.Manjunatha Rao

Gladiolus is a very popular bulbous ornamental flower crop. It is commercially propagated by corms and cormels which have a dormancy period. The period of dormancy varies with variety which is also influenced by the corm storage temperature and environment during crop growth period. A study to determine the effect of storage temperatures, duration of storage and effect of growth regulators was conducted. Corm storage temperature and duration of three varieties viz., 'Arka Amar', 'Darshan' and 'Kum Kum' significantly affected the days to sprouting, sprouting per cent, days to spike emergence and days to first flowering. The dormancy period was least in cultivar 'Kum Kum'. The dormancy period was least in corms stored at 4 °C. Planting the corms 90 days after storage resulted in earliness to sprouting compared to those planted at 70 and 50 days after storage. In cv. Arka Amar corms soaked with ethrel (250 ppm) for 24 hours took minimum number of days for sprouting (22.73 days). Biochemical tests revealed that cv. Kum Kum had the highest activity of the enzyme α -amylase in its corms. Cultivar 'Arka Amar' showed moderate activity of α -amylase followed by cv. Darshan which showed least activity of the enzyme. Catalyse activity among the varieties was not much. Corms stored under ambient conditions showed high catalyse activity.

M.Sc.

Title : **Hybridization and development of inbred line in *Petunia*** (2011)

Swathi Kolukunde, UAS, Bangalore, Guide : Dr.T.Tejaswini

Petunia is a popular bedding plant and also used in landscaping for its aesthetic value. *Petunia* is a major contributor in flower seed industry with an increasing demand for F₁ hybrids. Cost of developing hybrids is mainly dependent on cost of inbred development and hybridization. Inbreeding depression leading to poor seed set and reduced seed germination are problems encountered by seed industry. In this background the present study was taken up with the objectives to evaluate various selfing techniques to identify the efficient one for production of large quantity of seeds in short duration to facilitate inbred development and also for hybrid production. Among the different methods of selfing (threading, manual pollination, bagging of single bud and bagging of multiple buds), bagging of multiple buds resulted in minimum days to seed set (22 days), cent percent seed set, higher pod weight (0.252g) and number of seeds/g (8000). Seed germination percentage was high in manual pollination (86.44%) followed by bagging of multiple buds (68.44%). Inbred line IIHRP-WT recorded higher pod weight (0.149g), number of seeds/g (7350) and cent percent seed set compared to other inbred lines. In crossing programme, pollination with pollen mix of same line gave the highest pod weight (0.1109g) and number of seeds/g (11400) over the other methods *viz.*, pollination with single anther and pollen mix of same plant. Floral morphology studies revealed variations for flower colour (white, purple, pink, magenta, bicour of white and pink), anther and pollen colour (white, yellow and purple), number of anthers (5-7), position of stigma in relation to anthers (pin and thrum), receptivity of stigma in relation to anthesis, dehiscence of anthers and pollen viability (40.66-97.77%). All the inbred lines showed their ability to seed set in selfing experiments except in IIHRP-SI wherein self incompatibility was confirmed.

DIVISION OF POST-HARVEST TECHNOLOGY.

Ph.D

Title : **Mineral composition and anatomical changes in *Alphonso mango* during storage with reference to internal breakdown (1992)**

K.Haribabu, UAS, Bangalore, Guide : Dr.Shantha Krishnamurthy

The investigations were made on (i) Physico-chemical changes, mineral composition, histological and histochemical changes, during growth, development, storage and ripening and (ii) the effect of pre-harvest spray and post harvest spray and post harvest infiltration with calcium chloride on the above mentioned changes and also on the occurrence of internal breakdown (spongy tissue) in Alphonso mango. Fruit length, diameter, weight of fruit, pulp and peel increased gradually up to 45 days, followed by a sudden increase to maximum of 90days and pre harvest spray of calcium at 5000 and 10000 ppm significantly enhanced this increase. The effect of post harvest calcium infiltration was more pronounced in delaying ripening, reducing the weight loss and firmness, increase of peel colour, pulp colour (carotenoids), sugars and decrease of acidity during storage as compared to pre harvest sprays. Analysis of calcium (Ca), Potassium (K), Sodium (Na) and Phosphorus (P) during growth and development, in general indicated reduction in the concentrations from 15 days to 90days after fruit set both in the peel in the pulp. The distribution of minerals in 6 different pulp tissues during ripening indicated that Ca content was maximum in the basal pulp portion as compared to middle and apical parts. The distribution of minerals in 6 different pulp tissues during ripening indicated that Ca content was maximum in the basal pulp portion as compared to middle and apical parts. Further, the pulp towards the peel showed more Ca than in the pulp towards endocarp. In case of K & P, it was more in the pulp nearer to endocarp and no change was seen from base to apical portion of the pulp. Spongy tissue affected pulp showed low Ca (19.25 mg), high K (726 mg), P (135.6 mg) & Na (45 mg) as compared to 41.8 mg Ca, 501 mg K, 85 mg P & 37 mg Na in the healthy tissue. Both the pre & post harvest Ca treatments had no effect on spongy tissue development. Histochemical studies indicated the appearance of starch granules after 60 days of fruit set in all the tissues of the fruit & maximum accumulation was found after 90 days of fruit set. In pre harvest sprays of Ca, the cell of the fruit were bigger in size with more starch grains & degradation of these grains was delayed during ripening. Ripening process was initiated

in mesocarp region. Development of spongy tissue was found in pulp near endocarp. The cells in this were small, globular & thick walled with numerous starch grains.

Ph.D

Title : **Studies on low temperature storage of guava (*Psidium guajava* L.)** (1996)

G.Ramesh, UAS, Bangalore, Guide : Dr.Shantha Krishnamurthy

A detailed investigation was made on the effect low temperature storage on shelf life and quality of 3 cvs. of guava viz., Allahabad Safeda, Lucknow-49 and Arka Mridul a selection released from IIHR. Fruits were harvested at physiologically mature stage. Uniform size fruits with green colour were packed in 100 g polybags and stored at 24 °C with 45% RH (RT). Studies on changes in physico-chemical composition rate of respiration and ethylene release were made periodically both at RT and LT storage. The total weight loss range from 3-4% at RT storage as compared to less than 2% at LT storage. Firmness of the fruit at harvest in the 3 cultivars ranged from 21.6 to 26.5 kg/cm² and it decreased to 3.5kg/cm² at the end of storage. Rate of respiration increased from 49-180 mg CO₂ in Allahabad Safeda and 148-254 mg CO₂/kg/hr in Lucknow-49 after 9 days of storage and in Arka Mridul it enhanced from 90-275/mg/kg/hr after 7 days. Acidity decreased slightly in all the cultivars i.e., the range was from 0.4-0.68 to 0.25-0.56. a slight increase in Vit.C was observed during storage in all the cultivars. Lucknow -49 had the maximum Vit.C content of 260 mg/100 g as compared to 180 mg in the other 2 cultivars. Total soluble solids was in the range of 10.8-14.6 and there were minimum changes during storage both at LT & RT. Lucknow-49 and Arka Mridul. Yellowing of the fruit at RT was faster (4th day) in Lucknow-49 and Arka Mridul as compared to Allahabad Safeda (7th day). At LT storage Allahabad Safeda remained firm and green for 18 days and it could be kept for a period of 22 days. Allahabad Safeda and Lucknow-49 could be kept for 15 days.

Ph.D

Title : **Storage studies on sapota (*Manilkara achras*) cv. Cricket ball** (1996)

H.Nagaraja, UAS, Bangalore, Guide : Dr.Shantha Krishnamurthy

An investigation was made to study the optimum low temperature for extending the shelf life of sapota cv. Cricket Ball. The fruits were stored at 29+1, 25+1, 20+1 and 15+1 °C and the effect of temperature on ripening. Shelf life and physic-chemical changes were studied. Fruits at optimum mature stage and of medium size were manually harvested and used in the study. The fruits were packed in ventilated polybags and stored at the above temperatures and RH ranged from 40-75%. Periodical observations on changes in weight loss, respiration, firmness, total soluble solids, acidity, Vit.C, reducing and non-reducing sugars, rate of ripening and sensory evaluation of the ripe fruit were made at each storage temperature. The weight loss was 7.5% in 13 days at 29 °C storage and it decreased to 2-3% after 14-23 days at other temperatures. The firmness at harvest was more than 12 kg/cm and it decreased to 2.22 kg/cm² at the end of storage. A slight decreased in TSS from 23.6 to 20.0 was observed. Negligible changes were seen in acidity (0.13%), Vit.C (5 mg/100 g) reducing sugars (8.2-8.8%) and total sugar (13.1-13.5%). Rate of respiration showed an increase from 58 mg to 105 mg CO₂/kg/hr at the peak stage after 7 to 8 days of storage followed by a decline to 40 mg CO₂/kg/ht at the full ripe stage. The shelf life of the fruit was 13 days at 29 and 25 °C weight 95% of ripe fruits whereas at 20 and 15 °C it was 17 and 23 days respectively.

Ph.D

Title : Effect of shrink film wrapping on storage behavior of banana (*Musa paradisiaca* L.) cv. Robusta (1996)

M.K.Honnabyraiah, UAS, Bangalore, Guide : Dr.Shantha Krishnamurthy

Investigations on the effect of shrink film wrapping in Robusta banana stored at room temperature (RT 25+ 1 °C with 45% RH) and low temperatures (LT 15 °C with 65% Rh) on shelf life and quality was studied. Banana hands with 6-8 fingers, of optimum maturity were wrapped in shrink films BDF-2001 (100 guage) and D-955 (100 guage) and stored at RT and LT. periodical observations were recorded on weight loss, respiration rate, firmness, other chemical changes, shelf life and organoleptic quality of the stored fruit. The weight loss at RT was 11% in unwrapped fruits as compared to 2.5% in film wrapped fruits and this was reduced to 1-4% at LT storage. Fruit firmness decreased from 12.5 kg to 2.5 kg/cm during 14 days of storage at RT but LT this decrease was seen after 35 days of storage. Ripe fruits in film wrapping retained more firmness (3.5-4.5 kg/cm) both at RT and LT. Starch content was more in the film wrapped fruits (2.1-4.3%) at LT storage and less (1.8-2.1%) at RT storage. The increase in reducing sugar content was from 0.6 to 9.7 to 11.0% and total sugar content was in the range of 13.0-17.5%. The rate of respiration increased from 14 mg to 145 mg CO₂/kg/hr followed by a decline in the unwrapped fruits and the rate was reduced significantly in film wrapped fruit. The shelf life of unwrapped fruits was 14 and 30 days at RT and LT storage respectively. This was enhanced to 21 to 23 days by wrapping with BDF and D 955 films at RT and 30 to 37 days at LT.

Ph.D

Title : Studies on growth, development and storage of pomegranate (*Punica granatum* L.) cv. Ganesh (1997)

S.Nanda, UAS, Bangalore, Guide : Dr.Shantha Krishnamurthy

The investigations on (i) Pattern of growth and development to determine harvest maturity of Pomegranate fruit cv. Ganesh grown in two agro-climatic conditions *viz.*, Bangalore & Bijapur (ii) determination of optimum glow temperature for storage for maximum shelf life(iii) the quality of the fruits stored at 8,15 and 25 °C and (iv) the histological changes in the fruits during growth, development and storage were made. The salient findings were the fresh weight, length, breadth and volume of the fruit increased with growth of the fruit. The specific gravity of the fruit increased up to midgrowing period followed by a decline towards maturity. The rind weight increased with decrease in rind thickness. The maximum juice content of 122-165ml per fruit was observed at the harvesting period. There was a significant respiratory peak (113 mg CO₂/kg/hr) a few days after fruit set followed by a decline at harvesting stage (47 mg/kg/hr). There was a decrease in acidity and increase in ascorbic acid, total soluble solid and sugars. The fruits reached harvest maturity after 105-110 days of fruit set having a specific gravity less than 1.0 bright greenish yellow to full yellow coloured rind with a shining waxy surface, opening of the calyx and deep red colour soft juicy arils. Histological changes during growth showed increased thickness of epidermis and cuticle. Size of the cells below the epidermis increased and starch grains started accumulating after 60 days of fruit set. During storage, lateral compression of cells in the rind of unwrapped fruits was observed resulting in desiccation of the fruit. There were significant differences in all the parameters studied during growth storage between the cv. Ganesh grown in two different agro-climatic conditions.

Ph.D

Title : Studies on growth, development and storage of post harvest handling of custard apple (*Annona squamosa* L.) (1997)

Vishnu Prasanna, UAS, Bangalore, Guide : Dr. Shantha Krishnamurthy

Investigations on physico-chemical and histochemical changes during growth, development, ripening and storage were made in custard apple fruit cv. Balanagar to determine maturity indices for harvest and to extend the shelf life without affecting the quality. (i) Development of yellow colour between aerenchyma, age of the fruit (100-110, days after flowering), specific gravity of about 1.00, firmness of 3.00-3.50 kg/cm, moisture content of 67-69%, dry matter content of 31.0-33.0%, sugars of 3.5-54.0%, starch of 12-14% could be used as reliable maturity indices for the harvest of the custard apple fruits. Studies on the storage of harvest maturity on post harvest behaviors indicated that fruits harvested after 90, 100 and 110 days after flowering required 7, 5 and 4 days for ripening. Only 50-60% of the fruits were ripe with less taste when harvested after 90 days. Highest soluble solids (27.8), and total sugars (14.0%) with 0.28% acidity were recorded in fruits harvested after 110 days of flowering. Among the storage treatment, precooling of the fruit was advantageous in retention of texture during low temperatures storage. Shelf life of the fruit was extended 2-3 folds when they were stored at 10 and 15 °C. Histochemical changes during growth indicated increased starch granules after 60 days of growth till maturity. Degradation of starch granules were observed during ripening. In fruits held at 4 °C due to chilling injury, this was not observed.

Ph.D.

Title : Development of beverages from sweet orange (*Citrus sinensis* Osbeck) using sugar and sugar substitutes (2010)

C.N.Byanna, UAS, Bangalore, Guide : Dr.I.N.Doreyappa Gowda

Investigation on “Development of beverages from sweet orange (*Citrus sinensis* Osbeck) using sugar and sugar substitutes” was carried out at processing laboratory of Division of Post Harvest Technology, Indian Institute of Horticultural Research, Bengaluru during 2008-09 and 2009-10. Sweet orange beverages *viz.*, RTS beverage, nectar, squash, and blended beverages with kokum and pomegranate were prepared with different recipes. The products were subjected to chemical analysis and organoleptic evaluation at initial, 90th and 180th day of storage at ambient conditions RTS with 18 per cent juice, 15 °Brix and 0.3 per cent acidity, Nectar with 24% juice, 15 °Brix, 0.3 per cent acidity, Squash with 35 per cent juice, 40 °Brix, 1.0 per cent acidity, sweet orange : kokum (88:12), 15 per cent juice, 15 °Brix, 0.3 per cent acidity, sweet orange: pomegranate (50:50), 15 per cent, 15 °Brix, 0.3 per cent acidity were found to be superior recipes organoleptically. These superior recipes were used to prepare the products with sugar substitutes based on the sugar equivalents. Sugar substitutes were used in place of sugar for preparation of products. These products were subjected to chemical analysis and organoleptic evaluation over a period of 180 days starting from initial stage and subsequently at 3months interval. RTS with fructose followed by RTS with 50 per cent sucrose + 50 per cent fructose and RTS with 50 per cent sucrose +50 per cent sucralose, Nectar with fructose followed by nectar with 50 per cent sucrose + 50 per cent sucralose,nectar with sucralose and nectar with 50 per cent sucrose +50 per cent fructose ; Squash with sucralose, squash with 50 per cent sucrose + 50 per cent sucralose, squash with 50 per cent sucrose + 50 per cent fructose and squash with fructose ; Sweet orange : kokum (88: 12) with 50 per cent sucrose + 50 per cent fructose followed by 50 per cent sucrose + 50 per cent sucralose and fructose ; Sweet orange : pomegranate (50:50) with 50 per cent sucrose + 50 per cent fructose and 50 per cent sucrose+ 50 per cent sucralose were rated as superior recipes based on over all acceptability scores in sensory evaluation. In general, TSS, reducing sugars, titrable acidity and non- enzymatic browning increased, while pH, total sugars, non- reducing sugars, ascorbic acid and antioxidant activity decreased during storage in all type of beverages.

M.Sc.

Title : **Studies on some factors influencing quality of guava jelly** (1981)

K.H.Ramanjenaya, UAS, Bangalore, Guide : Dr.Amba Dan

Experiments were carried out to find varietal suitability for jelly making, fixing optimum stage of maturity of the fruit, ascertaining the optimum temperature for storage jelly and exploring the possibility of using plastic containers in place of glass container. The results indicated that a pink fleshed variety 'Beaumont' has given the best quality jelly. Another pink fleshed variety developed at the institute was also found to give higher yields of good quality jelly thus supporting the findings. Firm ripe fruits were found to be better for better quality and quantity of jelly than using mature and ripe fruits. The progressive deterioration in the quality of jelly stored at room temperature could be reduced to the minimum when stored at low temperature 5 ± 1 °C. For packing jelly PVC and HDPE containers can also be used instead of glass containers without any appreciable loss in the quality of jelly, and PVC was better than HDPE for this purpose.

M.Sc.

Title : **Studies on storage of mango (*Mangifera indica*)** (1983)

C.M.Kala, UAS, Bangalore, Guide : Dr. Shantha Krishnamurthy

An investigation on the effect of using skin coating waxol, in combination with heat treatment and fungicides on ripening and keeping quality of the important cultivar 'Alphonso' mango was made. The experiment had 10 treatments with replicates for each treatment. The effects of treatments on physicochemical changes, ripening and spoilage were observed during a storage period of 20 days. Post harvest hot water treatment of Alphonso mango at 52 ± 1 °C for 5 minutes resulted in hastening of ripening process, reduced spoilage and development of uniform orange surface colour of the fruit. The use of Benlate at 500 ppm reduced the spoilage and the extent of reduction was on par with hot water treatment. Further reduction of spoilage by combination of hot water and fungicides (Benlate and T.B.Z. at 500 ppm) was not evident. Waxol treatment retarded ripening by 5 days as compared to the control, and retained freshness of the fruit up to 20 days of storage. Waxol treatment combined with (i) hot water alone and (ii) with fungicides Benlate and T.B.Z. at 500 ppm were the best, with reference to the quality of ripe fruits and control of spoilage after 20 days of storage at ambient conditions. Organoleptic quality of the fruit was not affected by post harvest treatment.

M.Sc.

Title : **Storage studies in Coorg mandarins (*Citrus reticulata* Blanco) (1983)**

Y.Raghuramulu, UAS, Bangalore, Guide : Dr.Shantha Krishnamurthy

An investigation on the extension of storage life of winter crop of Coorg Mandarins was made using skin coatings with waxol and 'Tal Prolong', combined with or without packing in ventilated polythene bags and stored in cartons. The effect of treatments on physiological losses in weight, physicochemical changes, shelf life spoilage and organoleptic quality was observed during the storage period of 4 weeks, at ambient conditions. Packing the fruits in ventilated polythene bags and storing in cartons reduced the moisture loss significantly and extended the shelf life. Skin coating with 'Tal Prolong' at 1% and 2% was not as effective as 3% Waxol treatment in retaining the freshness of the fruit. There was no significant effect on the chemical composition like juice content, TSS, Vitamin C, and sugar content due to treatments. Organoleptic evaluation of fruits revealed that waxol treated fruits packed in polythene bags were the best after 20 days of storage at room temperature.

M.Sc.

Title : **Storage studies in banana, var. *Robusta*** (1984)

C.G.Kushalappa, UAS, Bangalore, Guide : Dr. Shantha Krishnamurthy

An investigation was in the comparative effects of skin coatings with 6% waxol, 1% and 2% Tal prolong with and without packaging of fruits in vented polyethylene bags and the use of polyethylene absorbent 'purafil' on extension of shelf life, ripening, weight loss and other related chemical changes at ambient conditions of storage. It was observed that Tal prolong in unpacked, retarded ripening of the fruit by 5 days. In packed prolong and waxol treated fruits, there was delay in ripening by 7 days. This delay in ripening was correlated with reduced rates of softening of the fruit and development of yellow surface colour. Changes in firmness, moisture, pulp/peel ratio, acidity and alcohol insoluble residues were also recorded. Losses in weight were reduced considerably. The quality of ripe fruits in untreated control, packed in polyethylene bags was superior to those kept without packing. Tal prolong treated fruits were acceptable, though slightly inferior, because of its yellowish green surface colour and soft texture. Use of purafil resulted in excellent quality as compared to all the other treatments.

M.Sc.

Title : **Studies on packaging of mango (*Mangifera indica* L.)** (1985)

V.R.Prasad.S, UAS, Bangalore, Guide : Dr.Shantha Krishnamurthy

An investigation to compare the effect of combination of post harvest dip treatments with waxol (3%) and hot water with waxol, with or without wrapping in tissue paper and polyethylene film on physic-chemical changes and keeping quality of Alphonso mangoes during storage at room temperature was made. It was observed that combination treatment of hot water alone followed with wrapping in polyethylene (HDPE) delayed ripening as compared to the unwrapped fruit of the corresponding treatment. Weight loss was reduced by more than 50% in the wrapped fruits. Spoilage was high (20%) in polyethylene wrapped fruits. Wrappers had to be removed after 10 or 15 days of storage for further ripening of the fruit at ambient conditions of storage. Organoleptic evaluation of the ripe fruits in waxol with hot water treatment showed good colour, texture and taste as compared to the control fruits which had shriveled by 15th day of storage.

M.Sc.

Title : Effect of hot water washing on seed viability and juice quality in tomato (1986)

B.C.Anand, UAS, Bangalore, Guide : Dr.Amba Dan

Temperature of water up to 60 °C and time of holding the fruit there for 8 minutes in case of Pusa Ruby was found to be optimum for ensuring the highest seed viability. Varietal responses to hot water at 60 °C for 8 minutes were similar. In respect of chemical composition of the tomato juice, prepared in the above experiments., the results showed that hot water washing of tomato not only had a higher juice yield and increased juice viscosity, but also resulted in reduced microbial load with better retention of ascorbic acid as well as lycopene. It had favorable effect on the flavour of product and undesirable effect on pH and total soluble solids. There was no significant variation in seed viability and juice quality when fruits at two stages of ripeness were used for hot water washing, varieties like NTDR-1, Selections-4 and Selection-11 responded favorably, followed by Roma and Punjab Chahara. From the point of view of chemical composition, sensory properties and microbial status of the juice, Roma cultivar was found to be the best suited followed by Selections-4 and Punjab Chahara.

M.Sc.

Title : **Effect of temperature on storage of Coorg mandarins (*Citrus reticulata* Blanco) (1988)**

Shekarappa.G.Angadi, UAS, Bangalore, Guide : Dr.Shantha Krishnamurthy

An investigation was carried out to compare the effectiveness of postharvest dip treatment with waxol (3%) combined with and without packing in ventilated polythene bags (polybags) on storage behavior and keeping quality of winter crop of Coorg mandarins at ambient ($15 + 2$ °C) and low temperature ($10 + 1$ °C) conditions. In unpacked fruits, waxol treatment showed significantly lower PLW as compared to untreated control after 19 and 42 days of storage at room and low temperatures respectively. In fruits packed in polybags, waxol treatment showed least PLW (5.16%), followed by untreated control (9.83%) at room temperatures. Packing in ventilated polybags helped in minimizing the weight losses significantly, as compared to unpacked treatments. Juice content decreased during storage for 19 and 42 days at room ($25 + 2$ °C) and low temperature ($10 + 1$ °C) respectively. In fruits packed in polybags, the juice content varied from 42.7 to 42.8% at room temperatures storage and 36.1 to 40.8% at low temperatures storage. At room temperatures storage the peel and weight decreased during 19 days storage period in untreated control and waxol 3% treatments (50.6 to 42.5% and 50.6 to 44.4% respectively.) Total titratable acidity expressed as percent citric acid decreased during storage at both room and low temperatures. At the end of the storage under room temperature conditions, the increase was seen from 4.04 to 7.33% in waxol treated fruits packed in polybags. waxol treated fruits kept in polybags had good colour, freshness, flavour and taste as compared to other treatments during the storage period of 19 days at room temperature and 42 days at low temperature ($10 + 1$ °C). Overall, waxol treatment was found to be better than other treatments, since it showed reduced weight losses, retained good colour, freshness, flavour and taste both at room temperature ($25 + 2$ °C) and low temperature ($10 + 1$ °C) storage. Packing the fruits (untreated control and waxol treated in ventilated polybags was found to be better as compared to without packing at low temperature storage.

M.Sc.

Title : **Studies on the mineral composition of banana during storage** (1988)

M.S.Ganapathy, UAS, Bangalore, Guide : Dr.Shantha Krishnamurthy

Mineral content and physicochemical changes in three commercial cultivars of banana during ripening were studied at ambient storage conditions. Rasabale banana had low calcium, potassium and iron contents, and the highest sodium content, both in the pulp & peel as compared to Robusta and Dwarf Cavendish banana. Peel had 2 to 4 times more calcium, sodium, potassium and 2 times more of iron as compared to pulp in all the three cultivars. Rasabale showed maximum weight loss during ripening (16.3%) with least firmness of the pulp (1.14 kg/cm^2) and maximum increase in pulp to peel ratio (3.01 to 7.00) as compared to 12.7% weight loss, firmness of 3.75 kg/cm^2 and pulp peel ratio of 3.47 in Dwarf Cavendish and Robusta cultivars. Dry weight of the pulp decreased and that of the peel increased in all the varieties during ripening.

M.Sc.

Title : **Changes in mineral composition of mango fruits during storage** (1991)

R.A.Reena, UAS, Bangalore, Guide : Dr.Shantha Krishnamurthy

Changes in weight loss, firmness, moisture, dry weight, surface colour and minerals were studied at 5 stages of ripening in four cultivars of mango namely Alphonso, Bangapalli, Rasapuri and Totapuri. The weight loss during ripening ranged from 13.4 to 17.4%. The loss of green colour was accompanied by appearance of yellowish orange colour. At the ripe stage, 'L' values ranged from 44.7 to 67.9, 'a' and 'b' values ranged from 4.0 to 8.1 and 23.4 to 34.9 respectively. Moisture content decreased with an increase in dry weight of the fruits during ripening. Alphonos mango recorded the lowest Ca content in both pulp (8.2 mg) and peel (73.9 mg), lowest peel Na content (6.0 mg) and highest P (112.4 mg) and Fe contents (100.2 ppm) in the peel and K content in the pulp (828 mg). Bangapalli recorded the highest of (466 mg) in peel, Fe (99 ppm) in the pulp, K (986 mg) in the peel and lowest K of 598 mg and Na content of (5.6 mg) in the pulp. Rasapuri recorded the low contents of all the minerals. Calcium content in the peel and pulp were 245.9 mg and 9.4 mg. Fe content was the lowest (5.8 ppm) in the pulp and in the peel (3.5 ppm), highest Na content in the pulp (11.2 mg) and in the peel (12.6 mg). Totapuri showed the highest Ca-content of 13.3 mg in pulp, P content of 78.4 mg & the lowest peel K content of 676.7 mg. these changes have been correlated with the shelf life of the cultivars.

M.Sc.

Title : **Studies on storage of pomegranate (*Punica granatum* L.) cv. Ganesh (1992)**

C.T.Shivananda, UAS, Bangalore, Guide : Dr.Shantha Krishnamurthy

Studies were made on the comparative effects of skin coating with 'Waxol', individual fruit wrapping with kiln film and a combination of these with storage at room temperature (RT) 25±1 °C and low temperature (LT) of 8 °C on the shelf life of pomegranate cv. Ganesh during –Feb, 1991-92. Weight loss of the fruit which is the main cause for desiccation and unmarketability of the fruit could be significantly reduced by waxol treatment and further reduced by film wrapping and low temperature storage. The respiration rate was high up to the 6th day, showed a sudden decrease by 8th day and it continued up to 22 days of storage. Among the changes in physico-chemical constituents, a slight decrease in firmness, acidity, reducing sugars, colour of the juice were observed during storage. Increases in TSS and total sugar content were also observed. Peel weight decreased in control and waxol treated fruits, but it remained the same in film wrapped fruits. Waxol treated fruits showed less spoilage as compared to untreated and film wrapped fruits. The maximum shelf life at RT was 3 weeks in film wrapped and 2 weeks in unwrapped fruits as compared to 10 weeks in film wrapped fruits held at 8 °C. Sensory evaluation indicated that film wrapped fruits, held at 8 °C was the best with good colour, freshness, taste and flavour.

M.Sc.

Title : **Storage studies in guava. *Psidium guajava* L. (1992)**

P.Padma, UAS, Bangalore, Guide : Dr.Shantha Krishnamurthy

Studies were made on the combined effects of skin coating and wrapping with film and tissue paper on changes in physic-chemical, quality and shelf life of two cultivars of guava *viz.*, Sarder and Allahabad Safeda held at room temperature 25 ± 1 °C (RT). Total weight loss of the fruits could be reduced significantly by Waxol treatment film wrapping. The peel colour development as measured by 'L', 'a' and 'b' values indicated, maximum increase in 'L' and 'b' values were observed in the control as compared to the treatments. There was a decrease in firmness, acidity, vitamin C and starch contents and an increase in reducing and total sugar contents. The shelf life could be extended from 5-6 days in the control to 8-9 days by waxol treatments and wrapping in paper.

M.Sc.

Title : Effect of stage of harvest, storage temperature, pulsing and preservative chemicals on vase life of gerbera (*Gerbera jamesonii* HOOK.) (1995)

R.Gopinath, UAS, Bangalore, Guide : Dr.Sangama

Gerbera is a popular cut flower having a seventh position in the global flower market. In India, gerbera cut flowers are produced both in open as well as under poly house. Gerbera cut flower has large flower head on a long slender stem. Due to its inherent structure, the post harvest handling and storage of gerbera cut flower is a challenge. After harvest, under water stress gerbera cut flowers exhibit bending and lose its market quality. Therefore, this study has been focused to find out suitable varieties for good postharvest quality to determine optimum stage of harvest and concentrations of preservative chemicals to enhance shelf life and vase life of gerbera cut flowers. Two gerbera single cultivars viz., Local Red and Local Yellow cut flowers harvested at three stages were evaluated. Observation on fresh weight, transpiration loss of water, uptake of water, water balance revealed that cv. Local Red cut flowers harvested at three stages were evaluated. Observation on fresh weight, transpiration loss of water, uptake of water, water balance, percent stem bent and vase life revealed that cv. Local Red cut flowers performed better over cv. Local Yellow cut flowers. Maximum mean vase life of 6.66 days was obtained with cv. Local Red cut flowers where as cv. Local Yellow cut flowers had vase life of 5.33 days. Among three harvest stages evaluated, cv. Local Red cut flowers harvested when ray florets were 3/4th open as compared the harvest stages of ray florets of half and fully open position. Higher vase life of 6.66 days was obtained at 3/4th open stage as compared to 5 days and 5.83 days with half and fully open stage respectively. Pulsing with sucrose 4% and AgNO₃ 250 ppm resulted in increased shelf life of 2 days with 7.33 days of vase life as compared to control cut flowers (6.66 days). Vase solution of sucrose 2% + STS 20 ppm was found beneficial in obtaining vase life of 11.33 days over control cut flowers (6-66 days) in cv. Local Red.

M.Sc.

Title : Effect of stage of harvest, storage temperature, pulsing, preservative chemicals and packaging on vase life of *Gladiolus (Gladiolus hybridus Hort.)* (1996)

N.S.Phanindra, UAS, Bangalore, Guide : Dr.Sangama

Gladiolus is an important cut flower, referred as queen of bulbous flowers, throughout Commercially cultivated for its long lasting spikes having florets of varied colour, shape and size. Commercially for easy handling and packaging *Gladiolus* spikes are harvested when basal floret show colour stage. It is observed that at this stage many florets are yet to grow and open but many a time they fail to open and even bend under water depletion. Therefore under this investigation, suitable varieties, optimum harvest stages, pulsing, packages, storage temperature and vase solutions were determined for better shelf life and vase life of *Gladiolus* cut flowers. Two *Gladiolus* cvs. Local Yellow and Psittacinus hybrid spikes harvested at three harvest stages were evaluated. Observation on spike length, rachis length, percent florets opened, fresh weight, transpiration loss of water, uptake of water, water balance, % bent/breakage, shelf life and vase life revealed that maximum vase life of 8.92 days was obtained with cv. Psittacinus hybrid cut flowers whereas cv. Local Yellow spikes gave vase life of 7.78 days. Among three harvest stages of cv. Psittacinus hybrid spikes evaluated revealed that spikes harvested at basal floret showing stage gave longer vase life of 9 days followed by 8.5 days of vase life with spikes harvested at basal floret half emerged and vase life was least (7.5 days) when harvested at basal floret was fully emerged. Among five packages tried, cellophane paper wrapping during storage of *Gladiolus* spikes was found more suitable in maintaining the flower freshness by reducing 10.78-24.30% PLW as compared to the other packages evaluated. Pulsing with sucrose 8% and AgNO₃ 250 ppm improved the floret opening (89%) and vase life (10.28 days) over the control (7.7% and 8.12 days respectively) in cv. Psittacinus hybrid spikes. Storage up to 6 days at 4 °C was found optimum with respect to vase life and floret opening whereas storage for 4 days at 7 °C was found optimum. Storage for two days at RT reduced the vase life (5.22 days) of *Gladiolus* cv. Psittacinus hybrid spike. Vase solution of BA 50 ppm and STS 20 ppm increased the vase life of Psittacinus hybrid spikes by 3 days over the control (8.66 days).

M.Sc.

Title : **Standardisation of post harvest handling techniques for carnation** (1998)

H.K.Beelagi, UAS, Bangalore, Guide : Dr.Sangama

Carnation is one of the important commercial cut flower crops of the world. Standardization of post-harvest handling techniques for carnation was carried out. Results of the experiment on determination of optimum harvest stage revealed that maximum vase life of 32.8 days was obtained at tight bud stage in cv. Michelle Lek Miche and vase life of 23 days was obtained with tight bud and cross bud stage in cv. Lek Petra. Pulsing solution of 10% sucrose + 100 ppm silver thiosulfate improved post-harvest quality of carnation cut at cross bud stage. Among different post-harvest practices, maximum vase life of 23 days was obtained with solution of 2% sucrose + 50 ppm of kinetin.

M.Sc.

Title : **Standardisation of post harvest handling techniques in rose (*Rosa hybrid L.*)**
(1998)

V.Surendra Kumar, UAS, Bangalore, Guide : Dr.Sangama

Rose is one of the important commercial cut flowers. In recent years there is an increase in production of rose cut flowers under polyhouse. This has necessitated to standardize post harvest handling techniques for polyhouse grown roses under our situation. Hence studies were carried out to determine the optimum harvest stage, pulsing treatment and post-harvest practices to enhance the vase life. Five rose varieties Tinike, Dream, Sasha, Prophyta and Lambada were evaluated for post-harvest qualities. Sasha with vase life of 10.58 days was found superior over other varieties. Optimum harvest stage was when one petal unfolded for varieties Sasha and Sunny Prophyta with vase life 10.74 days and 10.49 days. Pulsing trial was carried out in variety Sasha. Pulsing treatment with 3% sucrose plus 200 ppm 8-Hydroxy quinolone citrate was given for different duration. Results revealed that four hours pulsing was beneficial in improving the post harvest qualities such as vase life (11.63 days) in variety Sasha cut flower. Effect of different post harvest practices on vase life of rose variety Sasha was determined. It revealed that stem re-cutting on alternate days in vase gave maximum vase life of 11.13 days.

M.Sc.

Title : **Standardisation of drying techniques for static Cutflowers** (2000)

P.Padmavathamma, UAS, Bangalore, Guide : Dr.Sangama

Limonium (Statice) flowers are gaining popularity for this bright colour inflorescence in fresh attractive and dry form. Dry flower quality is greatly influenced by both pre and postharvest factors. Under the present study, optimum harvest stages for better dry flower quality was determined in three limonium var. Autumn yellow, Autumn blue and Crepe Limonium. Optimum harvest stage for all the three varieties tried was when 90% of the flowers had opened on the inflorescence which gave better quality dry flower. Among 3 varieties used, var. Autumn yellow found superior with respect to colour and texture. Best quality dry flower was obtained by shade drying compared to oven and sun drying. Dry flower texture was improved with 1:3 glycerol: water pretreatment.

M.Sc.

Title : Enzymatic liquefaction of sapota fruit pulp (*Manilkara achras* Mill.) for beverage making (2001)

C.B.Manjunath, UAS, Bangalore, Guide : Dr.I.N.Doreyappa Gowda

Sapota [*Manilkara achras*, Mill] commonly known as *chikoo* is one of the major fruits of India. Sapota fruits are rich in carbohydrates and tannins. The presence of fairly large quantities of tannins modifies the taste of the fruit and imparts an astringent taste. Sapota fruits are higher in calorific value, the pulp is sweet and rich in flavour. The post harvest loss in fruits is a major problem of farmers as well as of the fruit industry. Since sapota has a very short post-ripening life converting these perishable fruits into value added product like beverages to prevent losses and for better utilization. Fruit juices are generally cloudy due to the presence of a wide range of colloidal dissolved natural polysaccharides and other small particles like protein fragments or polyphenols. These kinds of pulp/juices are not very attractive and difficult to concentrate. These cloudy substances can be dissolved using pectinase enzymes. Standardization of best enzyme formulation and optimum concentration for liquefaction of sapota pulp was carried out using pectinase enzymes. The results revealed that enzymatically liquefied sapota pulp yielded higher juice compared to control. Also enzymatically liquefied juice recorded higher TSS, sugars and lower viscosity. Maximum juice yield was recorded in Pectinex Ultra at 0.1% - 62.25% yield followed by 0.08%, 61.25% juice yield) and lowest in control i.e., untreated sample (C₀: 40.00%). The viscosity of the un liquefied juice (control) was 2.94 cps and it was reduced to least (1.24 cps) at the highest concentration (C₄) of enzymes tried. Due to the interaction effects, Least viscosity was observed in E₂ C₄ (1.20 cps). The main objective of enzymatic liquefaction was to dissolve colloidal suspended juice particles so that the beverages prepared from this will be more attractive due to very clear and sparkling nature of liquefied/clarified juices.

M.Sc.

Title : Effect of low temperature storage on post harvest quality of carnation (*Dianthus caryophyllus*) cut flowers of different harvest stages (2002)

M.Siva Prasad, UAS, Bangalore, Guide : Dr.Sangama

Storage of cut flowers is an important postharvest horticultural technique to regulate market and low temperature storage is the most common commercial method used for cut flowers. 'The maintenance of flower quality during storage and length of time that flowers can be stored depends on several factors such as genetic characteristics, respiration rate, water loss, ethylene production and action, bacterial and fungal development. Storage of cut flowers mainly depends on the stage of harvest. Therefore, this investigation was carried out to determine the optimum stage of harvest for better storage life and quality. An experiment was conducted to study the effect of stage of harvest and bud opening solution on the postharvest quality and vase life of carnation cut flower cvs. Pink Donna and Design. Four harvest stages *viz.*, tight bud, cross bud, paint brush and fully open stages of the two cultivars were pretreated in bud opening solution containing 10 per cent sucrose + 200 ppm 8-Hydroxy Quinoline Sulfate (HQS) + 25 ppm Aluminium sulfate. Tight bud stage flowers pretreated in bud opening solution showed maximum vase life of 12 days in cv. Pink Donna, 11.3 days in cv. Design. It was also observed that pretreatment in the bud opening solution resulted in increase of flower diameter, higher water uptake and reduced number of days taken for bud opening. Rate of respiration and ethylene production were found to be least in tight bud stage flowers.

M.Sc.

Title : **Osmo-air dehydration of pineapple (*Ananus comosis L.*)** (2002)

H.B.Rashmi, UAS, Bangalore, Guide : Dr.I.N.Doreyappa Gowda

Studies were carried out to determine the optimum sugar syrup concentration for osmo-air dehydration of pineapple fruits using “Giant Kew” variety and to evaluate quality parameters somatically dehydrated product. Pine apple fruits were washed, peeled, cored and cut in to rectangular pieces and subjected to osmosis for 24 hours in three varying concentrations of sugar syrup (50, 60 and 70 °Brix syrup along with 0.2% citric acid and 700 ppm of potassium metabisulphite) followed by draining the pieces and drying in a drier at 60-65 °C. The dry product was packed in 400 gauge polythene covers and stored at ambient conditions (18-28 °C, 53-76% RH) and at Low temperature (4 ± 1 °C, 85-90% RH) up to 6 months. The product was analysed initially and subsequently at 3 months and 6 months. Significantly higher amount of moisture removal from fruits was observed in 70 °Brix syrup closely followed by 60 °Brix syrup. Pineapple fruits subjected to osmosis at 60 °Brix gave maximum dry fruit yield and showed lower moisture, higher ascorbic acid, carotenoids and also higher overall acceptability scores in sensory evaluation initially and also after a storage periods of six months. Storage at low temperature helped in the retention of ascorbic acid, carotenoids, total sugars and sugar acid ratio. Fresh product had lower moisture and reducing sugars. At the end of 6 months storage, the loss of ascorbic acids was to an extent of 37.14% and carotenoids were to an extent of 52.25%. At the end of storage, the product stored at low temperature had better overall acceptability score due to better retention of colour and flavour during storage.

M.Sc.

Title : Modified atmosphere packaging of papaya (*Carica papaya* L.) fruits for extension of storage life (2003)

Sukhvinder Pal Singh, UAS, Bangalore, Guide : Dr.D.V.Sudhakar Rao

Papaya is a commercial fruit crop of the sub-tropical and tropical regions of the world. Short postharvest life and chilling sensitive nature of the fruit limits its long duration storage, transportation and marketing. Quality conservation becomes indispensable for papaya because the greatest part of the amount harvested is destined to fresh fruit commerce. So, there is a need to develop an appropriate postharvest technology where the benefits of modified atmosphere as well as low temperature storage can be obtained to improve the storage life and maintain quality, thus allowing a greater rationalization in its distribution and commercialization. 'Solo' papaya is extolled for its demand in the domestic and international market. The present investigation was carried out to standardize the optimum modified atmosphere packaging (MAP) conditions for papaya fruit to extend its storage life at different storage temperatures and to study the effect of MAP on the alleviation of chilling injury (CI). Mature green fruits were individually packed in different types of polymeric films *viz.*, LDPE, PP, Pebax® and stored at 7, 13 °C and room temperature (27-32 °C). The physiological response and ripening behavior of the fruits was studied at regular intervals after storage and were evaluated for various quality parameters. MAP of individual papaya fruits with Pebax® or LDPE film could extend the storage life and maintain the quality up to two weeks over one week in non-packed fruits under ambient conditions. At low temperature (13 °C), the storage life of papaya could be extended to one month when packed in LDPE or Pebax® film without any CI symptoms and the fruits ripened normally in one week under controlled conditions (20 ±1 °C & 75-80% RH). The fruits stored at 7 °C failed to ripen normally and showed severe CI symptoms and disease incidence.

M.Sc.

Title : Studies on enzymatic liquefaction of banana (*Musa spp.*) fruit pulp for juice preparation (2004)

M.P.Swethak, UAS, Bangalore, Guide : Dr.I.N.Doreyappa Gowda

Two varieties of banana i.e. “Grand Naine” and “Robusta” were studied for enzymatic juice extraction. After extraction banana based beverages were prepared i.e. Nectar and concentrate (squash). The products were studied at room temperature for a period of 4 months and analyzed organoleptically and chemical composition at an interval of two months i.e. initially, after 2 months and 4 months. The enzymatic liquefaction of banana pulp yielded higher juice compared to control in both the varieties, “Grand Naine” and “Robusta”. The liquefied juice yield increased with the increase in enzyme concentration and prolonged incubation time, in both varieties. The enzymatically liquefied juice recorded higher TSS, sugars and lower viscosity. Among the varieties, “Grand Naine” yielded higher juice compared to “Robusta”. Higher TSS and sugars were seen in “Robusta” pulp after liquefaction, but lower viscosity was observed in “Grand Naine” variety of banana. In nectar, product prepared from “Robusta” banana variety using liquefied juice gave higher TSS and non reducing sugars. But “Grand Naine” variety nectar showed lower viscosity and higher reducing sugars. The nectar prepared from liquefied juice of “Grand Naine” variety of banana using enzyme (Pectinex ultra SP-L) with a concentration of 300 ppm enzyme and an incubation time of five hours was rated superior in overall acceptability. The squash prepared from liquefied juice of variety “Robusta” banana using enzyme (Pectinex ultra SP-L) with a concentration of 300 ppm with incubation time of five hours was rated superior in overall acceptability.

M.Sc.

Title : Individual shrink wrapping of papaya fruits (cv. Taiwan Red Lady) for extension of storage life and quality maintenance (2005)

S.S.Baskar, UAS, Bangalore, Guide : Dr.D.V.Sudhakar Rao

Mature green 'Taiwan Red Lady' papayas individually shrink wrapped in three different types of polymeric films. *viz.*, BDF-2001, D-955 and PE were stored at 13 °C, 18 °C and RT to study its effect on extension of storage life, alleviation of chilling injury and quality parameters (Total antioxidant capacity, Ascorbic acid, Total carotenoids, Lycopene, Phenols, firmness and surface colour development). The rates of respiration, ethylene production of unpacked fruits during ripening after different intervals of storage were measured to study the physiological response of papaya to shrink-wrapping and storage temperature. The storage life of papaya could be extended to 2, 3 and 4 weeks at RT, 18 °C and 13 °C respectively followed by 3 to 4 days for ripening after unpacking the fruits. Shrink-wrapping prevented the development of chilling injury during 4 weeks of storage at 13 °C where as non-wrapped fruits exhibited chilling injury symptoms after 2 weeks of storage. The respiration behaviour of shrink-wrapped fruits during ripening after different intervals of storage was normal exhibiting typical climacteric peaks at all the storage temperatures. Among the different films tried the appearance of fruits was better in PE and D-955 wrapped films, whereas the surface colour development was poor when wrapped in BDF-2001 film at all the storage temperatures. The quality parameters of fruits in terms of antioxidant capacity, total phenols and carotenoids were also better in fruits wrapped with the former films compared to the latter. However, at RT the Vit-C and carotenoids retained better when the fruits were wrapped with BDF film.

M.Sc.

Title : **Studies on osmotic dehydration of banana (*Musa spp.*) (2005)**

K.S.Thippanna, UAS, Bangalore, Guide : Dr.R.B.Tiwari

Banana (*Musa spp.*) a member of Musaceae family is one of the most important fruit crops of India with an annual production of 175 lakh tones having great socio-economic significance. Bananas are good source of Vitamin C, Vitamin B₆, and potassium. Banana being a highly perishable fruit suffers from high post harvest losses to an extent of about 20 to 40 per cent. Therefore, it is necessary to develop shelf stable value added products. Osmotic dehydration process involves subjecting fruit pieces to aqueous solution of sugar with high osmotic pressure which removes 30-50% of the water prior to drying. The inclusion of osmotic process in conventional dehydration has two major objectives quality improvement and energy savings. Present investigation was conducted to know the effect of syrup concentrations and duration of osmosis on weight loss, solid gain and yield of osmotically dehydrated banana slices of varieties Robusta and Ney Poovan. There were 13 treatments, 2 varieties and 2 replications and the data was statistically analysed using Factorial Completely Randomized Design (FCRD). Observation on physico-chemical composition and sensory characteristics were taken during experimentation. Variations were observed with respect to fruit size, TSS, acidity and sugar contents in fresh fruits of variety Robusta and Ney Poovan. Statistically significant variations were observed for weight loss, moisture loss, solid gain, yield, sugars, titrable acidity, NEB and sensory quality parameters. Maximum weight loss (26.43%), moisture loss (31.08%), solid gain (4.65%), yield (32.88%), reducing sugar (53.78%), non-reducing sugar (19.93%) and total sugar (73.73%) in banana slices were recorded with osmotic pretreatment of 70 °Brix syrup for 24 hours. Osmotically dehydrated Robusta slices had higher acidity (1.31%) than the Ney Poovan (1.00%). An increase in syrup concentration from 50 to 70 °Brix and duration of osmosis from 4 to 24 hours increased weight loss, moisture loss, solid gain and yield in the banana slices. However, osmotic pretreatment with 60 °Brix sugar syrup for 24 hours resulted in highest sensory score (83.50) while it was lowest in control (65.00). Osmotic pretreatment of banana slices with 60 °Brix sugar syrup for 24 hours was found best and Robusta slices were rated significantly superior over Ney Poovan.

M.Sc.

Title : Standardization of drying techniques for carnation (*Dianthus caryophyllus* L.) cut flowers (2005)

S.Ravichandra, UAS, Bangalore, Guide : Dr.Sangama

Globally dried flowers have gained popularity for their eco-friendly nature, durability and suitability in varied floral arrangement. Aesthetic qualities such as colour, shape, size, texture and shelf life of dried flowers are greatly influenced by variety, harvest stage and dehydration process. Hence this study was taken up with carnation which is an important cut flower. Objectives of this investigation were to find out a suitable variety, harvest stage and dehydration processes for quality dried flowers of carnation and to explore possibilities of using these dried flower suitability in varied floral art. Experiment was carried in vars. Malaga and Dona cut flowers harvested at tight bud, half open and fully open stages. Three dehydration methods tried were, sun, shade and hot air oven. Data on sensory score for aesthetic qualities of carnation dried flowers revealed that var. Malaga received highest sensory score of 3.8 as compared var. Dona (2.7). Among different harvest stages tried fully open stage was found optimum with respect to 4.2 sensory score for dried flower colour, texture and shape as compared to sensory score of 1.5 and 2.7 for tight bud and half open stage dried flower appearance respectively. Significant improvement with sensory score of 4.6 obtained for overall appearance of sand embedded hot air oven dried flowers of var. Malaga as compared to sensory score of 1.2 and 1.7 for sun and shade dried flowers respectively. Maximum sensory score of 4.2 and more than four months of shelf life was obtained for arrangements of these dried flowers in glass and least for wreath (3.2) with shelf life of 25 days.

M.Sc.

Title : Development of value added products of medicinal importance from pomegranate (*Punica granatum*) fruits (2006)

N.Adaha, UAS, Bangalore, Guide : Dr.I.N.Doreyappa Gowda

The present investigation on “Development of value added products of medicinal importance from pomegranate (*Punica granatum*) fruits” was conducted at Post Harvest Technology Division, Indian Institute of Horticultural Research (IIHR), Hessaraghatta, Bangalore, during the year 2005-2006 to explore the possibility of use of stevia leaf powder extracts in the preparation of pomegranate beverages, to study the physico-chemical composition of pomegranate beverages in fresh condition and after storage at different conditions and to study the sensory qualities and overall acceptability of the products initially and different storage conditions. The findings of study are summarized below:

There was slight increase in total soluble solids, pH, and total sugars during storage. However the increase in total soluble solids and total sugars were relatively lower in the beverages prepared with sugar and stevia leaf powder extract at 50:50. A decreasing trend was found in acidity, anthocyanin and ascorbic acid content during the storage. The retention of these parameters was more in beverages with higher juice percentage. The beverages prepared with sugar alone as sweetening agent had better appeal with respect to colour, flavour and consistency. Nevertheless, beverages with sugar and stevia (50: 50) leaf powder extract also showed acceptable organoleptic qualities. The RTS (Ready to Serve) beverages prepared with 20% juice, 15 °B and 0.25% acidity in both type of beverages that is sugar alone, and sugar and stevia (50: 50) had better overall acceptability. Squash prepared with 30% juice, 40 °B and 1.0% acidity had better overall acceptability in both non-stevia and stevia incorporated beverages. Low temperature storage was found to be preferable for the quality retention during longer duration storage.

M.Sc.

Title : **Studies on storage of bitter gourd** (2007)

Shankar Gouda, UAS, Bangalore, Guide : Dr.K.P.GopalKrishna Rao

The storage life of bitter gourd fruits, harvested at 12 and 15 days after fruit set could be extended to five and six days respectively by polyethylene wrapping in different modifications. Physiological losses in weight of the bitter gourd fruit could be reduced by wrapping with different polyethylene films. PE wrapped (ventilation) fruit had lowest PLW followed by PE wrapped (with ethylene absorbent) during storage at both the harvesting stages. The highest firmness was recorded in fruit PE wrapped (ventilation) followed by PE wrapped (with ethylene absorbent) in both the harvesting stages, but the fruits harvested at 15 days after fruit set showed higher firmness than the 12 days after fruit set. The PE wrapped fruits had the lower total soluble solids. The PE wrapped (ventilation) fruit had the highest ascorbic acid content followed by PE wrapped (with ethylene absorbent) fruits in both the harvesting stages, but the fruits harvested at 12 days after fruit set had higher acidity than that 15 days. The highest chlorophyll was found in PE wrapped (ventilation) fruits in both the harvesting stages. The storage life of bitter gourd fruits could be extended to 18 (harvested at 12 days after fruit set) and 20 (harvested at 15 days after fruit set) days by polyethylene wrapping (with ethylene absorbent). The PE wrapped (with ethylene absorbent) fruits showed decrease in respiration rate whereas, those unwrapped fruits showed a gradual increase in respiration rate during storage. The PE wrapped (with ethylene absorbent) fruits had the lowest Physiological loss in weight during storage followed by PE wrapped (ventilation) fruits. The PE wrapped (with ethylene absorbent) fruits had the highest firmness by PE wrapped (with ethylene absorbent) fruits in both the harvesting stages, but the fruits harvested at 15 days after fruit set had showed higher firmness than that 12 days after fruit set. The PE wrapped (with and without ethylene absorbent) fruits had the hard texture; whereas PE wrapped (ventilation) fruits had optimum edible texture in both the harvesting stages, but the fruits harvested 15 days after fruit set had higher firmness. The highest ascorbic acid content was found in PE wrapped (with and without ethylene absorbent) fruits followed by PE wrapped (ventilation). The PE wrapped (with and without ethylene absorbent) fruits had the highest chlorophyll content. The PE wrapped (with and without ethylene absorbent) wrapped fruits were deep green in colour. Sensory evaluation panel observed the development of off flavour and bitter taste in the unwrapped fruits.

M.Sc.

Title : **Studies on osmotic dehydration of guava (*Psidium guajava* L.)** (2007)

P.Anitha, UAS, Bangalore, Guide : Dr.R.B.Tiwari

Guava (*Psidium guajava* L.) is one of the commercial fruits of tropical as well as subtropical regions. It occupies an important place in the horticultural wealth of India and ranks fourth with respect to area and production after mango, banana and citrus. It is a rich source of vitamin C and pectin. Guava is a seasonal fruits with very short shelf life, therefore it needs to be preserved as self stable value added products using drying technology such as osmotic dehydration.

Osmotic dehydration process involves subjecting fruit pieces to aqueous solution of sugar with high osmotic pressure which removes 30-50% of the water prior to drying. The inclusion of osmotic process in conventional dehydration has two major objectives quality improvement and energy savings. This studies was aim to know the effect of syrup concentrations (50, 60 & 70⁰ Brix) and duration of osmosis (4, 18 & 24 hours) on weight loss, solid gain and yield of osmotically dehydrated guava slices of varieties Allahabad Safeda and Pink Flesh. Data was analysed using Factorial Completely Randomized Design (FCRD). Observation on physic-chemical composition and sensory characteristics were taken.

Variations were observed with respect to fruit size, TSS, ascorbic acid content, acidity and sugar content in fresh fruits of variety Allahabad Safeda and Pink Flesh. Statistically significant variations were observed for weight loss, moisture loss, solid gain, yield, sugars, ascorbic acid content, titrable acidity, NEB and sensory quality parameters. In osmotically dehydrated gyava slices the values ranged f weight loss (22.73 to 34.55%), moisture loss (36.16 to 53.24%), solid gain (6.24 to 13.97%), yield (32.37 to 39.67%), reducing sugar (29.57 to 38.64%), non-reducing sugar (8.37 to 23.68%) and total sugar (39.02 to 63.32%). Increase in the syrup concentration from 50 to 70 ⁰Brix and duration of osmosis from 4 to 24 hours resulted in increase in weight loss, moisture loss, solid gain and yield in the guava slices. In general, an increase in reducing sugar and non-enzymatic browning (NEB), and decrease in non-reducing sugar and overall sensory score was observed during storage. Dehydrated guava slices were acceptable after 4 months of storage at room temperature. For osmotic dehydration, Allahabad Safeda was rated significantly superior over Pink Flesh.

M.Sc.

Title : Studies on packaging and storage of osmotically dehydrated aonla (*Emblica officinalis* L.) (2010)

N.Sumitha, UAS, Bangalore, Guide : Dr.R.B.Tiwari

Indian gooseberry (*Emblica officinalis* L.), an important fruit crop, is being grown on commercial scale in different parts of India. There is a great demand for *aonla* fruits and its products owing to their nutritional, medicinal properties and delicacy. The osmo dried *aonla* has tendency to become brown during storage. The present investigation aimed at finding out the suitable packing material and storage condition for maintaining the colour and quality of osmo-air dried *aonla* segments during storage. Different kinds of packages viz., 200 gauge high density polyethylene (HDPE) bag, punnet and polyethylene terphthalate (PET) jar were used to pack the osmo-air dried *aonla* segments. Packed samples were stored at room temperature (20-30 °C, 53-76% RH) under light and dark conditions, and at low temperature (15 °C, 55-60% RH) for six months. Product was analyzed for changes in their chemical constituents and organoleptic qualities at two months intervals up to the end of storage period. Studies revealed that samples packed in PET jar and stored at low temperature retained highest ascorbic acid and acidity. Furthermore, there was an increase in reducing sugar, total sugars, and partial reduction in non-reducing sugar content in *aonla* segments during storage. Significantly low non-enzymatic browning was recorded in case of PET jar stored under low temperature. Highest overall acceptability was observed in samples packed in PET jar and stored under low temperature. In contrast, lowest sensory score was recorded in case of samples stored at room temperature under dark condition. Thus, it can be concluded that, packing samples in PET jar and storing them under low temperature is a promising way to improve the storage life of osmo-air dried *aonla* segments.

M.Sc.

Title : Modified atmosphere packaging of sapota (*Achras zapota* L.) fruits for extension of storage-life and quality maintenance (2010)

B.Manasa, UAS, Bangalore, Guide : Dr.D.V.Sudhakar Rao

Sapota on account of its taste and low cost of production is very popular in India. It is highly perishable which is a major problem in extending its shelf-life. Modified atmosphere packaging is recently getting popular by virtue of its role in extending shelf-life of the produce. The packaging is intended to create an appropriate gaseous atmosphere around a commodity to enhance shelf-life and to conserve the quality of produce. An attempt was made to increase the storage-life of sapota using different packaging films coupled with low temperature storage. Mature sapota fruits (cv. Cricket Ball) were packed in low-density polyethylene (LDPE) and cryovac PD-961 films with different permeabilities to gases and stored at 10 °C, 15 °C and room temperature. The results showed that the storage life of sapota fruits could be extended up to 3 weeks at 10 °C and 1 week at 15 °C when the fruits were packed in non-perforated LDPE and PD-961 films. These fruits ripened normally with maintenance of good quality in terms of firmness, total sugars, total soluble solids, acidity, reduced physiological loss in weight compared to non-packed when they were shifted to room temperature after unpacking. Today, estimation of antioxidant activity has become an important parameter to evaluate the nutritional quality of food. In our investigation, it was found that higher amount of ascorbic acid content, total phenols, total flavonoids, total antioxidants were also maintained in MA packed fruits during storage period. The MA packaging was not helpful in extending of storage-life at room temperature though packed fruits had uniform ripening with least weight loss compared to non-packed fruits.

M.Sc.

Title : **Alleviation of chilling injury of custard apple (*Annona squamosa* L.) fruits (2010)**

R.A.Patil R.A, UAS, Bangalore, Guide : Dr.D.V.Sudhakar Rao

Experiments were conducted to study the effect of modified atmosphere packaging (MAP) on alleviation of chilling injury in custard apple (*Annona squamosa* L.) fruits. Three different kinds of flexible films viz., low density polyethylene (LDPE), Cryovac Opti 300 and Cryovac PD-961 of 30×25 size were used for packing the fruits. Eight fruits were packed in each film bag and these packs were further packed in ventilated CFB boxes. The boxes were stored in “Walk-in” cold rooms maintained at 8, 12 and 15 °C (85-90% RH) respectively. Each treatment was replicated thrice. At weekly intervals the fruits stored at different temperatures were taken out from film and allowed to ripen at room temperature (RT) to study their ripening behaviour. Experiments revealed that MAP of custard apple fruits with LDPE or Cryovac PD-961 film could alleviate the chilling injury to considerable extent, besides extending the storage life. Furthermore, MAP at lower temperature could maintain the quality of the fruits for a longer duration (two weeks) when compared to non-packed fruits at RT (four days). Fruits stored at 8 °C though maintained their quality up to three weeks of storage, but lacked desirable appearance due to development of chilling injury. At 12 °C, the fruits could be kept in unripe condition up to two weeks, when the fruits were packed either in LDPE or Cryovac PD-961 film. These fruits ripened normally without CI in three days when they were shifted to RT after unpacking. However, at 15 °C the MA packed fruits ripened within the pack by two weeks of storage life when compared to one week in non-packed fruits. Hence, it can be concluded that the storage life of custard apple fruits could be extended at 12 °C without any CI by packing the fruits in LDPE or Cryovac PD-961 film.

M.Sc.

Title : **Studies on dehydration of orchid flowers** (2010)

Rameeza Salma, UAS, Bangalore, Guide : Dr.Sangama

Dehydration is an important process of moisture removal to enhance the shelf life and preserve the flower colour, shape, size and texture in natural form. Dried flower quality is depends on flower structure, variety, stage of harvest, time of harvest, desiccants, drying methods and their storage in a suitable packages. Hence the present study was conducted with the objectives of selection of suitable variety with optimum harvest stage, embedding media and drying method for better display quality with longer shelf life of dried flowers of *Dendrobium* orchid. Dried flowers of *Dendrobium* orchid var. Sonia-17 had higher sensory score of 22.80, 23.40 and 23.30 for colour, texture and shape respectively as compared to the dried flower sensory score of 15.00 & 14.60, 17.00 & 13.00 and 21.20 for colour, texture and shape respectively in vars. Caesar Red and Emma White. Among three harvest stage viz., half opened, $\frac{3}{4}$ th opened and fully opened flowers of *Dendrobium* orchid var. Sonia-17 dried flower qualities revealed that flowers harvested at $\frac{3}{4}$ th opened stage yielded dried flowers of brighter colour, glossy texture, medium in size with small white centre, having petals and sepals in intact positions exhibiting an attractive shape. Silica gel embedded hot air oven dried flowers obtained a sensory score of 21.00 and 24.00 for colour and shape respectively whereas better texture (22.12) was observed in sand embedded hot air oven dried flowers. Dried flowers stored under dark in an air tight plastic container obtained a sensory score of 19.37 and 21.00 for colour and texture respectively which indicated good keeping quality of above six months. Among various products prepared from dried flowers, floral arrangement in acrylic package obtained a maximum sensory score of 22.40 as compared to dried flower arrangement in bamboo basket and dried labellum greeting card.

M.Sc.

Title : **Studies on osmotic dehydration of carrot (*Daucus carota* L.)** (2011)

R.Selvakumar, UAS, Bangalore, Guide : Dr.R.B.Tiwari

Carrot is one of the important root vegetables rich in bioactive compounds like carotenoids and dietary fibers with appreciable levels of several other functional components having significant health-promoting properties. Osmotic dehydration of carrot seems to be convenient alternative for long-term storage as compared to cold storage or canned products. Keeping this in view the present investigation was carried out on “Studies on Osmotic Dehydration of carrot (*Daucus carota* L.)”. Among the osmotic pre-treatments 70°B syrup for 40h resulted in maximum weight reduction (11.24%), water loss (49.29%) and solid gain (38.05%). Pretreatments with low sugar syrup concentration of 40 and 50°B at both osmotic duration 20 and 40h resulted in an overall weight gain as values for weight reduction (WR) were negative (-9.37 to -29.00%), as well as an increase in solid gain and water loss in osmotically dehydrated carrot slices. Carrot slices subjected to 70°B syrup for 40h osmosis had maximum yield (58.33%) and lowest drying ratio (1.71:1) followed (58.26%) by 60°B syrup for 20h and (57.17%) 60°B syrup for 40h. Lowest yield 7.37 per cent and maximum drying ratio 13.88 was observed in untreated control samples. In osmotically dehydrated slices of carrot slices at initial stage the values were in range of reducing sugar (52.31-58.45%), non-reducing sugar (10.22-17.36%), total sugar (67.31-70.70%), carotenoids (32.04-39.09 mg/100 g) and total titrable acidity (0.31-0.52%). There was loss in carotenoids after six months storage and values ranged from (28.52-32.15 mg/100 g). Non-enzymatic browning in osmo-dried samples were very low at initial (0.100 to 0.151) and increased during storage which was (0.168-0.306) after six months of storage. Osmotically dehydrated carrot slices made by dipping in 50°B syrup for 40h were found superior with respect to sensory characteristics at initial as well as during storage. However, all osmotic dehydrated samples were found to be acceptable after six months of storage at ambient temperature. Hence osmotic dehydration was found to be very effective in improving the quality of dehydrated carrot slices.

M.Sc.

Title : **Estimation of field residue of cabbage and development of fortified foods (2011)**

Prashanth Naik, UAS, Bangalore, Guide : Dr.C.K.Naraayana

Cabbage represents an important group of plants which produce significantly large amount of biomass consisting of leaves. Cabbage outer leaves were reported to contain high amount of fibre and bioactive compounds with high antioxidant activity. So a study was conducted to estimate cabbage field residue and development of fortified foods. The results showed that total crop residue was 15.08 tonnes/ha (27.89%) and leaves were the major residue (13.13 tonnes/ha). After harvesting, the residual leaves were collected and divided into two lots; one was subjected for blanching to inactivate the native enzymes and another was unblanched, the leaves were dried at 60 °C and powdered. Common bakery food products such as bread, biscuits and rusk were prepared by fortifying the raw material with blanched and unblanched residual cabbage leaves (RCL) powder at 5, 7 and 10% **levels**. The nutrient compositions such as protein, carbohydrates, fat, crude fibre, total carotenoids, vitamin C and total antioxidant activity were estimated for unblanched and blanched RCL, their powder and fortified products and found significant differences among the treatments. The data indicated that, with increase in RCL powder there was an increase in all the nutrient components except fat and carbohydrates. The fortified products were evaluated for sensory qualities which exhibited no significant differences among the treatments but 10% fortification was less preferred because of cabbage flavour and slight bitterness. Besides these products, encapsulation was also done with blanched RCL powder and powdered aonla pomace with twelve different combinations and their nutrient composition were also determined.

M.Sc.

Title : Effect of ethylene action inhibitor and *Ethylene absorbent* on the postharvest life and quality of guava (2011)

S.Vijay Rakesh Reddy, UAS, Bangalore, Guide : Dr.D.V.Sudhakar Rao

Guava (*Psidium guajava* L.) is one of the important fruits of tropics, also known as “Apple of tropics”. Being a climacteric fruit, it is highly perishable in nature. Due to faulty or improper handling during transportation and storage, 25-30% of the produce goes waste. Hence to reduce these losses and to extend the shelf life of the fruits a study was conducted on effect of ethylene action inhibitor and ethylene absorbent on the postharvest life and quality of guava (*Psidium guajava* L.) cv. Lucknow -49” at Division of Post Harvest Technology, IIHR, Bangalore during 2010-11. Guava fruits were pre-treated with three treatments viz., ethylene action inhibitor (1-MCP 500 ppb), ethylene absorbent (KMnO₄ 10 g/kg) and control. After the pre-treatments, fruits were stored at three different temperatures of 8, 12 and room temperature (22-28 °C). 1-MPC treatment significantly reduce the respiration rate, ethylene production and delayed the ripening irrespective of the storage temperatures. However, KMnO₄ treatment was helpful in extending the storage life of guava fruits only marginally. At room temperature (RT) the 1-MPC treatment extended the postharvest life of guava fruits to 10 days compared to the control fruits that couldn’t be stored for more than 5 days. The storage life of 1-MPC treated guava fruits could be further extended to 30 days when stored at 12 °C compared to 15 days in un-treated fruits. At 8 °C, through 1-MPC treated fruits stored 12 °C showed maximum firmness, total soluble solids and higher retention of ascorbic acid till the end of ripening compared to control and treatments.

M.Sc.

Title : **Standardization of blended guava and papaya fruit bar** (2012)

L.Jeebit Singh, UAS, Bangalore, Guide : Dr.R.B.Tiwari

Guava and papaya are two commercially important crops grown widely standing 4th and 5th position in production among fruit crops in India thereby holding a prominent place among fruits. These fruits are rich in different phytochemical components like vitamins, minerals etc. On the other hand, these two fruits also suffer high post-harvest losses. Keeping this in view the present investigation was carried out on “Standardization of blended guava and papaya fruit bar”. Fruit bar prepared from guava pulp only recorded maximum yield (29.18 %) and drying ratio was 3.56. The lowest yield (24.15 %) was observed in fruit bar prepared from papaya pulp only and drying ratio was 3.85. In blended fruit bars at initial stage the values were in the range of ascorbic acid (43.81-226.6 mg/100g), carotenoids (0- 1627.1 µg /100g), reducing sugar (35.74-46.10 %), non-reducing sugar (21.22-32.83 %) and total sugar (65.67-73.57 %). Fruit bar prepared from 40 per cent guava pulp and 60 per cent papaya pulp was found superior with respect to sensory characteristics at initial and also during subsequent storage period. However, all the samples were found to be acceptable after four months of storage at room temperature. The fruit bar samples packed in biaxially oriented polypropylene (BOPP) showed better result with respect to nutrient retention and sensory characteristics. Microbially all the samples were found to be safe from consumption point of view till the end of four months of storage. Hence, blending of guava and papaya pulps to make fruit bar was found to be effective in yielding a product of nutritionally rich, stable and highly acceptable product.

DIVISION OF PLANT PATHOLOGY.

Ph.D

Title : **Development of integrated disease management package and transgenic technology for the control of powdery mildew (*Leveillula taurica*) in capsicum (*Capsicum annuum* L.)** (2007)

A.Manoj Kumar, Kuvempu University, Shimoga, Guide : Dr.Girija Ganeshan

Bell pepper (*Capsicum annuum* L.) is an important vegetable crop in India and World. Powdery mildew (*Leveillula taurica*) takes heavy toll under field and greenhouse conditions. The major goal of the study was to develop an Integrated Disease Management (IDM) package for the control of powdery mildew (*Leveillula taurica*) in bell pepper and development of transgenic bell pepper using *Agrobacterium tumefaciens* mediated *in plant* transformation protocol.

Five commercial varieties were evaluated for the disease incidence and yield during *kharif* 2004 and *rabi* 2005 with five sets of sprays of dinocap @ 1 ml/lit was found significantly effective in controlling powdery mildew disease and increase in yield of all genotypes. Among the OP varieties, Arka Mohini recorded maximum yield and minimum disease incidence and F₁ hybrid, Indra also performed well reporting high fruit yield and lowest disease incidence. Later all these five commercial genotypes were screened using RAPD primers. From 58 primers about 219 unambiguous, readable and reproducible bands were produced, 57 (26%) were polymorphic and shared among at least two individuals, 144 (65.8%) were monomorphic common to all the individuals and 18 (8.2%) were polymorphic and unique. The grouping of varieties with similar morphological features was done based on cluster analysis. The variety grouped under cluster A were high yielding with low disease incidence, indicating that they are hybrids. The varieties grouped under cluster B recorded relatively low yield and high disease incidence.

Among thirteen fungicides, eight biological control agents and thirteen plant products evaluated *in vitro* for the control *L. taurica* indicated that three fungicides, Triademifon, Tebuconazole and Dinocap, all biological control agents and two plant products *viz.*, neem oil and pongamia oil effectively reduced the powdery mildew spore germination. Fungicides *viz.*, Triademifon, Tebuconazole and Dinocap; biological control agent, *Ampelomyces quisqualis* and plant products neem oil and pongamia oil significantly reduced the powdery mildew disease incidence and increased the fruit yield

for both the seasons in both the varieties. Higher levels of chlorophyll a, b, total chlorophyll, total soluble sugar, total phenols and ortho dihydroxy phenols were recorded in *T. viride* and *T. harizianum* treated leaves as against untreated control and other treatments. The increased levels of biochemical constituents induced by *T.viride* and *T.harizianum* may play a vital role in plant defense mechanism.

Adopting the IDM strategy developed including *A.quisqualis*, *T.harizianum*, pongamia oil and best fungicide there was a decline in the powdery mildew disease incidence around 93.0 per cent over control in Indra and California Wonder. In the yield, 122.3 and 342.8 per cent increase over control in Indra and California Wonder respectively.

Transgenic technology was standardized to incorporate disease resistance gene. In Arka Gaurav, 45 T₀ transformants were raised and fruits were harvested. 110 T₁ plants were raised and screened using gene specific *uidA (gus)* (463 bp) primers by PCR amplification. 21 PCR positives were identified from T₁ generation was identified with an expected fragment size. In T₂ generation, 76 plants were analysed for the presence of transgene in which 68 plants were PCR positives against *uidA (gus)*, *hpt II* and *35s-uidA* specific primers. The total RNA was extracted from the selected plants (TAG-2, TAG-6 and TAG-8 of T₁ generation) and was reverse transcribed to single stranded cDNA and the ss cDNA was employed as template in a PCR reaction using *uidA (gus)* specific primers. The transcripts of expected size were present in all the selected plants. Over all the efficiency of transformation was 6.66 per cent.

In case of Arka Mohini, 35 T₀ transformants were raised and fruits were harvested. 31 T₁ plants were screened using gene specific *uidA (gus)* (463 bp) primers by PCR amplification. 8 PCR positives were identified from T₁ generation was identified with an expected fragment size. Further, these plants were also screened using *hpt II* (509 bp) and *35suidA* (687 bp) specific primers. In T₂ generation, 30 plants were analysed for the presence of trans gene in which 14 plants were PCR positives against *uidA (gus)*, *hpt II* and *35s-uidA* specific primers. The total RNA was extracted from the selected plants (TAM-2, TAM-4 of T₁ generation) and was reverse transcribed to single stranded cDNA and the ss cDNA was employed as template in a PCR reaction using *uidA (gus)* specific primers. The transcripts of expected size were present in all the selected plants. Over all the efficiency of transformation was 5.71 per cent.

M.Sc.

Title : **Molecular diagnosis of citrus greening bacterium** (2002)

P.Kamesh Babu, UAS, Bangalore, Guide : Dr.M.Krishna Reddy

The investigations on Citrus greening disease indicated that survey based on symptoms indicated 38.5 to 63.7% disease incidence in Andhra Pradesh and 20.0 to 86.7% incidence in Karnataka. The graft transmission experiments using greening affected scion material from Sweet Orange, Coorg Mandarin and Lime indicated that grafting successfully transmitted greening disease. In the case of Rangapur Lime rootstock 100% transmission was observed, with different scion materials, whereas 50 to 100% transmission was observed when Acid Lime, Troyer Citrange, Cleopatra Mandarin and Rough Lemon were used as rootstocks. In the grafted plants, symptoms appeared 7 to 9 weeks after grafting. Collecting psyllids, feeding on infected plants and transferring them onto susceptible plants successfully transmitted greening bacterium. Hundred percent transmission was achieved when more than 5 psyllids per plant were released and symptoms appeared after 2 to 4 months. Positive results were obtained from the DNA isolated from grafted plant samples and psyllids when subjected to PCR amplification. Among the bark, midrib and leaf lamina tested for the quality DNA for PCR analysis for CGB, bark tissue was found to be the best source for quality DNA followed by midrib. Even though DNA was successfully isolated from leaf lamina, it was not amplified when subjected to PCR analysis for CGB. This may be due to lack of phloem tissue in lamina as the CGB resides in phloem tissue. Among the fresh tissue and shade-dried tissues tested for quality DNA, the fresh tissue samples are found to be the best source. For PCR amplification, rDNA primers specific- to rDNA region successfully amplified 1.2 kb DNA fragment from CGB infected plant material, but not from healthy citrus plants or water as template indicating the specificity of the primers. Positive amplification of PCR confirming the presence of CGB was obtained in Coorg Mandarin, Rangapur Lime, Sweet Orange. Kinnow Mandarin, Acid Lime, Seedless Lime and Rough Lemon.

M.Sc.

Title : Identification and diagnosis of chilli veinal mottle potyvirus (CVMV) infecting hot pepper (*Capsicum annuum* L.) (2003)

H.M.Kantharaju, UAS, Bangalore, Guide : Dr.M.Krishna Reddy

Chilli Veinal Mottle Potyvirus (ChiVMV) is an important virus disease of chilli pepper in India. The virus produced initial symptoms of mosaic mottling on young leaves 10 days after inoculation followed by characteristic vein banding, reduction in leaf size, cupping in leaves and leaf distortion. Host range studies of ChiVMV revealed that only Plant species belonging to family Solanaceae (9 species out of 16 species of Solanaceae) were susceptible. Hosts, which took systemic infection, are *Capsicum annuum* L. cvs. Arka Lohit and California wonder, *Datura metel*, *Nicotiana glutinosa* L. *Nicotiana tabaccum* L. cvs. Bhavya and Gold line. One plant that found to be local lesion host is *Nicotiana tabaccum* L. cv. Hartensis. The ultra thin section of infected tissues revealed the presence of cytoplasmic cylindrical inclusions as pinwheels and short curved inclusion bodies typical of potyvirus group. ChiVMV was successfully purified from systemically infected *Datura metel* L. leaves 3-4 weeks after inoculation. First the virus was extracted using 0.02 M HEPES buffer (pH 7.5) containing mercaptoethanol, sodium diethyl dithiocarbamate, triton X-100 and urea. The virus was finally concentrated by sucrose density and differential centrifugation in HEPES resuspension buffer (pH 7.5) containing sodium sulfite and urea. The UV absorption spectrum of purified preparations of ChiVMV showed typical nucleoprotein pattern with a maximum and minimum absorbance at 260 nm and 240 nm respectively. The A₂₆₀/A₂₈₀ ratios measured from several purified preparations were in the range of 1.1101 to 1.2101 and the virus yield estimated was 1.0 to 1.2 mg/100 g of leaf tissue. Electron microscopy of the purified preparation of ChiVMV after negative staining with 2 per cent uranyl acetate revealed the presence of numerous virus particles which were flexuous rods measuring about 640 to 700 nm long, 12 nm in diameter indicating the relationship of virus under study belonging to potyvirus group. SDS Polyacrylamide gel electrophoresis of the purified preparation of ChiVMV coat protein on 12 per cent SDS gel revealed the presence of a band with an approximate molecular weight of 35000 daltons in freshly purified virus. A direct antigen coating ELISA (DAC-ELISA) and Dot Immuno Binding Assay (OIBA) were standardized and successfully used to detect virus and identify resistant and susceptible lines.

M.Sc.

Title : **Development of safe, effective and eco-friend (*Pasteurization L.*) techniques**
(2004)

Saritha, S.K.University,Andhra Pradesh, Guide : Dr.Meera Pandey

Steam and hot water are the best methods for substrate pasteurization for oyster mushroom cultivation by chemical pasteurization and solarisation although prevented contamination, the yield was reduced. This could be due to the fact that the straw in these treatments was not soft enough (cooked) for obtaining better nutrition by the mushroom mycelium. The average yield of the oyster mushrooms in chemical pasteurization was reduced by 55% and with solarisation the average yield is reduced by 75% when compared to Hot water treatment. Heat was found to be best method for killing the contaminants on the straw as compared to chemicals. Therefore, Hot water (or) steam pasteurization can still be the best recommendation for substrate pasteurization for oyster mushroom cultivation

M.Sc.

Title : **Molecular characterization of chilli veinal mottle virus infecting chilli (*Capsicum annuum* L.)** (2006)

C.Laxminarayana Reddy, UAS, Bangalore, Guide : Dr.M.Krishna Reddy

Chilli Veinal Mottle Virus (ChVMV) disease is emerging as major constraint in the production of chilli pepper (*Capsicum annuum* L.) in India and many other Asian countries. This is the first attempt in India and elsewhere in the world to study the molecular characterization and variability of ChVMV isolates. The survey results revealed the presence of ChVMV in all chilli Karnataka, Maharashtra, Andhra Pradesh, Tamil Nadu and Kerala and the incidence ranged from Zero to 87.9 per cent. Differentiation of 30 ChVMV isolates using 31 plant species was found difficult because of no significant differences in the symptoms produced on these test plants. However the new host plants identified in the study will be very useful for the management of the virus disease. The electron microscopy of purified virus preparations revealed flexuous rod shaped particles measuring 650-700X13 nm. Diagnostic tools RT-PCR, ELISA, DIBA, SDS-PAGE, western blot and RNA blot hybridization were found sensitive for detection of the virus.

Polyclonal antiserum was raised in rabbit against purified native virus and its titer was equivalent to the commercially available antisera. A survey was undertaken in chilli growing areas of Southern India for the ChVMV incidence, the virus was confirmed by DAC-ELISA. During the survey, several ChVMV samples were collected, named as different isolates and were maintained on *Datura metel* in the glasshouse conditions. Biological differentiation of the 30 ChVMV isolates was carried out on 32 different host plants, indicating the similar type of reaction to the test plants with all the isolates. The Immunological differentiation of the ChVMV isolates were observed by performing ELISA by using ChVMV, PVBV, PVMV, PVY antisera. In the dot immuno assay, all the isolates showed positive reaction to the ChVMV polyclonal antisera. SDS-PAGE, RNA blot using the synthesized probe and Western blot were standardized for the detection of ChVMV and used for differentiation of isolates. All the above studies confirmed that the isolates were closely related. Analysis of 30 ChVMV isolates sequences revealed that the coat protein region is highly conserved and variation is present in the Nib region among the isolates. Further, the conserved regions present in the potyvirus genus were observed in all the isolates. The Phylogenetic analysis of ChVMV isolates along with the other

members of family *Potyvirdae* revealed that these isolates are distinct from other viruses by forming a separate cluster. The ChVMV isolates were classified into five strainal groups based on the phylogenetic analysis and identity matrices of both nucleotide and deduced amino acid sequences which exhibit more than 5 per cent variation at nucleotide level and more than 3 per cent variation at amino acid level. The partial NIB region, complete coat protein region and 3' UTR of 30 ChVMV isolates were sequenced. The comparison and phylogenetic analysis of ChVMV isolates nucleotide and deduced amino acid sequences with the other members of Potyviruses and Potyviridae revealed that the ChVMV isolates were distinct from all other viruses. The comparison and phylogenetic analysis among the ChVMV isolates indicated five groups, which may be considered as distinct strains as they exhibit more than five per cent variation at the nucleotide as well as more than three per cent at the amino acid levels. Screening of 87 chilli lines to ChVMV revealed that, 44 were immune, four highly resistant, four resistant, 14 moderately resistant, three susceptible and 18 highly susceptible. Some of the lines identified as immune were also the advanced breeding lines, which are ready to be used as varieties. Resistant source in chilli against ChVMV was identified by screening 84 germplasm lines using AUSPC (Area Under Symptom Progress Curve) criteria and utilized in the breeding programme.

M.Sc.

Title : **Development of sporeless/low spore shedding strains of *Pleurotus* species**
(2006)

Sandhya Ravishankar, Kuvempu University, Shimoga, Guide : Dr.Meera Pandey

Di-mon matings were carried out between monokaryons of commercial *Pleurotus* species (*P.florida* and *P.sajor-caju*) with dikaryotic mycelia of natural sporeless mutant (Psm) yielded 16 (*P.florida* x Psm) and 18 (*P.sajor-caju* x Psm) hybrids. Exposure of spore suspension of commercial *Pleurotus* species (*P.florida* and *P. sajour-caju*) to Ultra violet radiation for variable timings resulted in yielding few mutants. Few mutants obtained from *P.florida* spores even though exhibited spore less character in 1st generation failed to maintain the character (stability) in 2nd generation. The mutant obtained from exposure of spore suspension of *P. sajour-caju* exhibited sporelessness (low sporing character) with good morphology. The stability of the low sporing character was maintained even after 40th generation. It proved the mutation obtained was permanent. Gill sections of low sporing UV mutant along with its parent *P.sajor-caju* and commercial species *P. florida* and sporeless mutant (Psm) observed under microscope, showed *P. sajour-caju* and *P. florida* more spore intensity. The biological efficiency of *P.florida* was 61.09% and *P.sajor-caju* was 62.02%. Low sporing UV mutant showed lower biological efficiency of 52.67%. Natural sporeless mutant (Psm) showed highest biological efficiency of 70.93%. The shelf life of sporophores of commercial *Pleurotus sajour-caju* and sporeless strains (Psm and low sporing UV mutant) in pp covers at room temperature was 2 days as compared to only one day in 1.33% ventilation pp cover, commercial perforated cover, pp covers lined with brown paper and air tight container. Whereas sporophores of commercial *Pleurotus florida* could be stored in good condition only for one day in all the treatments the sporophores of *Pleurotus sajour-caju* and sporeless mutants (Psm and low sporing UV mutant) showed better shelf life compared to *Pleurotus florida*. Under cold storage condition (4 °C) UV mutant and Psm showed 14 days extended shelf life compared to 11 days in *Pleurotus florida* and 13 days in *Pleurotus sajour-caju*. As the ventilation increased number of storage days also reduced. The present studies on dehydration of commercial *Pleurotus* species and two sporeless strains were carried out at room temperature (28-32 °C) and drier (40 °C). It took 2-3 days for optimal drying (8-10% moisture) at room temperature as against 5-6 hours in drier for both commercial *Pleurotus* and two sporeless strains. RAPD analysis was carried out with random primers

to know the polymorphism between the species and strains. The cluster analysis of RAPD markers showed two groups. In first group *P. florida* and Psm were closely related with 43% similarity, which also reflected in distance measure. Even though *P. florida* and Psm were closely related, morphological characters of both strains were different. *P. florida* have white sporophores with high spore content. Whereas Psm have light gray funnel shaped sporophores with no spores. In second group *P.sajor-caju* and UV mutant were closely related with 64% similarity. However sporophore morphology of both the strains was similar to certain extant. *P.sajor-caju* having gray sporophores with eccentric stipe and slight wavy margin with high spore content. Whereas UV mutant showed highly lobed (flower type) sporophores with very less spore content. Thus, RFLP and RAPD analysis found to be a suitable technique for observing the polymorphism between the strains.

M.Sc.

Title : **Molecular characterization of bhendi yellow vein mosaic virus (2008)**

V.Venkataramanappa, UAS, Bangalore, Guide : Dr.M.Krishna Reddy

Bhendi/Okra (*Abelmoschus esculents* (L.) Moench) is one of the important vegetable crops grown extensively throughout the tropical, subtropical and warm regions of the temperate zones of the world. Bhendi yellow vein mosaic virus (BYVMV) is one of the most severe diseases which take a heavy toll in India. A roving survey revealed that the occurrence of BYVMV disease incidence ranged from 23.0 to 67.67% in Karnataka, 45.89 to 56.78% in Andhra Pradesh, 23 to 75.64% in Tamil Nadu, 42.45 to 75.64% in Kerala, 23 to 85.64% in Maharashtra, 24.85 to 65.78% in Haryana, 35.76 to 57% in Uttar Pradesh, 45.45% in Delhi, 67.78% in Chandigarh and 45.89 to 66.78% in Rajasthan and The highest disease incidence was recorded in the districts of Gulbarga (75.0%) and least is in Bangalore rural (44.01%). Single whitefly of B biotype and two whiteflies indigenous *B. tabaci* could be able to transmit BYVMV with 30% and 20% efficiency. Nine B biotype and 10 indigenous viruliferous whiteflies required for 100% BYVMV transmission. Minimum AAP and IAP found to be 15 min, in B biotype and 20 min. in indigenous whiteflies. 100% transmission obtained in 24 hrs. AAP and 16 hrs. IAP given to B- biotype compared to indigenous whitefly which required 24 hrs. AAP and IAP. Females of B-biotype and indigenous *B. tabaci* were more efficient in transmitting BYVMV compared to males. Age group of 7-15 days old Bhendi plants were found more susceptible for infection. BYVMV was successfully purified from the systemically infected okra leaves using the modified procedure with addition of sucrose gradient. The UV spectrum observations of 260/280 ratios showed 1.20-1.27 OD with the yield of 12-15 mg/Kg of infected leaves. SDS-PAGE analysis and western blotting of the purified preparation resulted in the presence of band with an approximate molecular weight of 28000 Daltons, which is expected monomeric size of BYVMV coat protein. The direct antigen coating ELISA (DAC-ELISA) was standardized and successfully used to detect virus using polyclonal antibody raised against ACMV and goat anti-mouse IgG-alkaline phosphatase conjugate. The ELISA results showed that BYVMV detect in infected leaf extracts up to 1:10000 antigen dilution. However, optimum reaction has been obtained at 1: 1000 antigen concentrations. Further the BYVMV also detect in infected flowers, pollen, petals, calyx and fruits but not in seed. Dot immuno binding Assay (DIBA) was standardized and successfully used to detect virus using polyclonal antibody raised

against ACMV. The result showed that BYVMV detected in non purified sample up to 1: 1000 antigen dilution and 1: 10000 dilution of purified virus with the antibody dilution of 1: 500 from the infected leaf tissues. Dot blot hybridization was standardized using diagoxygenin labeled probes. The methods were found to be equally sensitive in detecting viral nucleic acid up to a concentration of 0.001 ng from purified BYVMV. Further, the BYVMV isolates were detected using DNA was extracted from the infected leaf tissues. This method could also be used as diagnostic tool for identification of BYVMV with more precision. The complete DNA-A sequence of 113 isolates nucleotide sequence of the DNA-A genome of different isolates size ranged from 27722 to 2793nt. The complete nucleotide sequence of 113 isolates has 84 to 100% similarity among themselves. Ten groups are formed in phylogenetic grouping that have sequence identity of less than 89% with other reported begomoviruses. Ten species were identified as distinct from already known begomovirus species in India. These are Bhendi yellow vein Haryana virus (BYVHV), Bhendi yellow vein Guntur virus (BYVGV), Bhendi yellow vein India virus (BYVIV), Bhendi yellow vein Kamataka Virus (BYVKV), Okra leaf curl India virus (OKLCIV). Bhendi Yellow Vein Kerala Virus (BYVKV), Bhendi Yellow Vein Delhi Virus (BYVDV), Bhendi Yellow Vein Trichy Virus (BYVTV), Bhendi Yellow Vein Bhubaneswar Virus (BYVBV), Okra Enation Leaf Curl Virus (OELCV). Most of isolates of BYVMV showed high percentage of nucleotide sequence and amino acid identity with in ORFs AV1, AV2, AC1 AC2 AC3, AC4, AC5 and intergenic region with BYVMV.NOL751, BYVMV-Madurai, OYVMV, BYVMV-Pak301, CLCuVA and (CLCuMV-(Okra)] and some isolates showing the nucleotide sequence and amino acid identity ToLCNDV-A VT. The complete DNA-B sequence of 7 isolates nucleotide sequence genome of different isolates size ranged from 2695nt (OY77, OY81, OY174) to 2707nt (OYI64). The complete nucleotide sequence of 7 isolates has 84 to 100% similarity among themselves lead to form four groups which are associated with okra yellow vein mosaic disease namely the isolates OY77, OY142, OY81 and OYT closely with Tomato leaf curl New Delhi luffa isolates (EF620535) and Tomato leaf curl New Delhi AVT1 isolate (AY438563 ToLCNDV [Lucknow] and ToLCNDV-sever [Jessor] isolates. the isolate OY164 form separate group with ToLCNDV-AVT1 and ToLCNDV-luffa. Pk. and one isolate OY131 which shows the nucleotide identity of less than 85% with other okra DNA-B we considered as distinct species of okra yellow vein virus. The full length of 36 isolates Beta DNA molecules ranging in size from 1324 to 1403nt in length the sequence of these presumed full length DNA ~ molecules have these conserved

features an A-rich region, a satellite conserved region (SCR), and a single open reading frame (putative coding region of gene C 1). The complete nucleotide sequence of 36 Beta DNA molecule revealed the occurrence of four types of Beta DNA molecules were present among the isolates *viz.*, Bhendi yellow vein beta satellite (BYVB), okra leaf curl betasatellite (OLCuB), Ludwigia leaf distortion betasatellite (LuLDB), Croton yellow vein mosaic beta satellite (CroYVMB) and these may be associated with BYVMV. 57 different genotypes were screened for BYVMV under glasshouse and 29 different genotypes under natural conditions. None of the genotypes tested was highly resistant or immune. Only 3 genotypes showing resistant reaction, 3 genotypes showing moderately resistant.

M.Sc.

Title : **Morpho-cultural characterization of indigenous *Pleurotus* isolates** (2008)

A.Yasotha, Bharathiar University, Coimbatore, Guide : Dr.Meera Pandey

Pleurotus species is a promising mushroom form a group of edible species. Mushroom varieties are at present hard to protect since they are mainly characterized by variable fruit body and yield characteristics. It seems to be morphologically different and is taxonomically discrete. They are greatly influenced by environmental factors. In the present study, six isolates from different geographical regions, Bangalore, Shimoga, Madurai, Udaipur and Banswara (Rajasthan) were studied. All the six isolates showed high degree of variability in terms of colony morphology, media, temperature, mycelial characters and spore production. *Pleurotus djamor* grew faster than the other *Pleurotus* species at 25 °C. Linear growth of mycelium was observed in all the region isolates. The two isolates, *P. cystidiosus* showed a different kind of growth which produced black heads of coremia on MEA, SSM and RC. Pinkish pigment in the mycelia of *P. djamor* was produced on MEA, PCA and SSM, which is a characteristic observation.

Influence of temperature on the growth of isolates showed variability based on geographical regions. Bangalore isolates showed an optimum of 25 °C, Shimoga, Madurai and Udaipur isolates of 30 °C and Banswara (Rajasthan) isolate showed optima of 40 °C suggesting the existence of variability. Out of six isolates, Bangalore and Udaipur showed a high degree of variability in mycelial thickness in both skeletal and generative hyphal system. There exists variability in the kind of hyphal system also. Bangalore, Shimoga and Udaipur isolates showed Dimitic hyphae, whereas Madurai showed monomitic hyphae. But Banaswara isolate showed trimitic hyphae, which is only showed the existence of variability in all study. Basidiospore and asexual spore characters are considered an important character for species identification. They are similar in structure but size varied. Only *P. cystidiosus* produced the asexual spore, which is used to distinguish from the other *Pleurotus* sp. Morphological studies are also used to determine the species. In this, only *P. cystidiosus* and *P. djamor* showed a different morphology that is *P. cystidiosus* showed very large fruiting bodies exists in a single and blackish brown in colour, whereas *P. djamor* showed pink colour fruiting bodies.

M.Sc.

Title : Development of recombinant protein based diagnosis for chilli *Veinal mottle virus* infecting chilli (2010)

M.J.Pavankumar, UAS, Bangalore, Guide : Dr.M.Krishna Reddy

Chilli veinal mottle virus (ChiVMV) is a positive sense single stranded RNA virus, with monopartite genome belongs to genus *potyvirus* of family potyviridae. In this study, specific rabbit polyclonal antibodies against bacterially expressed coat protein of Chilli veinal mottle virus (ChiVMV, genus Potyvirus) were produced using a recombinant DNA approach. The ChiVMV coat protein (CP) gene was cloned in an expression vector pET-15b (Novagen). Expression of the CP with an N-terminal hexahistidine tag in *Escherichia coli* BL 21 DE3 cells was induced by adding isopropyl-3-D-1-thiogalactoside (IPTG) to a final concentration of 250 μ M. About 4 mg of bacterially expressed CP was purified from 500ml of bacterial liquid culture using a Ni-NTA resin column (Qiagen). The expressed CP which migrated as a protein of approximately 34 kDa in sodium dodecyl sulphate (SDS)-polyacrylamide gel electrophoresis (PAGE) was identified by its strong reaction with polyclonal antibodies produced against ChiVMV purified particles in Western blots. Expressed and purified CP (SDS-PAGE 34 kDa band) was injected into a white female New Zealand rabbit, approximately 3 month old, four times at weekly intervals by intramuscular injections. The antiserum produced was evaluated for ChiVMV detection in DAC-ELISA. The antiserum raised against the expressed CP (ChiVMV) gave strong ChiVMV specific DAC-ELISA reactions and very weak background reactions with non-infected tissues. Three ChiVMV ELISA-positive samples of chilli, were also confirmed by reverse transcription (RT)-PCR and sequencing. The expected 1.2-kb viral cDNA was amplified from all three samples using ChVMVCPF/CPR primers. Excluding the 3' poly-A tail, was 1,147 nucleotides (nt) long, comprising the 3'-terminal of the coat protein region (1 to 861 nt), and the 3'-untranslated region (865 to 1,147nt). Comparison of the Coat protein gene sequence with corresponding sequences of potyviruses in GenBank revealed that ChiVMV. Tomato had greatest nucleotide (90.3 to 93.8%) and amino acid (91.6 to 97.2%) identity with pepper isolates of ChiVMV from India, Where as it shared 90.2 to 93.0% nucleotide and 93.7 to 96.1% amino acid identity with ChiVMV isolates from China, Indonesia, Taiwan, Thailand and Vietnam

DIVISION OF ENTOMOLOGY & NEMATOTOLOGY.

Ph.D

Title : **Investigations on the root-knot nematode (*Meloidogyne incognita*) (Kofoid & White, Chitwood) resistance in cowpea (*Vigna unguiculata*, L.) walp (1983)**

D.B.Singh, UAS, Bangalore, Guide : Dr.P.Parvatha Reddy

Resistance to *M. incognita* in cowpea selections IC 9642-B and TVU 2430-P was associated with reduced larval invasion, root galling, egg mass production and fecundity; delayed development of larvae to adult female stage coupled with high concentration of magnesium. Histological studies revealed that was a direct correlation between the number of cork layers and resistance to *M. incognita*. Cortical sclereids were noticed in resistant selections, while they were absent in the susceptible cultivars. There was more number of starch grains in the cortex susceptible cultivars than in that of resistant selections. Histopathological investigations revealed that there was less number of giant cells which were smaller in size with less number of nuclei in resistant selections as compared to susceptible cultivars. Death of cells (hypersensitive reaction) around infecting *M. incognita* larvae occurred in the roots of resistant selection IC 9642-B. Histochemical studies revealed that there were more of insoluble polysaccharides, proteins and nucleic acid in susceptible cultivars as compared to the resistant selections of cowpea. Cowpea selections IC 9642-B and TVU 2430-P (resistant to *M. incognita* were crossed with commercial cultivars S-288 and S-488 (susceptible). The mode of root-knot nematode inheritance in F₁'s, F₂'s and back cross generations indicated a Mendelian pattern of segregation. The F₁ plants were all resistant. The F₂ populations segregated as expected assuming monogenic control and complete dominance with resistant and susceptible plants occurring in a 3 to 1 ratio. The back crosses generations of these crosses with the susceptible parents segregated in the ratio of 1 resistant to 1 susceptible. Hence it was concluded that resistance to *M. incognita* in IC9642-B and TVU 2430-P selections of cowpea is conditioned by a dominant allele at a single locus.

Ph.D

Title : Aphid (*Aphididae: homoptera*) vectors of papaya ringspot virus (prsv) disease and their management (2006)

C.M.Kalleshwara Swamy, UAS, Bangalore, Guide : Dr.Abraham Verghese (2003-05) & Dr.N.K.KrishnaKumar

A. gossypii, *A. craccivora* and *M. persicae* are the dominant aphid species in yellow funnel traps. Among these, *A. gossypii* was observed to be the pre-dominant species in terms of number in yellow funnel trap catches compared to *A. craccivora* and *M. persicae*. A number of *A. gossypii* trapped in yellow funnel trap was higher between March and April and from December to Second fortnight of February. Fresh PRSV infection was higher in April-May. Fresh incidence of PRSV (%) coincided with alates caught in yellow funnel traps in the fourth previous week suggesting the strong relationship between aphid number and PRSV incidence. Multiple regression models point to total number of alates caught in traps, maximum and minimum temperature in influencing the PRSV incidence. The model developed for 2004-5, when validated for 2005-6 explained 80%($R^2=0.80$) variation by a combination of three factors (total of three species of aphid vectors, maximum temperature and minimum temperature) which indicates the strength of the model developed. The cropping pattern also has bearing on higher trap catches. In south Karnataka, cultivation of cucurbits has an influence on PRSV epidemiology. Alate production of *A. gossypii* is dependent on the density of apterous forms and age of the plant. *A. gossypii* a dominant vector in terms of number is also an efficient vector and can inoculate PRSV to a number of plants (at least four) once acquired the PRSV. Leaf – disc assay is the first of its kind to use for PRSV vector efficiency of aphids and opens a window of opportunity for studying virus-vector relationship. Time of infection was observed to influence total yield. Avoiding early PRSV infection was crucial to enhance yield. The plants which were infected prior to flowering (9 months after planting) yielded very less fruits compared to plants infected later.

M.Sc.

Title : Species complex, biology and management of thrips on grapes, cv. Bangalore Blue (2002)

R.Harish, UAS, Bangalore, Guide : Dr.Abraham Verghese

The investigations on the thrips species complex, biology & seasonal incidence of *S. dorsalis* in relation to weather climate parameters; extent of damage and management chemical control of *S. dorsalis* were made from 2001-2002 for two seasons one being carried out(winter and summer) in the field and laboratory during 2000-01. During survey in South India five species of thrips belonging to three different families were recorded. Of these, four are new records for India. This study has revealed two families viz., Aeolothripidae and Phlaeothripidae as having new records of species that are associated with *S. dorsalis*. This is a significant addition to the known species complex of thrips in Karnataka and India. No inter vine variation was observed in the thrips distribution. However, the density of thrips differed between the different crop stages. The larvae and adults of *S. dorsalis* caused damage to all stages of the crop. The insect pierced the leaves, petioles and berries and sucked the sap resulting in silvery white scorch patches on the leaves and scars on berries, Under severe infestations, the leaves withered and ultimately fell down. Further, scarring and cracks on fruit surface was exhibited. The affected mature berries turn ugly and severely affected bunches are unfit for marketing. Phenology of the crop played a significant role in determining the level of thrips infestation. The density of *S. dorsalis* and other species of thrips reached the peak level (12.92 and 0.74 during winter) at 30-40 days after pruning, when the crop was in tender leaf stage and flowering initiated. Similarly, in summer, peak populations of *S. dorsalis* (16/49) and other species of thrips(0.80) coincided with tender leaf and flowering stage. As far as the effect of crop phenology on thrips density, tender leaves were found to have positive effect. Fully matured leaves, small, medium and large size fruits were found to have negative effect. The female laid eggs singly in the tissues mostly on the tender pods, occasionally in older pods. The egg was kidney or oval shaped and glossy white in colour. On an average it took $14.35 + 3.18$ days to complete the life cycle. On an average each stage viz., egg, first, second instar larva, prepupa and pupa lasted for $3.97 + 1.58 + 0.42$ days, $2.92 + 0.55$ days, $1.03 + 0.28$ days and $3.88 + 0.46$ days, respectively. The oviposition started after a period of $1.5 + 0.48$ days and lasted for $1.89 + 0.65$ days. Female laid on an average $2.1 + 0.94$ eggs per day and lived for $4.48 + 1.03$ days. The

incidence of *S. dorsalis* prevailed throughout the cropping period, except during the late fruiting stage. The pest number attained a peak during the first week of November (12.92 *S. dorsalis*/shoot) and third week of May (16.48 *S. dorsalis*/shoot) in winter and summer season, respectively. Regarding the effect of weather parameters on *S. dorsalis* infestation, temperature (both maximum and minimum) was found to have positive effect. Relative humidity, rainfall and wind speed were found to have negative effect. The per cent damage due to attack of *S. dorsalis* on Bangalore Blue grapes was 5.67 and 33.18 during winter and summer, respectively. The efficacy of synthetic, contact and botanical insecticides viz., acephate 75% SP @ 0.075% verticel 100 SP 0.2% endosulfan 35 EC @ 0.07%. chlorphiphos 20EC @ 0.05% carbaryl 50% WDP, cartap hydrochloride 5% SP, fipronil 5% SC, fish oil rosin soap, azadirachtin 0.03 EC, endosulfan + azadirachtin and soil raking were evaluated against *S. dorsalis* on grapes in the form of two folia applications at 10 days interval. Of these endosulfan followed by cartap hydrochloride and carbaryl proved effective in the control of *S. dorsalis* during both the seasons. Whereas, fipronil, endosulfan+ azadirachtin and acephate had moderate effect, verticel and soil raking were less effective in controlling *S. dorsalis*.

M.Sc.

Title : **Studies on short hole *Xylosandrus crassiusculus* on grapes cv. Bangalore Blue (2003)**

G.Keshava Reddy, UAS, Bangalore, Guide : Dr.Abraham Verghese

The investigations on different aspects of grape shot hole borer, *Xylosandrus crassiusculus* (Motshulsky) (Coleoptera: Scolytidae) were carried out during 2002-03. The studies included distribution of the beetle infestation on grapes in and around Bangalore, potential of ethanol in trapping scolytid beetles, effect on growth parameters of grape vine with relation to infestation, spatial distribution of beetle damage on main trunk and management of *X. crassiusculus*. During the survey, two species of scolytid beetles viz., *Xylosandrus crassiusculus* and *compactus* (Eichhoff) were recorded on grapes vines. Of these, the latter is new record, which has been sighted only on cuttings of *Vitis vinifera*. The present study revealed that *Xylosandrus crassiusculus* mainly preferred cv. Bangalore Blue grapes and its infestation was more in Bangalore North (Urban) area than other areas like in Bangalore rural and Kolar districts. Significant relationship was not observed between beetle infestation and number of vines in a garden or type of irrigation. However, infestation was more as the age of the vines increased. Traps with 20% ethanol were found most effective in trapping scolytid beetles. The trap catches of scolytids showed significant negative relationship with minimum temperature and wind speed. However, there was no significant correlation with other abiotic factors viz., maximum temperature, relative humidity and rainfall. The number of scolytid damaged holes on the main trunk was significantly and negatively correlated with total number of sprouts. This implied that as the infestation levels of scolytids increased on the vine trunk, the number of sprouts produced by the vines after pruning reduced. Due to the stress caused by the beetle attack on the main trunk of the vines, the flow of water and nutrients to the growing tips and leaves, after bud sprouting may have been affected. Similarly as the number of sprouts decreased with the severity of the shot hole borer infestation, the number of bunches per vine also decreased. However, within a bunch, the number of berries, which directly contributed to the weight of the bunch, was not affected. But overall productivity was affected. From the study carried out at the IIHR vineyard, it was found that if control measures are taken immediately after noticing the shot hole borer attack on the trunks by regular and close monitoring for pest attack, the growth and development of the vines and yield (No. of bunches) are not affected. Distribution of

Xylosandrus crassiusculus damage holes was found to be clumped or aggregated at all height intervals on the main trunk as variance-mean ratio was more than unity. This was further confirmed by indices like negative binomial of 'k' and David and Moore Index.

The correlation coefficients were worked out to know whether the infestation (bored holes) at different height intervals, was related to the overall density of holes on a trunk. It was found that scolytid holes density at all height intervals was significantly and positively correlated with total number of holes on the trunk. However, the number of holes present at 0-30 cm and 60-90 cm height intervals showed highly significant 'r' values with total number of bored holes on the trunk. Based on these 'r' values, different models were developed. The models which had higher 'R²' values were used for predicting the total number of holes on a vine. At 0-30 cm height, power model, $y=6.28 x^{0.95}$ and 60-90 cm height power model, $y= 18.78^{0.66}$ would explain the reliability of variation of total number of scolytid holes of a vine up to 81% and 94%, respectively. So these models can be recommended for further sampling and prediction. Further, the predicted estimates using the above said models were not significantly different from observed values (based on 't' test). Management studies showed that the efficacy of chemicals viz., dichlorvos 76 EC @ 0.228%, acephate 7SSP @ 0.225%, dichlorvos + acephate, dichlorvos+ acephate + carbendazim 50% WP @ 0.30%, Neem oil @ 1% and cypermethrin 25EC @ 0.225% were evaluated against *Xylosandrus crassiusculus* on grape vine trunk in the form of two swabbing at 30 days interval. Of these, dichlorvos + acephate + carbendazim, dichlorvos+ acephate and dichlorvos emerged as the most promising treatments from two trials. Acephate, neem oil and cypermethrin had moderate effect in controlling *Xylosandrus crassiusculus*. For low levels of infestation, especially if detected early, dichlorvos is sufficient. The swab with combination of chemicals was more efficacious, cost-effective and less hazardous, in terms of drift to non-target areas compared to sprays taken by farmers.

M.Sc.

Title : Bio-ecology, population dynamics, pest-predator-ant interactions with reference to the aphid, *Aphis punicae* Passerini in pomegranate ecosystem (2003)

K.Sreedevi, Kuvempu University, Shimoga, Guide : Dr.Abraham Verghese

Studies on "Bio-ecology, population dynamics and prey-predator-ant interaction with special reference to pomegranate aphid, *Aphis punicae* Passerini" were carried out during 2000-2003 at the Division of Entomology and Nematology, Indian Institute of Horticultural Research, Hessaraghatta Lake - PO, Bangalore (12°58'N; 77°35'E), India. The major conclusion drawn from the present study were - The aphid, *A. punicae* has 4 nymphal instars of duration 1 – 1.5 days each. Thus total nymphal duration was found to be 4 – 5 days and adult longevity ranged from 2 – 8 days. Total life cycle was observed to range from 6 to 13 days. The seasonal incidence of *A. punicae* has shown two peak periods. A major peak during January – February and a minor one during July – June were observed. Predators were found in abundance during both the peaks and showed numerical response to its prey, *A. punicae*. The fungus, *E. aphidis* was found to occur in epizootic form on aphids. The ants were not associated with aphid during January – March, however, they were found associated during July – September. The crop phenology factors that influenced aphid population the most were tender shoots, which favoured the aphid multiplication while the full matured leaves and medium to large fruits that did not favour the population build up. Predators were also negatively correlated with the full matured leaves. Ants were positively related with full matured leaves and negatively with tender shoots showing just opposite relationship with what aphids showed. Among meteorological factors, the relative humidity and minimum temperature showed negative influence on *A. punicae* population. However, predators were not influenced by weather parameters, once again confirming that they were prey- dependent. Ants were positively related to the wind speed and temperature. The aphid infestation had negative impact on fruit size and development. Among different predators, *C. sexmaculata* was found to be the most abundant species followed by *Scymnus* on *A. punicae* in pomegranate ecosystem. Prediction models were developed for *A. punicae* with three independent variables viz., tender shoot, relative humidity and minimum temperature. These findings can serve as a basis to develop further IPM strategy.

M.Sc.

Title : **Population dynamics, biology and management of *Amrasca splendens* Ghauri (2004)**

S.Rudresh, UAS, Bangalore, Guide : Dr.Abraham Verghese

The present investigations were made during 2003-04 on the different aspect of *Amrasca splendens* Ghauri at IIHR namely, seasonal incidence, biology, extent of damage, management of *A. splendens* and response of leaf hopper to Alphonso, Banganapalli and Totapuri varieties, All the aspects were summarized below. Seasonal incidence of *A. splendens* indicated that three population peaks were observed, with the second peak was observed during third week of April (23.20 mean leafhoppers per shoot). The first peak during third week of June (11.05 mean leafhoppers per shoot) and third peak was during last week of November (0.29 mean leafhoppers per shoot). Incidence of *A. splendens* was found on all the commercial varieties studied namely, Alphonso, Banganapalli and Totapuri from May 2005. On these varieties the incidence gradually increased from February to March and reached its peak during April, from then the population started declining and reached a minimum during July to October, July to March and May to January, in Banganapalli, Totapuri and Alphonso, respectively. The Incidence of *A. splendens* had showed positive significant correlation with maximum temperature($r=0.38$) minimum temp. ($r=0.36$) and flushing($r= 0.67$). Tender leaves were found to have positive effect. Further, the studied showed that co-occurrence of factors like maximum temperature at third week prior to leafhopper incidence and flushing at one week prior to leafhopper incidence explained the leafhopper density up to 65 per cent. Relative humidity and wind speed were not found to have any effect. Studies on the biology of *A.splendens* on mango were conducted under laboratory conditions, during April 2004. Preoviposition, oviposition, and post oviposition periods lasted for 8 to 10, 10 to 12 and 4 to 6 days, respectively. The total fecundity based a nymphal emergence ranged from 15 to 26 eggs per female. Eggs were slightly oval and transparent and were laid in the midrib, vienlets and occasionally in leaf lamina. Oviposition per days varied from 1 to 4 during peak season for per female. It took 4 to 5 days for hatching. The nymphs passed through five instars and they lasted for 0.69, 1.25, 1.94 and 2.63 days, respectively. During the course of the study three predators namely *Isyndus heros* Fab. And *Mantis religiosa* Lab., were found attacking the different stages of the leafhopper. However these were of no major consequence. The female adults caused the major damage by ovipositing in midrib

towards anterior region of tender leaf, which resulted in blockage of phloem tube due to which, drying of leaf apex backward was observed. However in majority of damaged leaves the dried tip just break off leaving a typical “tip cut” symptom. After emergence nymphs cluster on the lower side of the tender leaves and suck sap from midrib and vienlets. Under server infestations, the leaves of sprouting shoots withered and ultimately fell down. The oviposition in the midrib caused anatomical changes in the leaf midrib and as well as in lateral veins of the leaves. The healthy midrib stained in toluidine blue mercuric bromophenol blue and periodic acid Schiff’s reagent has indicated the presence of vascular bundles and other related structures, where as in infested tissue the staining was either blank or very lightly indicated the degeneration of tissue or the presence of chitinaceous materials in the midrib (left out material of chorion). Further, it could be clearly seen that there was an opening in the midrib to indicate the escape of nuymphs by rupturing midrib. Studies were conducted on the management of *A.splendens* during April 2005. The botanicals namely viz., Pongamia soap 10 g/l, Neem soap 10 g/l, Neemazal 1.5ml/l, Neemark+ 1.5ml/l, Neem oil 10ml/l, NSKE 4% were used for the study. Endosulfan 2ml/l was used to compare the efficacy of botanicals. The results showed that neem oil 10ml/l and NSKE 4% giving 100 per cent control of the leafhoppers.

M.Sc.

Title : **Ecology and management of stone weevil** (2005)

D.K.Nagaraju, Kuvempu University, Shimoga, Guide : Dr.Abraham Verghese

Mango stone weevil, (MSW) *Sternochetus mangiferae* (Fabricius) (Coleoptera: Curculionidae) is an important monophagous pest of mango, its ecology and ethology have escaped the attention of entomologists, but its effects as a pest of mango fruit is highly pronounced affecting yield and exports. In order to understand the insect better, for better management, there is a need to follow the insect, into its niches like seed and bark in an intensive manner. Hence, the present study was conducted at the laboratory and fields of Indian Institute of Horticultural Research (IIHR), Bangalore (12°58'N; 77°35'E) during 2001-2005. The different linear and non-linear models employed could explain the variability in infestation at harvest due to the infestation in fallen fruits to the extent of 57 to 83% in different varieties. Further, per cent infestation at harvest was predicted using polynomial model order 2 equation in Alphonso and Banganpalli, and polynomial model order 3 in Totapuri. An adult infested by *Beauveria bassiana* (Balsamo) Vuillemin was found. The natural occurrence was < 1%, but under laboratory conditions, the fungus gave 100% mortality of adults in 2-7 days when sprayed at 1.3×10^9 spores per ml concentration. Carbaryl, acephate and deltamethrin with 3.33, 6.67 and 8.15% infestation, respectively were effective. Ethofenprox with 14.82% infestation gave intermediate control. Fish oil rosin soap and azadirachtin were not effective. The study clearly brought out for the first time that infestation begins on fruits of 2-4 cm diameter. This is the time to initiate management interventions. The discovery that majority of the adults eventually rest in junctions of main trunk and primary branches augur well to target spot application of insecticides on the main trunk prior to fruiting, thus obviating full canopy sprays. The fact that older trees harboured more MSW is also crucial in being vigilant to MSW infestation. This is environment friendly cost effective and time saving, as trunk spot application requires only 1/5th of spray liquid. The study showed that prediction of weevil infestation in a variety is possible. As stretches of mango of one variety are common in India, this will be useful in forecast and surveillance. The efficacy of *B. bassiana* demonstrated that the eco-friendly IPM is a potential future venture.

DIVISION OF PLANT PHYSIOLOGY & BIOCHEMISTRY.

Ph.D

Title : **Physiological and biochemical basis of internal breakdown in *Alphonso mango*-a study on the roles of ethylene, calcium and oxidative stress (2006)**

J.E.Nagamani, Kuvempu University, Shimoga, Guide : Dr.S.Shivashankar

Reduction in ethylene evolution in the spongy tissue was mainly due to the reduced activity of ACC oxidase leading to the accumulation of ACC. This might have lead to the reduced ripening of the tissues resulting in sponginess. There are many softening enzymes and the major ones are polygalacturonase, pectin methyl esterase and cellulase. Results indicated the lower softening of the tissues in the spongy tissue when compared to the healthy tissues. In climacteric fruits like mango respiratory raise during ripening is very important for proper ripening and development of good aroma. The ethylene hormone strictly controls this. In this direction an attempt has been made to assess the respiratory enzymes to understand whether they are affected due to the formation of spongy tissue. Activities of starch and sugar metabolising enzymes are decreased in spongy tissue leading to the lower sugar formation. Study of antioxidative enzymes in spongy tissues. Oxidative free radicals have been associated with many membrane related disorders. Lipid peroxidation is one of the important effects of free radicals damage. Oxidative free radicals combined with metallic ions like ferrous results in greater damage due to the production of highly reactive hydroxyl radicals. Free radicals are usually scavenged by the antioxidative enzymes like SOD, catalyse, peroxidase, polyphenol oxidase, ascorbate peroxidase, glutathione reductase etc.,. However, if there is damage to the free radical scavenging mechanism then there will be an accumulation in free radicals resulting in the damage of membrane. As a measure of oxidation products MDA has been analysed and antioxidative enzymes like super oxide dismutase, peroxidase, catalyse, polyphenopl oxidase have been estimated in different samples.

Spongy tissue has higher oxidative products and lower activity of antioxidative enzymes indicating the lipid peroxidation of membranes. Minerals are essential for the normal functioning of membranes and also for the maintenance of turgor of the cells and for enzyme activities. In this regard, minerals like Zn, Fe, Ca and Mg are estimated in spongy and healthy tissues. Most of the minerals except Ca did not show any significant differences between the tissues. Calcium showed a marginal reduction in spongy tissue.

M.Sc.

Title : Isolation and characterization of polygalacturanase inhibitor protein from chillies (*Capsicum annuum* L.) (2004)

C.Thimma Reddy, UAS, Bangalore, Guide : Dr.S.Shivashankar

The experimental study undertaken for “Isolation and characterization of polygalacturonase-inhibiting protein from chillies affected by anthracnose fruit rot” is described in this thesis. Chilli fruit PGIP was purified by ammonium sulfate fractionation, gel-filtration on Sephadex G-150 column and ion-exchange chromatography on DEAE cellulose. The degree of purification achieved was 24.08 –fold in resistant variety and 20.96 in susceptible variety. The PGIP preparation was homogenous with one major band as revealed by native PAGE. The molecular weight of chilli PGIP of both resistant and susceptible variety determined by SDS-PAGE suggested that chilli PGIP is a single polypeptide chain of 37kDa molecular weight. The chilli PGIP was found to be stable in the pH range of 3.0-9.0. The chilli PGIP was maximally active at 60 °C although the activity was retained up to 90 °C. By using increasing doses of the purified chilli PGIP, it was possible to inhibit up to 90% of *Colletotrichum capsicii* polygalacturonase activity. Chilli PGIP demonstrated high level of specificity for polygalacturonase from *Colletotrichum capsicii* when assayed against the polygalacturonases from other five fungi. The chilli PGIP from both resistant and susceptible varieties were found to be similar in their physico-chemical characteristics. The high specificity and the degree of inhibition obtained with chilli PGIP are pointers to the effectiveness of PGIP in avoiding pathogen ingress.

M.Sc.

Title : **Role of seed in spongy tissue formation in *Alphonso mango* biochemical studies** (2005)

Linda Louis, UAS, Bangalore, Guide : Dr.S.Shivashankar

Biochemical Studies showed that moisture content was significantly higher in seeds from spongy-tissue-affected fruits (STS) than seeds from healthy fruits (HS). Analysis of seed components revealed that STS had significantly lower starch content (33.5%) and higher levels of soluble sugars (27.7%) than HS. The incidence of spongy tissue was associated with increased seed respiration rate and amylase activity indicating that the seed in ST fruits had switched over to germination phase. A substantial increase in the content of soluble protein (43.1%) in STS indicated *de novo* synthesis of various enzymes associated with germination. There was a significant increase in spongy tissue incidence in pre-harvest GA₃ treated fruits (70.2%), while there was a considerable reduction in incidence in paclobutrazol (16.4%) treated fruits as compared to 51.5% incidence in the control. GA₃ treatment also resulted in higher intensity of spongy tissue. The seeds from HS and STS fruits were distinctly different in their physiological status and biochemical composition. The data clearly indicated that spongy tissue in Alphonso mango is triggered by the onset of seed germination associated events. These events lead to development of spongy tissue in the pulp close to the stone by the continuous transfer of water from pulp to the germinating seed. This theory of seed origin of spongy tissue is amply supported by experimental data and more importantly this concept is able to explain all the facts known so far about spongy tissue.

M.Sc.

Title : Biochemical studies on the development of corky tissue in sapota [*Manikara achras* (Mill.) Fosberg] (2009)

Jaya Joshi, UAS, Bangalore, Guide : Dr.S.Shivashankar

Corky tissue (CT) of sapota is a physiological disorder characterized by hard lump in the pulp, slightly desiccated in nature and acidic to taste. This disorder shows no distinct external symptoms and becomes visible only when fruit is cut open. Under extremely severe conditions, corky skin eruptions are seen. Corky tissue incidence is estimated to vary from 20 to 50 per cent in Cricket Ball, while in other varieties like Kalipati it is up to 5 per cent. Biochemical analysis revealed that total and reducing sugars, soluble protein and activities of amylase and lipase were higher in the mesocarp of healthy fruits compared to CT affected fruits, while content of starch and free amino acids were lower. These indicated that degradation of starch into sugars was hampered in CT affected fruits. Starch content, soluble protein and free amino acid were higher in healthy seeds than seeds from CT affected fruits, while total and reducing sugars and amylase activity were lower. Under field conditions, regulation of sink strength by exogenous application of GA3 and PBZ showed that, CT occurred in the weaker sink thus confirming the role of inter-fruit competition in CT development. Seed viability seems to play an important role in CT development. Sink strength of fruit depends upon number of viable seeds it has. Moisture content in seed and mesocarp of healthy fruits was higher in comparison with that of CT affected fruits, showing thereby that seed from CT affected fruits had lost moisture leading to reduction in seed viability. Reduction in seed viability in corky tissue affected fruit was confirmed by data on germination, dehydrogenase activity, DNA content and analysis of endogenous levels of GA3, ABA and JA using HPLC. Conditions of increased temperature, evaporative demand and decreased relative humidity showed marked increase in corky tissue incidence.

M.Sc.

Title : Induction of systemic acquired resistance in tomato inoculated with early leaf blight pathogen (2009)

S.Renuka, Mahathma Gandhi University, Kottayam, Kerala, Guide : Dr.S.Shivashankar

The results of this study provide evidence that application of simple non-toxic chemical solutions such as potassium phosphate can control early blight of tomato, Their low toxicity to animals, comparative environmental safety and nutrient value make them ideal foliar fertilizers which can be used for application in the field for disease control. The ability of potassium phosphate to induce high levels of three defence enzymes and four antioxidants in tomato leaf could be of use in elicitation of SAR in disease management programme. Thus potassium sulphate spray to tomato plants can provide a degree of protection to tomato plants against early leaf blight and help in disease control.

M.Sc.

Title : **Biochemical changes in seed in relation to corky tissue development of sapota** [*Manikara achras* (Mill.) Fosberg] (2010)

Jayashree Ugalat, UAS, Bangalore, Guide : Dr.S.Shivashankar

Corky tissue is a physiological disorder affecting Cricket Ball variety of sapota to the tune of 50% or more especially in the summer season. The affected fruits do not show any external symptoms and becomes apparent only after the fruit is cut open. Corky tissue affected fruits are characterized by a hard lump within the pulp and are less sweet to taste and in extreme cases the fruits give out a unpleasant odour. As such, the corky tissue affected fruits become unfit for consumption. Very little work has been reported so far on the biochemistry of the disorder. Studies conducted in this work showed that CT incidence increased with increasing number of fruits per panicle. GA3 treated fruits showed lower incidence of CT as compared to control and PBZ treatment increased the incidence of CT. CT incidence increased in fruits harvested during summer season (Mar-April) as compared to winter season (Nov-Dec) and similarly incidence was more under rain fed treatment as compared to irrigated treatment. Radio tracer experiment showed there was an increased flow of water away from the fruit to shoot during CT formation. Biochemical studies revealed that in CT affected fruit pulp, reduced sugars, total soluble sugars, proteins, fatty acids, mineral nutrients and enzyme activities like amylase, lipase were reduced and starch content was higher as compared to healthy fruit pulp. And in case of seeds of corky tissue affected fruits, protein, free fatty acids, starch and enzyme activity like total dehydrogenase, lipase and germination percentage showed decreasing trend, but reducing and total soluble sugars content were higher compared to seeds from healthy fruit. These above findings, indicated the dominant role of competition among different sinks and loss of viability of seeds in the induction of CT in sapota

M.Sc.

Title : **Biochemical studies on the development of aril browning in pomegranate**
(2011)

Hemalata Singh, UAS, Bangalore, Guide : Dr.S.Shivashankar

Aril browning (AB) in pomegranate is a physiological disorder free of external symptoms. Browning of aril starts with a dark dot on the aril and spreads further to the entire aril. The incidence is at first observed at 50% fruit maturity near the calyx end just under the skin. Present studies showed that AB incidence was higher in panicles as compared to those on main shoots. Fruits exposed to sun showed lesser incidence. AB incidence also increased with fruit maturity. Biochemical studies revealed that sugars, TSS, starch and pH were higher in AB affected aril as compared to healthy arils whereas anthocyanin, polyphenols, titratable acidity, protein and ascorbic acid were less in AB affected aril. Enzyme activities like amylase, total dehydrogenase activity in seed were reduced in seed of AB affected aril compared to healthy, whereas enzyme activity like polyphenol oxidase was more in seed of AB affected aril as compared to seed of healthy aril. Healthy arils showed higher moisture content and the seed higher percentage and faster rate of germination as compared to seed of AB affected aril, revealing that seed of AB affected aril had lost moisture leading to reduction in seed viability. Field experiments with growth regulators showed that GA3 treatment reduced incidence of AB and PBZ treatment increased the incidence of browning as compared to control. These findings indicated that the development of AB in pomegranate is a result of combination of many factors like inter fruit competition, biochemical and physiological changes in aril during fruit growth.

DIVISION OF SOIL SCIENCE & AGRICULTURAL CHEMISTRY.

Ph.D

Title : **Behavior of metalaxyl and mancozeb residues in soils and tomato** (1996)

T.H.Hanumantha Raju, UAS, Bangalore, Guide : Dr.M.D.Awasthi

The present investigation on “Behaviour of metalaxyl and mancozeb residues in soil and tomato” was taken up with the main objectives of finding the extent of adsorption and degradation of fungicide residues in soils, their uptake and persistence in tomato plants. The studies were conducted on a systemic fungicide metalaxyl and a contact fungicide mancozeb along with its major metabolite ETU interacting with tomato plant and three main types of soil from Bangalore, Chettalli and Hiriya representing the different textural classes. The salient features of the investigation are summarized as below. Adsorption of metalaxyl was mainly influenced by the clay content of the soils. Metalaxyl adsorption in soils decreased in the order of Hiriya > Chettalli > Bangalore, which is also the order of decreasing clay content. Freundlich equation provided a good fit ($R^2 > 0.9$) for the adsorption data metalaxyl and ETU in all the soils. The sorption coefficients for organic carbon (K_{oc}) were higher for metalaxyl than ETU in all the soils and ranged from 362 to 2275 $\mu\text{g ml}^{-1}$ for metalaxyl and 128 to 581 $\mu\text{g ml}^{-1}$ for ETU. The degradation pattern of metalaxyl, mancozeb and ETU residues indicated a close correspondence to first order exponential degradation kinetics in soils and mainly influenced by soil moisture and temperatures. Slower degradation of metalaxyl was noticed in the soils and their half – life values were higher than mancozeb and ETU as evident by wide range of half – life values from 41.24 to 165.11 days. In case of metalaxyl Hiriya soil was found to be superior in degrading the metalaxyl. Lower persistence of mancozeb and ETU was observed in the soils resulting in rapid rate of degradation at smaller half – life values as compared to metalaxyl indicating the faster degradation of mancozeb and ETU. In mancozeb treated soils, the ETU formation was increased up to 30 days of incubation and thereafter it declined. The plant studies have indicated that maximum concentration of metalaxyl and ETU residues in tomato plants following uptake from soil was attained after 15 and 20 days of soil application respectively. The residues were however residue further and reached below the prescribed MRL in fruits by harvest itself. The degradation of soil retained fungicide residues followed the first- order exponential reaction ($R^2 > 0.9$) and metalaxyl persistence was higher than mancozeb. The half-life values for metalaxyl

were in the range of 6.52 to 9.57 days, while mancozeb ranged from 9.74 to 12.41 days for different treatments. The rapid disappearance of metalaxyl and mancozeb residues to the extent of 59.2 to 72.4 and 3.81 to 48.3% was found within 10 days of fungicide applications at the two application rates. Foliage accumulated comparatively higher initial residues of fungicides than fruits following foliar applications. Metalaxyl residues dissipated at higher rate of residue decay in foliage as compared to fruits. A reverse order on dissipation of mancozeb residues was found in foliage and fruits. The half – life of metalaxyl in foliage from 3.13 to 4.14 days and 7.82 to 8.75 days for tomato fruits as compared to the mancozeb half-life of 13.87 and 13.56 days for foliage and 5.23 and 6.95 days for fruits from 0,2 and 0.4% metalaxyl-MZ spray respectively. The persistence of ETU in foliage continued beyond 40 days but fruits were devoid of any detectable residues. The degradation rate constants were accordingly higher in field conditions (75.63×10^{-3} to $127.85 \times 10^{-3} \text{ day}^{-1}$) compared to laboratory incubation studies (10.24×10^{-3} to $46.99 \times 10^{-3} \text{ day}^{-1}$). Fungicide residues in general were decreased upon washing and cooking of tomato fruits after 5 and 10 days of spray application. The rate of loss of residues were almost same from the two application rates upon washing followed by cooking while the intensity of dislodging the residues being severe from washing followed by cooking. Further the dislodging effects were more pronounced on the less aged residues. Decontamination processes of washing followed by cooking removed as high as 78.3 to 78.86% metalaxyl; 74.6 to 78.4% mancozeb and 44.5 to 48.3% ETU residues.

M.Sc.

Title : Comparative efficiency of citrus rootstocks in the absorption of ^{15}N and ^{32}P labelled nutrients (1988)

S.V.Keshava Murthy, UAS, Bangalore, Guide : Dr.B.R.V.Iyengar

Comparative efficiency of some commercially important citrus rootstocks and the scion cultivar Coorg mandarin in the absorption and utilization of N and P was studied through field and pot culture experiments and also kinetics of P absorption in solution culture using their isotopes ^{15}N and ^{32}P . Trifoliolate oranges had significantly higher N concentration in the shoot but lower rate of N utilization. The nitrogen derived from fertilizer (Ndff) in the shoot was significantly more in Citrumelo, Troyer and Carrizo citranges, the two Trifoliolate oranges and the scion cv. Coorg mandarin indicating their greater efficiency in the absorption nitrogen than the other rootstocks Rough lemon, Sour orange, Cleopatra and Kodakithuli mandarins. Trifoliolate oranges, Citrumelo, Troyer citrange also had finer roots and higher anion exchange capacity. In studies on the comparative efficiency of citrus rootstocks in the absorption of P in pot culture, it was found that Trifoliolate oranges, Rough lemon, Troyer citrange Kodakithuli mandarin and the scion cv. Coorg mandarin derived more P from the fertilizer (Pdff) than Cleopatra mandarin and Sour orange. Field studies on the comparative efficiency of P absorption by scion cultivars Italian lemon and seedless lime budded on seven rootstocks revealed that Italian lemon on two hybrid rootstocks Carrizo citrange and Citrumelo derived significantly more fertilizer P than the other, where as in Seedless lime, Rough lemon and Trifoliolate oranges resulted in higher Pdff. Mean effects of the two scion cultivars showed that the dwarfing rootstock Trifoliolate oranges resulted in higher Pdff. Of the two scion cultivars, Italian lemon derived more P from the fertilizer than Seedless lime. Rootstocks Troyer citrange, Citrumelo, and scion cv. Coorg mandarin had higher inflow (I_n) and maximum uptake (I_{\max}) rates than the others, indicating that they had greater number of absorption sites. In Rough lemon and Citrumelo the (I_{\max}) increased with increase in the concentration of P in the external solution indicating that these two rootstocks respond to increase in the concentration of P in the soil solution brought about by fertilizer application. Rootstocks Rough lemon and Trifoliolate oranges had lower K_m values (external P concentration corresponding to half the maximum rate of uptake) implying greater affinity of their roots for P and that they may be more efficient on unfertilized soils of low fertility.

M.Sc.

Title : **Persistence and degradation of chlorothalonil in selected soils** (1998)

Binaya Kumar Choudhury, UAS, Bangalore, Guide : Dr.M.D.Awasthi

The study was taken up to determine the persistence and dissipation pattern of a commonly used fungicide chlorothalonil in two major soils of India differing widely in their physico-chemical properties under the influence of various moisture regimes at non sterile conditions. The two soil types were black clay soil from National Bureau of Soil Survey & Land Use Planning (NBSS & LUP), regional station, Bellary, Karnataka and loamy sand soil. Persistence and degradation of chlorothalonil in soils were determined by adding 100 ppm of toxicant to both the soil at sterile and sterile conditions and incubating them under different soil moisture regimes. The degradation reaction rate constants "K" and half life values ($t_{1/2}$) for both the soils were computed from the amount of fungicide in soils at different periods following periodic residue analysis. The salient features of the investigation are summarized below:

The two different soils collected from different locations represented fairly wide range of variation in soil characteristics such as textural make up, pH, organic matter content, CEC etc., (loamy sand Hesaraghatta soil:Haplustalf and black clay Bellary soil: Typic chromustents) were used for the study. The organic matter content was fairly high in black clay Bellary soil, while it was moderately low in loamy sand Hesaraghatta soil. There were similar differences in the other characteristic such as clay content, pH and CEC also. The recovery analysis of the fungicide residue in soils indicated that the recovery percentage were fairly high exceeding 90% indicating the analytical technique with modification was proved to be better for further studies.

There was a marked difference in the persistence chlorothalonil in both the soil type. The degradation pattern of chlorothalonil residues indicated a close correspondence to first order exponential degradation kinetics in soils and mainly influenced by soil moisture. Increased degradation was observed with increased moisture content from air dry condition to submerged condition. Higher persistence chlorothalonil was noticed in black clay Bellary soil than that of loamy sand Hesaraghatta soil. Similarly marginally higher persistence was recorded in autoclaved soil condition than that autoclaved condition indicating that the involvement of micro-organisms in degradation was low at high concentration. The half life period ($t_{1/2}$) of chlorothalonil in black clay soil for autoclaved condition ranged from 8.4 to 12.3 days, while for non autoclaved it ranged

from 8.1 to 11.2 days at different soil moisture regimes. Similarly for loamy sand soil, it ranged from 8.0 to 11.1 days for autoclaved condition and 7.8 to 10.8 days for non autoclaved condition at different soil moisture levels. The half life period decreased with increased moisture content of soil, and the half life period was higher for autoclaved soil condition than non autoclaved condition. So also the half life values were fairly high for black clay Bellary soil than loamy sand Hessarahatta soil.

The degradation of soil retained fungicide residues followed first order reaction ($R^2 > 0.96$). The degradation rate constant (K) increased with increasing moisture levels and K was always less in autoclaved condition than of non autoclaved condition. “ K_{deg} ” was fairly high for loamy sand Hessarahatta soil than that of black clay Bellary soil at particular point of time and treatments.

M.Sc.

Title : Persistence and different formulations of imidacloprid in soil and okra (*Abelmoschus esculentus* L. Moench) plant (2000)

H.R.Indumathi, UAS, Bangalore, Guide : Dr.Debi Sharma

Persistence and degradation of imidacloprid was determined by fortification of soil and incubating under different soil moisture regimes. Plant uptake of imidacloprid was also studied by growing imidacloprid treated okra seeds in glass house. Dissipation pattern of imidacloprid in okra was studied by spraying imidacloprid at effective and a double dose under a supervised field trial at initial fruit set stage (45 days after germination). Imidacloprid dissipated slowly in soil at field capacity as well as 50% field capacity conditions. Residues of imidacloprid persisted for more than 75 days with half lives of 76.8 and 74.0 days respectively. There was no marked difference between the persistence of imidacloprid in soil under the two soil moisture conditions studied. The persistence of imidacloprid is only slightly higher at 50% field capacity condition than at field capacity condition. Imidacloprid was taken up by okra plant from treated (9 g a.i./kg) seeds and translocated residues were found to be 1.59 ppm at 15 days after germination. However these residues were detected in the plant for more than 30 days after germination, no residues were detected in fruits at harvest (50 days after germination). Foliar application of imidacloprid in okra resulted in high initial residues (1.12 to 2.01 ppm and 1.34 to 2.21 ppm) in first and second seasons respectively. Imidacloprid residues in okra fruit following spray treatment persisted for more than 10 days in lower concentration (0.3ml/L) and for more than 15 days in higher concentration (0.6ml/L) in both the season. The residue dissipated with a half life of 2.2 to 3.7 days in the first season and 2.4 to 4.0 days in the second season at the recommended and double the recommended doses of application respectively.

M.Sc.

Title : **Studies on persistence of hexaconazole in selected soils of Karnataka** (2002)

Harish Kumar Dubey, UAS, Bangalore, Guide : Dr.M.D.Awasthi

The study was taken up to determine the persistence and dissipation pattern of a commonly used fungicide Hexaconazole in two major soils of India differing widely in their physical and chemical properties. The two soils types were black clay soil from National Bureau of Soil Survey & Land Use Planning (NBSS & LUP), regional station, Bellary, Karnataka and loamy sand soil from IIHR, Hesaraghatta, Bangalore. Persistence degradation of Hexaconazole in soils was determined by adding 10 ppm of the toxicant to both the soil and incubating them under different soil moisture regimes. The degradation reaction rate constants "K" and half life values ($t_{1/2}$) for both the soils were computed from the amount of fungicide remaining in soils at different periods following periodic residue analysis. The salient features of the investigation are summarized below:

The two different soils collected from different locations represented fairly wide range of variation in soil characteristics such as textural make up, pH, organic matter content, CEC etc.,(loamy sand Hesaraghatta soil:Haplustalf and black clay Bellary soil: Typic chromustents) were used for the study. The organic matter content was fairly high in black clay Bellary soil, while it was moderately low in loamy sand Hesaraghatta soil. There were similar differences in the other characteristic such as clay content, pH and CEC also. The recovery analysis of the fungicide residue in soils indicated that the recovery percentages were fairly high exceeding 85% indicating the analytical technique with modification was good. There was a marked difference in the persistence hexaconazole in both the soil type. The degradation pattern of hexaconazole residues indicated a close correspondence to first order exponential degradation kinetics in soils and largely influenced by soil moisture. Increased degradation was observed with increased moisture content from air dry condition to submerged condition however there was a faster rate of degradation in 50 percentage field capacity soil moisture condition. Higher persistence of hexaconazole was noticed in black clay Bellary soil than in loamy sand Hesaraghatta soil. In general, the persistence of hexaconazole residues was high but persistence was influenced by moisture level. The half- life period ($t_{1/2}$) of hexaconazole in black clay was found to 55.00 to 80.58 days at different soil moisture regimes. Similarly for loamy sand soil, it ranged from 17.11 to 27.28 days at different soil moisture levels. The half life period increased with increased moisture content of soil. The half life

values were fairly high for black clay Bellary soil than loamy sand Hesaraghatta soil. The degradation of soil retained fungicide residues followed first order reaction ($R^2 > 0.96$). The degradation rate constant (K) increased with increasing moisture levels and K was always less in autoclaved condition than of non autoclaved condition. “ K_{deg} ” was fairly high for loamy sand Hesaraghatta soil than that of black clay Bellary soil at particular point of time and treatments.

M.Sc.

Title : **Persistence and mobility of paclobutrazol in soil** (2004)

L.Shalini, UAS, Bangalore, Guide : Dr.Debi Sharma

A field experiment was conducted at IIHR, Hessaraghatta, Bangalore, to study the persistence and mobility of paclobutrazol, a predominantly soil applied plant growth regulator to counter alternate bearing in mango following its application to mango tree basins at the rate of 5 and 10 g as per hectare. Soil, water and mango samples from Konkan region of Maharashtra were also collected in order to assess the extent of paclobutrazol residue contamination in these samples, as this area is the largest consumer of paclobutrazol in India. Samples were collected from both conventional soil cultivated orchards and laterite rock cultivations. The study indicated that paclobutrazol persisted at all soil depths for at least 150 days and reduced to below detectable limit at 210 days. It persisted at the surface (0-15 cm) with half lives of 30.7 and 29.7 days from the lower and higher treatment concentrations respectively. It was also seen that paclobutrazol moved quickly down the soil to reach up to or beyond 60 cm. soon after its application. The residues of paclobutrazol in the conventional soil cultivated mango orchards located at Konkan region of Maharashtra ranged below detectable limit to traces. No detectable residues of paclobutrazol were found in soils from laterite rock cultivated mango orchard from the same region irrespective of the number of years for which paclobutrazol applications had been made. The paclobutrazol residues were either below detectable limit or present in traces in mango whole fruits collected from either type of orchards at harvest, notwithstanding the frequency of its application in the orchard. Water samples collected at the time of fruit harvest from open wells located orchards did not contain detectable residues of paclobutrazol.

M.Sc.

Title : **Soil and nutrient management studies in *Coleus vettiveroides*. Jacob (2009)**

B.Mamatha, UAS, Bangalore, Guide : Dr.T.N.Shivananda

Application of 100:50:50 NPK kg ha⁻¹ recorded significantly higher plant growth (50.86 cm), biomass accumulation (32.75 t ha⁻¹), and nutrient uptake (uptake of 50.60 kg N, 7.21 kg P, 126.04 kg K ha⁻¹) of *C. vettiveroides* at 116 days after planting (DAP). *C. vettiveroides* plant grown in 18 inch diameter with 30 inch length PVC column produced significantly higher total root yield (315.2 g plant⁻¹) and biomass accumulation (3597.2 g plant⁻¹) at 121 DAP. Growth media comprising of sand and soil mixed in equal proportion (100 kg) added with 0.5 kg Farm Yard Manure (FYM) recorded significantly higher biomass accumulation (728.34 g plant⁻¹ and 1653 g plant⁻¹) of *C. vettiveroides* in cement pots and PVC column respectively at 135 DAP. Application of FYM (282.80 g plant⁻¹) or inorganic fertilizer (312.73 g plant⁻¹) along with bio-fertilizer recorded higher biomass accumulation of *C. vettiveroides* as compared with sole application of FYM (210.49 g plant⁻¹) or inorganic fertilizer (261.56 g plant⁻¹) at 130 DAP. Significantly higher root yield (3.16 t ha⁻¹), biomass accumulation (49.66 t ha⁻¹) and nutrient uptake (uptake of 50.13 kg N, 7.75 kg P, 119.11 kg K ha⁻¹) of *C. vettiveroides* recorded with application of recommended FYM (10 t ha⁻¹) + recommended NPK (100:50:50 NPK kg ha⁻¹) at 140 DAP. Application of Mukuna mulch 10 t ha⁻¹ recorded significantly higher plant growth (51.74 cm) and application of FYM mulch 10 t ha⁻¹ recorded higher biomass accumulation (33.37 t ha⁻¹) and nutrient uptake (uptake of 49.30 kg N, 9.41 kg P, 148.74 kg K ha⁻¹) of *C. vettiveroides* at 139 DAP. The different chemical constituents identified in oil of root of *C. vettiveroides* are hydrocarbons (β -Himachalene, etc.), oxygenated compounds like alcohols (Vellerdiol, Isothujol, etc.), aldehydes (β -Cyclocitral, etc.), esters (Sabinyl acetate, etc.), ketones (β -Ionone, Traseolide etc.).

DIVISION OF EXTENSION AND TRAINING.

M.Sc.

Title : Time utilization and decision making in horticulture: antecedent to gender mainstreaming (2011)

T.P.Bharath Kumar, UAS, Bangalore, Guide : Dr.Nita Khandekar

Women in India, today stand poised between a collapsing past and an uncertain future seeing the quantitative and qualitative changes. Women are involved where physical labour is more, men participate in agriculture activities with lesser physical labour, but are involved in all important aspects related to agriculture. Although women work for longer hours and contribute substantially to family income, they are not recognised either by their family members or by the society. Hence, the research was conducted to study the time utilization and decision making of horticulture farmers as antecedent to gender mainstreaming. Four villages in two taluks of Kolar district were selected for the study. Data were collected from 120 respondents (horticultural workers and spouse) using structured interview schedule. Majority of the respondents were old aged, had medium level of education, family education status, farming experience, annual income, extension contact, innovativeness, risk orientation, scientific orientation and achievement orientation. Majority of the respondents had a low level of social participation, high level of mass media exposure and cosmopolitanism. The time utilization and decision making in horticultural activities was of medium level. Most of the women respondents spent more number of Man days/year in horticultural activities where drudgery is involved. Most of the decisions were taken collectively by family members followed by jointly by husband and wife and husband alone. Women respondents were not involved in taking horticulture related decisions alone. Most of the respondents perceived that field preparation, harvesting, carrying fertilizer and harvested crops, seed treatment and use of various kinds of implements involved drudgery. Age, education, risk orientation and achievement motivation were significantly but negatively correlated whereas, land holding, annual income and innovativeness were positively and significant correlated with time utilization among male respondents. In case of female respondents age and education were significantly but negatively correlated, while, land holding and annual income were significantly and positively correlated with time utilization. Age, education, land holding and social participation were significant in case of both male and female respondents.

DIVISION OF PLANT GENETIC RESOURCES.

Ph.D

Title : ***Ex situ* conservation and physiological studies in some threatened medicinal plant species** (2003)

P.E.Rajasekharan, Bangalore University, Guide : Dr.S.Ganeshan

Research investigations involving endangered medicinal plant species of south India (*Coleus forskohlii*, *Kaempferia galanga*, *K. rotunda*, *Rauwolfia serpentina* and *Tylophora indica*) were carried out to design suitable conservation strategies. In all species, regeneration was normal *in vitro* resulting in large no. of vitro plants. Attempts to conserve the regenerated *in vitro* plantlets by lowering the incubation temperature, media constituents and osmoticum resulted in development of protocols, which could be used to conserve these species. Artificial seeds which resulted in regeneration of normal plantlets were formed by encapsulation of explants using sodium alginate and subsequent storage at low temperature. *In vitro* plants regenerated from these five species could be successfully conserved *in vitro* for durations ranging from 9-18 months reducing the intervening sub-culture frequency. Such material was capable of regenerating normal *in vitro* plants when they are recultured in regular medium under SCC. The conserved vitro plants thus regenerated could be established extra vitrum in pots containing “soil rite” prior to establishment in Field Gene Bank. Cryopreservation of nodal and apical explants resulted in <15% vitro plant recovery profiles. (Further investigations are required for obtaining optimal recovery of cryopreserved vitro plants.) out of 9 experiments in 3 species and 3 for *Kaempferia galanga* involving rapid freezing techniques carried out, only few vitro plants could be recovered and from these there was no survival extra vitrum in pots with “soil rite”. Conservation of gene pool components like pollen and seed was successful in *Tylophora indica* and to a certain extent in *Rauwolfia serpentina*. Plants were also domesticated and conserved in Field Gene Bank, exclusively established for these species. The physiological and bio chemical studies on phenolics, total alkaloids, saline soluble proteins and PAGE (Poly Acrylamide Gel Electrophoresis) using two species namely *Kaempferia galanga* and *Tylophora indica* revealed no perceivable changes occurring due to conservation at low temperature and reduced light. Eco-rehabilitation studies using these species *Kaempferia galanga*, *Rauwolfia serpentina* and

Tylophora indica were successful and the plants could be re-established in their respective place of collection.

Ph.D

Title : ***Ex situ* conservation strategies for the threatened medicinal plant species *Acorus calamus* Linn and *Adhatoda beddomeii* c.b. Clarke (2006)**

Sunitha Bhaskaran, Kuvempu University, Shimoga, Guide : Dr.S.Ganeshan

An effective *ex situ* conservation strategy was developed for establishment of FGB followed by *in vitro* conservation using tissue culture techniques for two red listed plant species *Adhatoda beddomeii* C.B. Clarke & *Acorus calamus* Linn. *Adhatoda beddomeii* C.B. Clarke is a critically endangered endemic shrub used in medicinal preparations for its antiemetic and haemostatic properties. *Acorus calamus* Linn. Is a non-endemic critically endangered used to cure diarrhea, dysentery digestion abdominal obstruction and colic. In two plant species collected from different region were successfully acclimatized and established in FGB without any mortality. A perennial problem regarding the true identity and existence of *Adhatoda beddomeii* has been solved by reporting it as a variant of *A. vasica* and true *A. beddomeii* merged with *A. gingiana* based on the morphological evidences which showed variation. The molecular characterization of the above through RAPD analysis followed by electrophoresis of PCR products and the banding patterns emerged was scored. The resulting dendrogram revealed two clusters that is *A. beddomeii* one and *A. vasica* and *A. gingiana* another which is a clear indication that *A. beddomeii* cannot be considered synonymous with *A. gingiana*. Phonological events showed variation with regard to few morphological traits in *A. beddomeii* and *Acorus calamus* accessions established in FGB. For both the species morphological characterization were reported with about 20 quantitative and 25 qualitative characteristics in *A. beddomeii* and 9 quantitative and 22 qualitative characteristics for *A. calamus*. Cytological studies attempted to ascertain the ploidy level and somatic chromosomes number in both which showed $2n= 34$ and $4n=44$ in *Adhatoda beddomeii* and *Acorus calamus* respectively. TLC and HPLC were carried out to estimate the active principles and vasicine and asarone were identified in *A. beddomeii* and *A. calamus* respectively. *In vitro* regeneration was observed in both species under SCC. *A. beddomeii* could be maintained for a short duration of 1 year at SCC and *A. calamus* could be maintained for period of 1 year without sub culture. Encapsulation of *A. beddomeii* and *A. calamus* were attempted for long term storage by cryopreservation technique using liquid nitrogen. Along with pollen germination studies the pollen cryopreservation enabled the storage for

very long periods in cryobanks. This is a complementary conservation strategy in an integrated PGR conservation program.

M.Sc.

Title : **Pollen biology of few horticulturally important plants** (2008)

S.Shashikumar, UAS, Bangalore, Guide : Dr.S.Ganeshan

Studies on pollen biology were carried out in flowering plant species, categorised under herbs, shrubs and trees. The investigation carried out includes pollen biology, development of protocols for pollen collection, extraction and viability assessment through germination and staining methods. Storage under short, medium and long term duration using refrigeration, freezers, freeze-driers and cryobiological containers has been attempted, followed by post storage germination and field pollination studies were carried out. The study elucidates differential responses to various treatments imposed, new methods developed for pollen germination, and potential use of cryopreserved pollen for conserving nuclear genetic diversity. In all, 39 species have been investigated for floral/pollen biology, all the species have been studied for pollen collection, extraction, germination procedures, 18 species for storage protocols, post storage germinability and 8 species attempted for post storage fertility by assessment of fertilizing ability of stored pollen. New technique for germination of mango pollen was developed and the technique was optimized for other species. Interesting results were observed in pollen viability studies on gallmidge infested flowers of *Solanum melongena*

The results obtained in this study provide newer insights to pollen biological investigations, in addition to morphological and quantitative studies, such as pollen production, anthesis, duration of flowering etc.,. Investigations carried out on pollen storage especially using cryogenic technology in these species and promising results have been obtained. Results of cryogenic storage of pollen was also predicted on extent and longevity of pollen under cryogenic storage condition based on non linear estimation which was effectively applied for estimating prediction based on few years data and was helpful in predicting survival of pollen for long term storage and management of nuclear genetic diversity in gene banks.

M.Sc.

Title : Genetic divergence, morphological and molecular characterization and conservation of germplasm in *Capsicum* spp. (2003)

Deepu Mathew, UAS, Bangalore, Guide : Dr.S.D.Doijode

The *Capsicum* germplasm with 56 accession studied had high level of genetic divergence for fruit number, fresh and dry fruit yield, seed number, fruit width, fruit wall thickness, fruit weight and flower weight. Characters such as fruit number, fresh and dry fruit yield, recovery ratio, fruit length, fruit width, fruit wall thickness, single fruit weight, seed number, thousand seed weight, plant height, canopy width, days taken for 50% flower opening, dry yield and flower weight had high level of heritability. Genetic advance measured as percentage over mean was high for fruit number, fresh and dry fruit yield, fruit width, fruit wall thickness, fruit weight, seed number and flower weight. Based on these, selection for the character fruit weight will be most successful in a breeding programme. Morphological characterisation using 16 quantitative morphological characters following D-square statistics has resulted in 11 clusters. With higher genetic distances within *C. annuum* accessions than that between *C. annuum* and other wild species studied, consideration of all possible qualitative as well as quantitative characters and transformation of data to a common scale to avoid numerical weightage in morphological characterization were necessitated. Hierarchical cluster analysis using transformed data of 58 morphological characters had resulted in 7 major clusters. Using this methodology, wild species were very clearly distinguished from hot peppers. *C. chinense* which is closer to *C. annuum* and *C. baccatum* formed a separate clusters. Bell peppers with their highly distinct morphological features had shown maximum genetic diversity from all other accessions. Molecular characterization using RAPD markers was proved to be very precise in estimation of genetic distances as well as for reallocation of accessions to their correct species categories. Using this methodology, all *C. annuum* accessions were found to be distinguishable from other species. Genetic identity of bell peppers was proved and they formed a sub cluster within *C. annuum*. All the male sterile lines formed a single cluster and comparatively, *C. chinense* was proved to be genetically closer to *C. annuum*. Suryamukhi, a Nepalese accession and genetic identity of which was not previously known was found to be distantly related to *C. praetermissum*. *C. frutescens* was comparatively closer to *C. praetermissum* and all the 3 *C. baccatum* accessions formed a single cluster which was most distant from *C. annuum*. Methodology

for conservation of *Capsicum* seed germplasm was standardized. Storage at $-20\text{ }^{\circ}\text{C}$ in aluminium foil laminated pouches was found to be the best method to maintain seed viability, vigour, speed of germination and seedling dry weight in all the 10 hot pepper cultivars experimented over 22 months. Storage using iodine and chlorine was found to be on par with storage at $-20\text{ }^{\circ}\text{C}$ in aluminium foil pouches in retention of seed viability during the period. Storage under modified atmospheric conditions using nitrogen and carbon dioxide had enhanced the seed *storability*. Storage at low temperature and sealed containers was proved to be superior than unsealed in maintaining seed quality parameters.

Thus for most efficient conservation of *Capsicum* germplasm, seed storage should be performed at subzero temperatures of $-20\text{ }^{\circ}\text{C}$ in sealed aluminium foil pouches. Under circumstances where this facility is not available, storage could be done using iodine or chlorine (both 1 per cent w/w) and/or with nitrogen atmospheres.

DIVISION OF BIOTECHNOLOGY.

Ph.D

Title : **Studies on the beneficial microbial association in brinjal (*Solanum melongena* L.)** (2000)

Jennifer Lolita, Bangalore University, Guide : Dr.Sukhada Mohandas

Nitrogen fixing bacteria were isolated from the endorhizosphere and phylloplane of *Solanum melongena* L. cultivars Arka Shirish, Arka Keshav, Arka Kisumakar, Pusa Purple long and 17 IIHR accessions. Nitrogen fixation was recorded by acetylene reduction bioassay. The bacterial colonization in the endorhizosphere was recorded by electron microscopy and on the rhizosphere by scanning electron microscope. The bacteria were cyst forming, gram positive, motile and having polar flagellum. Transverse sections of the root of brinjal revealed the colonization of the bacteria in the inter and intracellular spaces of the cortex. On the phylloplane also the bacterial colonies were present in large number. Using several physico-chemical tests and API kit, the bacteria were identified as *Bacillus polymyxa* which is a nitrogen fixer and phosphate solubiliser. Bacteria produced 114.7 pg mole⁻¹ of zeatine riboside in culture in 24 hours period. The amount of gibberellins produced was 0.08 ug ml⁻¹ in the same period. Brinjal plants treated with the bacteria produced higher Zeatine riboside (65.66 pg g⁻¹ fresh weight) compared to untreated control plants (16.77 pg g⁻¹ fresh weight) and 61% higher gibberellins than controls. The beneficial effects of the bacterial colonization was tested in pots under sterile conditions by inoculating the same to the crop at seed germination stage. The bacteria improved seed germination, enhanced plant growth, plant height and enhanced flowering, Under field conditions also the inoculation of the bacteria helped in improving plant growth, flowering and yield.

Ph.D

Title : Utilisation of VAM fungi for improving the establishment of micropropagated plants (2002)

Sowmya, Bangalore University, Guide : Dr.Sukhada Mohandas

In the present investigation, the utilization of vesicular arbuscular mycorrhizal (VAM) fungi in the establishment of micropropagated plants of *Bacopa monnieri* (L) Pennell and banana, *Musa paradisiaca*. L. cv. Dwarf cavendish was studied. *Bacopa monnieri* L.Pennell is an important medicinal plant used in Ayurvedic, Siddha, Unani and modern system of medicines. The available reports indicate their importance as memory vitalizer and nervine tonic with special reference to their saponin content. From the present study, the obtained results indicate that, vesicular- arbuscular mycorrhizal fungi *Glomus mosseae* and *Glomus fasciculatum* could colonize well in both normally raised and micropropagated plants. The micropropagated plants of *Bacopa monnieri* responded excellently to the VAM inoculation in the pots which compared with the normal plants. These mycorrhizal plants were compared with uninoculated control plants. The efficiency of *Glomus mosseae* and *Glomus fasciculatum* helped the micropropagated *Bacopa* plants in availing the good growth, improved physiological condition by attaining the better establishment in the pots. The establishment of mycorrhizal plants is expressed by increase in their biomass and bacoside-A content. This is a first report of utilization of VAM fungi in micropropagated *Bacopa* plants. Banana is an important commercial fruit crop. In the present study the two *Glomus* species, *Glomus fasciculatum* and *Glomus mosseae* benefited the banana plant growth in pots and establishment in the field. Both single inoculation and dual inoculation with PSM, *Trichoderma viride* gave better results compared to uninoculated control plants. The results of this study clearly indicate that micropropagated banana plantlets showed better establishment when they are raised in the presence of VAM fungi from pots to field condition. By utilizing these VAM fungi there can be improvement in the cultivation of both medicinal and horticultural plants propagated *in vitro*.

Ph.D

Title : **Studies on *in vitro* propagation of Chrysanthemum (*Dendranthema grandiflora tzvelev*)** (2006)

Bindu Panicker, UAS, Bangalore, Guide : Dr.Pious Thomas

The investigations were carried out with the objectives of optimizing an *in vitro* propagation protocol for the naturally shy propagating chrysanthemum, detecting the presence of any covert endophytic bacteria associated with *in vitro* chrysanthemum cultures, isolation and identification of covert endophytes, evaluating the effect of plant growth promoting rhizobacteria and VAM during acclimatization and subsequent field performance of micropropagated chrysanthemum, and testing the micropropagated and conventionally propagated plants in the field. The experiments were carried out using chrysanthemum varieties Arka Swarna and Arka Ravi and there were eight major experiments. The salient findings of the study included: (i) Rapid propagation of shy-suckering chrysanthemum varieties Arka Swarna and Arka Ravi was accomplished using shoot tip and nodal microcuttings; (ii). Higher level of growth regulators reduced the net propagation rate besides causing more rampant bacterial contamination, (iii) Indexing the cultures through could detect the covert contaminants, which was rampant in chrysanthemum cultures, (iv) Endophytic bacteria associated with the cultures of chrysanthemum were isolated and were identified based on 16S rDNA sequence homology analysis. *Curtobacterium flaccumfaciens pv. basellae* was a common endophyte of Arka Swarna cultures and *Enterobacter hormaechei subsp. steigerwaltii* and *Methylobacterium sp* were isolated from Arka Ravi cultures, (v) Cleansing the cultures from covert contaminants was accomplished through disinfection treatment of shoot tips followed by challenge with single antibiotics (gentamycin, streptomycin or cefazoline) at 50-100 mg L⁻¹ for one month, and selection of the clean cultures through repeated indexing of tissue and medium for 2-4 passages; (vi) Among the four bioinoculants (VAM, phosphate solubilising bacteria, *Azospirillum* and *Bacillus pumilus*) tried singly or in combination, combined inoculation with VAM, *Azospirillum* and PSB at 40 g Kg⁻¹ enhanced the flower yield per plant in Arka Swarna. In Arka Ravi, single inoculation with VAM at 40 g Kg⁻¹ enhanced the yield per plant. (vii) Bio-inoculants as such did not improve the % survival during acclimatization in both the varieties, (viii) Micropropagated plants showed no deviation in the growth pattern and performance in the field condition.

Ph.D

Title : Generation of single chain antibody fragments (scfv) for detection of *Ralstonia Solanacearum* causing bacterial wilt of tomato (2006)

K.N.Chandrashekara, Kuvempu University, Shimoga, Guide : Dr. Akella Vani

The bacterial wilt disease is widespread causing severe loss on many economically important solanaceous vegetables in India in general and Karnataka in particular. Wilt symptoms caused by several pathogens such as fungal pathogen (*Fusarium*, *Rhizoactonia* and *Phythium*), insect damage (shoot borer and nematode damage) and bacterial wilt caused by *Ralstonia solanacearum* show same symptoms. Hence the present study was undertaken to develop a single chain monoclonal antibodies (scFv) which is cost effective and easy to handle both by researchers and farmers to detect the pathogen at very low concentrations. Fifty seven isolates from different host plants viz., tomato, potato, brinjal, bird of paradise, capsicum, coleus and davana from different geographical locations of Karnataka and different states of India (Himachal Pradesh, Andhra Pradesh, Kerala, Maharastra and Orissa) were isolated. This is the first report of *Ralstonia solanacearum* isolated from davana and *coleus* crop. Phage Display Technology was used in the present study to generate scFv. ScFv monoclonal antibody was developed against both virulent and avirulent strains of *Ralstonia solanacearum* with very high specificity. These antibodies detected as few as 10 cells of the bacterium in an infected tissue. This is the first time that single chain antibody were developed against race-1 biovar – III of *Ralstonia solanacearum*. Amplification with OLI1 & Y2 and Y1 & Y2 (Seal *et al.*, 1993b) primers further confirmed that the isolates were indeed *Ralstonia solanacearum*. All the 57 isolates were determined as belonging to race-1, biovar-III on the basis of their pathogenicity to infect different plant species and their inability to infect mulberry and banana. Three SSR primers were developed against *Ralstonia solanacearum* by using the ‘Tandem Repeats Finder Program’ and were used for fingerprinting the bacterium. The primers gave highly polymorphic bands. It was evident that the fingerprinting pattern was unique and suggested that the bacterial genome also carries repeats of genomic segments which were as many as 13 repeats in a single genome. DNA fingerprinting of all 57 isolates was carried out to study variability of the strains with respect to host plant and geographical location. This is also first time that a highly specific dipstick based nucleic acid detection kit was developed for any pathogen.

Ph.D

Title : Isolation, cloning and characterization of chitinase gene from entomogeneous fungus *Nomuraea rileyi*/*Metarhizium anisopliae* (2006)

C.Suneetha, Kuvempu University, Shimoga, Guide : Dr.J.B.Mythili

Crop losses due to pathogens results in substantial reduction in potential crop production annually. Conventional breeding for resistance to these diseases has not been very successful. Hence genetic engineering approach to introduce specific genes especially chitinase that could offer resistance to various fungal pathogens is being widely used in the development of transgenic crops with enhanced resistance to fungal diseases. Of late, there are reports on the variation in the efficacy of the chitinase genes isolated from various sources and chitinases isolated from the biocontrol fungus *Trichoderma harzianum* have been shown to be more effective. Keeping this in view, the study was aimed at “Isolation, cloning and characterization of chitinase gene from entomogenous fungi *Nomuraea rileyi*/*Metarhizium anisopliae*” Chitinase gene from *M. anisopliae*, was isolated through RT-PCR using primers designed from the sequences of *Metarhizium* obtained from NCBI site. The RT-PCR resulted in 1.5 kb product. This was cloned and sequenced. Sub cloning was followed to amplify the middle portion of the gene product. The primers were designed using the sequence data obtained from the forward and reverse sequences and the PCR amplification resulted in 875 bp Product. The sequence with and without introns (1275bp) showed very high homology of 90-99% to chitinase sequences from *Metarhizium* species while, 70-90% homology with other fungal chitinase sequences including *Trichoderma*, which have already been deposited in the NCBI database. The full length 1275bp chitinase gene encodes 425 amino acids with the potential chitin binding domain which is conserved across the entomopathogenic fungal species and amongst the class V chitinases of various fungal species. The gene was then cloned into binary vector pBIN by directional cloning method and was mobilized into *A. tumefaciens* strain LBA 4404 through triparental mating technique. The gene construct containing chitinase gene was used for transformation studies in tobacco. Transgenic tobacco plants confirmed for the presence of transgene were generated. Efficacy of the gene in inhibiting the pathogen growth was demonstrated through *in vitro* pathogen (*Alternaria alternata*) inhibition studies from protein extracted from tobacco plants transformed with the gene construct in comparison with the untransformed plants.

Ph.D

Title : *In vitro* studies on banana cultivars (2007)

K.Y.Pratibha, Bangalore University, Guide : Dr.Sukhada Mohandas

Banana cvs. Rasthali (AAB) and Neypoovan (AB) are seriously affected by Fusarium wilt and the former is under the threat of extinction. In order to transform the cultivars with disease resistant genes a regeneration protocol using somatic embryogenesis was developed using immature flower buds. Immature flower buds cultured *in vitro* resulted in embryogenic callus formation in banana cvs. Rasthali (AAB) and Neypoovan (AB). The cv. Rasthali took less time to regenerate plantlets from somatic embryos compared to Neypoovan. Immature flower buds were found to be better to induce embryogenic callus than shoot tip explants in both the cvs. Histological observation of embryogenic callus of Rasthali, revealed the origin of somatic embryos to be multicellular. Interestingly the studies showed many differently shaped embryos at all stages of development. Histological studies of germinated embryo showed well developed plumule with leaf primordia, coleoptile, cotyledon, provasculature and many root initials. Studies on histochemical changes during somatic embryogenesis in Rasthali showed the presence of higher amounts of biomolecular substances such as insoluble polysaccharides, proteins and nucleic acids during different stages of embryo formation. Direct secondary somatic embryogenesis was observed on the epidermal region of primary somatic embryos of banana cv. Rasthali. Secondary somatic embryos were formed in two different modes on primary embryos. Histochemical observation of secondary somatic embryos showed the presence of higher amount of total insoluble proteins, total polysaccharides and nucleic acids. Morphological studies of commercially propagated *in vitro* bananas in the field have shown the enormity of the off-types generated through micropropagation. Through field study 25 types of variants were identified and molecular markers for Dwarf variants and bunch variants which were the most common types of off-types causing heavy loss to the farmers were identified. Molecular markers like RAPD, SSR, ISSR, SRAP were used to identify the genetic variations in banana cv. Grand Naine. All the markers clearly showed polymorphism between the off types and the normal banana plants. Overall 9-17% polymorphism was observed in variants indicating the level of genetic change. The primers OPS-05 were redesigned as a marker for dwarf off-type and AR-14 for dwarf non-flowering.

Ph.D

Title : Generation of transgenic tomato carrying single chain antibody fragments (scfv) against viral expressed genes of tospovirus (2008)

K.Jagadish, Kuvempu University, Shimoga, Guide : Dr.Akella Vani

I) To generate transgenic tomato carrying single chain antibody fragments (Scfv) against viral expressed genes of tospovirus for resistance to tospovirus (PBNV) Through Plant body Mediated Approach. In the present study, the nucleocapsid protein gene (n-gene) of peanut bud necrosis virus (PBNV-Bangalore isolate) was amplified by RT-PCR using gene specific primers and was cloned into pUC18 vector for sequencing. The sequence revealed that it had an open reading frame of 831 bp (reported for the first time NCBI ACCESSION AAO17798). The n-gene of PBNV when expressed from pET27b, a bacterial expression vector, gave a protein of molecular weight of approximately 30 KD. Monoclonal scFv antibodies against nucleocapsid protein of PBNV were generated by phage display technology. Further, a diagnostic kit was developed by fusing the Antibody scFv gene with the gene coding for alkaline phosphatase enzyme. Griffin scFv library developed by MRC, London was "used to generate monoclonal antibodies. This involved 3 rounds of biopanning of the library phages against purified nucleocapsid protein followed by selection of individual phagemids for developing monoclonal antibody. The following monoclonals namely, ScFv NP-50, 51, 52, 54, 59, 63, 65, 66, 67, 71, 73, 75, 76, 79, 80 and 86 had in an ELISA reading which was greater than one standard deviation over the average reading of forty one monoclonals selected in the study. Two best monoclonal phages scFvPBNVNP-65 and 71 were selected based on biological validation where in PBNV infected field samples were used. The antibody gene was excised and fused with the gene for alkaline phosphatase of E.colL The resulting clones had alkaline phosphatase activity and the antibody domain could detect PBNV in field-infected samples. Out of them pAVMabPBNVNPALP clone 65-7 was developed into a detection kit for PBNV. Tissue samples as little as 1 g were adequate for detecting the virus in an ELISA experiment or a 1:1280 dilution of PBNV infected sap in a DIBA experiment. The antibody could detect PBNV in infected field samples when tested by dipstick assay where NUNCTTM immunosticks were used as solid support onto which a capture antibody, scFvPBNVNP-71 was coated. The antibody gene from scFvPBNVNP-71 was further mobilized into a plant expression vector, which was then used for developing transgenic tomato cultivar

Arka Vikas by electroporation of apical buds. The transgenic plants obtained in T₁ were further analyzed by PCR to check for the presence of scFvPBNVNP gene in tomato genome. Southern Blotting on the genomic DNA of 4 transgenic events revealed that the plants had one copy of the transgene each. Expression studies of single chain variable fragment (scFv) against the nucleocapsid protein of the PBNV were conducted. The presence of the scFv plantibody protein in sap obtained from transgenic and control plants were analyzed by ELISA. The scFv plantibody protein was detected in the tomato sap from 2 transgenic plants out of a total of 8 PCR positive plants (244d) in T₁ generation and 12 plants out of 17 in T₂ generation of the two individual primary transformants, while none of the control plants tested positive indicating that these antibody fragments were functional. The recombinant proteins synthesized in the sap of the other six plants functioned poorly as antibodies. Hence, although all the 8 transgenic plants harboured the scFv gene, expression of the protein varied between the individual plants in quantity and in function. The plants expressing plantibody protein, when challenged with viruliferous thrips, were resistant to PBNV, where as all the control plants were susceptible.

II) To generate transgenic tomato for resistance to tospovirus (PBNV), TLCV and combined resistance to PBNV and TLCV through pathogen derived resistance approach

In this study, the nucleocapsid gene of peanut bud necrosis virus was amplified by RT-PCR and the replicase gene of TLCV was amplified from infected leaves through PCR. The nucleocapsid gene of PBNV, replicase gene of TLCV and a transcriptionally fused chimeric construct containing the replicase gene and n-gene were individually cloned into pAV vector with plant promoter and transcription terminator. The clones were further characterized by PCR, restriction digestion and sequencing analysis. These constructs were transformed into four different cultivars of tomato namely, Arka Vikas, Arka Sourabh, Arka Meghali and Pusa Ruby. The transgenics were screened for the presence of gene(s) and complete cassette by PCR. The copy number and the integration pattern of the transgene was assessed by Southern blot hybridization.

T₁ progeny of plants transformed with nucleocapsid gene of PBNV gave 57 PCR positive plants out of a total of 240 plants tested. This was further confirmed by hybridization. Forty plants out of 57 plants with the transgene were resistant when challenged with viruliferous thrips, and all the non-transgenic plants tested were completely susceptible to the virus. In case of T₂ generation transgenic lines carrying nucleocapsid gene of PBNV, 50 plants out of 59 with the transgene were resistant and produced n-protein as revealed

in ELISA. Southern blot analysis on 5 plants showed that 2 plants, had multiple copy integration and 3 plants had single copy integration. ELISA was carried with transgenic plants under challenged and unchallenged conditions. The level of the N-protein was low in challenged transgenic plants when compared to unchallenged plants indicating the RNA mediated resistance may be in operation. Transgenic plants carrying the chimeric construct for resistance to 2 different viruses namely, TLCV and PBNV when analysed showed that 26 plants were PCR positive in T₁ (out of a total of 61 plants tested). In T₂ generation, fourteen out of 35 plants had the complete construct, which were further confirmed by hybridization. Further, PCR positive plants when challenged with both viruliferous thrips and white flies only 12 plants were resistant to both the diseases in T₁ and 13 out of 14 plants were immune to both the diseases in T₂ and were found to be resistant till the end of the crop. The plants, which were resistant for both the viruses showed the integration of both transgenes, when detected with individual probes in a separate experiments in Southern blot. Transgenic plants were also generated with plant expression construct for replicase gene of TLCV alone in order to authenticate the ability of the replicase gene to confer resistance to TLCV. Twenty-nine plants out of 83 plants tested in T₁ progeny and 39 plants out of 62 in T₂ progeny were positive for the presence of gene. This was further confirmed by hybridization. Twenty-three plants out of 29 PCR positive plants in T₁ and 32 out of 39 plants in T₂ were completely resistant to TLCV when challenged with the viruliferous white flies. Southern blot analysis on four events revealed a single copy integration. The PCR positive plants when challenged with the viruliferous white flies were resistant to the virus whereas all the non-transgenic plants were susceptible to the virus.

Ph.D

Title : Generation of a transgenic plant carrying single chain antibody (scFv) gene against coat protein of citrus tristeza virus (2008)

K.B.Krishna Moorthy, UAS, Bangalore, Guide : Dr.Akella Vani

Acid lime (*Citrus aurentifolium*) belongs to the family Rutaceae and is one of the most important fruit crops cultivated throughout the world. The main reason for low production and productivity in the country is due to Citrus Tristeza Virus (CTV). CTV a member of the genus Closterovirus of the Closteroviridae, a family of positive sense RNA viruses transmitted by range of vectors that include aphid (*Toxoptera citricidis*), white flies and mealy bugs (Karasev, 2000) are very important causing loss up to 100 per cent by destroying the whole plant. Generating transgenic citrus for resistance to CTV appears to be the most promising control strategy because, control of vector under field conditions is very difficult. Moreover, use of chemicals to control the vector may result in the development of resistance to these chemicals in the vector. Developing resistant varieties against CTV by conventional method of breeding is not only a long procedure but also time consuming. The source of resistance to this virus has not been reported in acid lime. The current methods of managing CTV are use of disease free material and through cross protection. However disease free material only ensures delay in acquiring the infection while, cross protection has not yielded good results. Therefore, breeding transgenic citrus through biotechnological approaches is the need of the hour. The most flexible, powerful new approach to pathogen resistance is the expression of recombinant antibodies (Single chain variable fragments). Here, the cloned antibody gene is tailored to inactivate the pathogen when expressed in plants. Single chain variable fragment (ScFv) antibody consists of heavy and light chains (Fab region - Fragment antigen binding region) joined by 15 residue linker peptide. This ScFv protein retains the antigen-binding potential and consists of only one polypeptide chain. Repertoires of antibody fragments are displayed on the surface of filamentous bacteriophage, each displaying a single antibody (Fecker *et al.*, 1997). From such a phage display library, the isolation of ScFv specific for almost any antigen is possible. The selection procedure is rapid and reliable. Selection of phage, which reacts with a specific antigen, is carried out by a biopanning procedure (Winter *et al.*, 1994). An advantage of this procedure is that while selecting for an antibody with a high specificity, the gene encoding this fragment is also simultaneously available on the genome of phage which can then be excised and manipulated further. Such gene can be

mobilized into plant expression vectors and used for transforming the plants to get the pathogen resistant transgenic plants. In the present study,, the coat protein gene of Citrus Tristeza Virus was amplified by RT-PCR using gene specific primers and was cloned into pUC18 and was sequenced. The clone had an open reading frame of 651bp. The coat protein of CTV was cloned into pET 22b vector which gave a protein of approximately 25 KD when analysed by SDS-PAGE. The CTVCP was used as antigen against Griffin scFv library (MRC London) and polyclonal scFv phages were obtained at the end of 3 rounds of biopanning. The affinity of the polyclonal antibodies was determined through an ELISA technique. From a population of selected polyclonal phages, monoclonal antibodies are selected and were screened for their affinity to bind to the antigen.12 monoclonals *viz.*, 1, 10, 13, 17, 20, 21, 22, 23, 26, 35 and 41 were selected based on their performance in an ELISA based experiment where the affinity to bind to the antigen was greater than one standard deviation over the average performance of forty two monoclonals selected at random. The best monoclonal phages were biologically validated against CTV infected field samples of citrus. The scFvCTVCP-41 monoclonal which performed better than other monoclonals, was transcriptionally fused to the gene coding for alkaline phosphate (ALP) to reduce the time required for ELISA. The resulting clone (anti CTVCPALP conjugate) had alkaline phosphatase activity and the antibody domain could detect CTV in infected field samples as well in glass house grown graft inoculated seedlings. Tissue samples required for detection was as little as 1 mg. The antibody domain could detect CTV in infected field samples when tested by DIBA where nitrocellulose membrane was used as solid support onto which scFvCTVCP monoclonal antibody was coated and CTV antigen was captured.

Antibody based dip stick method was standardized for detecting CTV in infected field samples, where NUNCTM immunosticks were used as solid support onto which CTV antigen was captured and it was directly detected with anti CTVCPALP fusion protein.

The plantibody construct was developed by subcloning the scFvCTVCP gene into plant expression vectors with NOS promoter and NOS terminator and the construct was electroporated into floral buds of citrus and apical buds of model plant.

The T₁ transgenic model plants when analysed by PCR showed the presence of scFvCTVCP gene in their genome. The Southern Blotting was carried out for PCR amplified products as well as on the genomic DNA of transgenic plants. A strong hybridization signal was obtained with labeled scFv indicating transgene integration.

Expression of plantibody gene by transgenic plants was analysed by ELISA. The scFv plantibody protein was detected in the sap of 6 transgenic events (tomato was used as a model plant) out of 12 PCR positive events, while none of the control plants tested positive, indicating that these antibody fragments were functional.

Ph.D

Title : **Biochemical and molecular changes in banana cv. Neypoovan colonized with AM fungi (*Glomus mosseae*) and *Trichoderma* in the management of *Fusarium oxysporum* f.sp.*cubense* causing panama wilt (2008)**

R.Manjula, Kuvempu University, Shimoga, Guide : Dr.Sukhada Mohandas

Fusarium wilt is regarded as one of the most devastating diseases of banana, affecting plantations in almost all banana-growing countries of the world. In the present study different BCAs, viz., *Glomus mosseae*, *Trichoderma harzianum* and *Pseudomonas fluorescens* were studied for the effect of their inoculation on *Fusarium* resistance, in banana cv. Neypoovan. Under controlled and field conditions plants inoculated with biocontrol agents performed better than uninoculated controls and were able to withstand challenging with FOC to a significantly greater extent. Under field conditions plants preinoculated with BCAs for 45 and 90 days were better than uninoculated plants (or 0 days inoculated plants) when challenged with FOC. Among the plants pre-inoculated for 90 days with BCAs and challenged with FOC the vascular discolouration index was less in *G. mosseae* + *P. fluorescens* + FOC treatment followed by *G. mosseae* + *T. harzianum* + FOC. The light microscopic observations showed that in biocontrol agents brought about structural changes in the roots of treated. In the FOC challenged combinations; cell wall thickening was more compared to respective unchallenged treatments. The electron microscopic studies of the banana roots showed the colonization of BCAs in epidermis and cortex regions and were characterized by thick cell wall apposition, high electron dense material and accumulation of dense amorphous material along the cell wall. The immunological studies were carried out to detect FOC in banana roots using FITC conjugated antibody. Colonisation of FOC was seen in the vascular region of the root as bright fluorescent colonies. Reduction in the number of bright fluorescent colonies of FOC was observed in BCA treated plants there by strengthening it. The results of ELISA assay revealed that FOC population had drastically reduced in biocontrol treated plants in both glass house and field conditions. In the experiments carried under controlled and field conditions a gradual reduction in FOC population was seen in banana roots treated with biocontrol agents and then challenged with FOC for six months. More reduction in FOC was observed in *G. mosseae* + *T. harzianum* + FOC inoculated plants.

The BCA inoculation induced increased peroxidase activity in roots of banana compared to control. The *G. mosseae* and *T. harzianum* treatments given separately

showed 3 folds increase in the activity and in plants inoculated with *G. mosseae* + *T. harzianum* + FOC. The gluconase activity in banana leaves was 1.5 to 2 fold higher in BCA inoculated plants compared to control. The highest initial activity was observed in *G. mosseae* + *T. harzianum* + FOC which declined to 1.5 fold of control levels at 30 DAI. In the roots of banana plants inoculated with different BCAs chitinase activity was higher than control plants and increased to nearly 2 fold at 7 DAI. *G. mosseae* + *T. harzianum* + FOC treatment it reached maximum of 3.4 fold at 4 DAI. Of the ten peroxidase isozymes observed in banana roots, biocontrol agent treatments induced PO 4, 5, 6, 8 and 10 isozymes at various stages after inoculation and these bands were not induced in control plant roots. In leaves only six peroxidase isozymes were observed with no significant difference among treatments. In PPO isozyme analysis, the BCAs treatment induced 4, 5, 6 and 7 isozymes in roots compared to untreated control. The intensity of these bands increased when challenged with FOC. In chitinase isozyme analysis, a unique CHIT 1 band was induced in the combination of *G. mosseae* + *T. harzianum* treatment which was not present constitutively in control plants and also had an increased intensity of all the isozymes compared to control.

The study clearly demonstrated the ability of BCA to impart disease resistance and help in the management of *Fusarium* wilt of banana. It should be noted here that it was our observation that if *Fusarium* has already infected the suckers before precolonization with BCAs the plant would succumb to the disease as *Fusarium* being very aggressive would over power the colonizing organisms. A precolonization with BCAs for 90 days is a pre-requisite for deriving the benefit of structural, biochemical and molecular changes induced by the organism and eliciting defense response in the host plant.

Ph.D

Title : ***Agrobacterium*-mediated transformation in tomato and chilli for fungal resistance** (2008)

H.J.Rashmi, Kuvempu University, Shimoga, Guide : Dr.J.B.Mythili

Fungal pathogens are potent microorganisms and pose a threat to cultivated crops worldwide. Plant pathogens are known to destroy 12% of world's crops through disease epidemics. Tomato and chilli are the two important vegetable crops grown in the topical and subtropical parts of the world. These crops are attacked by various fungal, bacterial, viral and nematode pathogens and are known to severely affect the economic yields in these crops. As conventional breeding for resistance to early blight in tomato and fruit rot in chilli have met with limited success, alternative methods of diseases control by introduction of genes for disease resistance by novel biotechnological approaches have been tried.

The study was aimed at transforming chilli and tomato using chitinase genes from different sources such as baculovirus, *Trichoderma harzianum* and *Metarhizium anisopliae*. Chilli, being a recalcitrant crop for regeneration, exhaustive treatments including use of ethylene inhibitors and phenyl acetic acid were tried during standardizing the protocol. Seven putative transformants of chilli with baculovirus chitinase gene were obtained. In tomato, two transformants each with baculovirus, *T. harzianum* and *M. anisopliae* chitinase gene were obtained and *T. harzianum* and *M. anisopliae* gene constructs gave rise to significantly greater percent of transformants as compared to baculovirus chitinase gene construct. The presence of the transgene was demonstrated through PCR, dot blot and Southern blots. Additionally, the expression of the gene was studied through chitinase and *in vitro* fungal inhibition assay in the transgenic plants.

Ph.D

Title : **Breeding and development of molecular markers linked to bacterial blight (*Xanthomonas axonopodis* pv. *dieffenbachiae*) resistance in *Anthurium* (*Anthurium andreanum* Lind.)** (2009)

Patil Manjunath Sidlingappa, UAS, Bangalore, Guide : Dr.C.Aswath

Studies on "Breeding and development of molecular markers linked to bacterial blight resistance in *Anthurium* (*Anthurium andreanum*) are presented here. The minimum number of days taken to attain marketable flower was recorded in Deep Pink (15.50 days), Honduras Red (16.0 days). Minimum interval between flowering were recorded in the variety Sunglow (45.75 days), maximum spike length was noticed in Simba (56.7 em), maximum spathe length in Tropical (18.43), maximum spathe width in Chaco (14.03 em), minimum spadix length was recorded in IIHR selection A1 (4.78 em), minimum spadix diameter was recorded in Honduras Red and Chaco (0.73 em each). The maximum number of days taken for stigma receptivity was recorded in Meringue White (53.25 days). The minimum number of days taken for pollen dehiscence was recorded in Acropolis (34.75 days). The maximum number of days inflorescence remain receptive was recorded in IIHR selection A1 (11.25 days). The maximum number of days stigma remain receptive was recorded in IIHR selection A1 and Simba (5.25 days each). The minimum number of days taken for seed maturity (183.65 days) was recorded in Singapore Red. Based on evaluation studies and economical characters varieties Sunglow, Simba, Meringue White, Acropolis and Fla Orange were recommended for commercial cultivation. Based on the screening studies IIHR selection A1 was found to be moderately resistant recording low PDI (9.83%). The other varieties like Honduras Red, Meringue White, Regina, Fantasia, Deep Pink, Tropical, Acropolis, Fla Orange and Heritability was very high (> 90) for all the characters like spathe length, spathe width, spadix length, spadix diameter, days taken for pollen dehiscence and days taken for seed maturity. While days of interval between two flowers, days taken to attain marketable flower, spike length, days taken for stigma receptivity, number of days inflorescence remain receptive and number of flowers per plant per year showed low heritability indicating heritability estimates in conjunction with the estimates of genetic advance are more useful in selecting superior genotypes. The sixteen genotypes were grouped into six clusters based on the distant values. Out of the six clusters formed Cluster I was the largest with seven genotypes followed by Cluster IV with three genotypes. The intra cluster distance was

highest for Cluster IV (45.20) and lowest for Cluster V and Cluster VI (0.00). Spadix length and days of interval between two flowers contributed maximum for divergence (20.00 and 20.22 per cent, respectively). Number of flowers per plant per year contributed 6.67 per cent to divergence and per cent disease incidence contributed (10.00 per cent). Spike length was lowest in cluster V (50.48 em), Spathe length was highest (16.74 ern) in cluster IV. Spathe width was maximum (12.12 em) for cluster IV. Spadix length was maximum in cluster IV (10.07 ern).

To breed for increase in stalk length the V cluster can be used, to increase in spathe length the IV cluster can be used and to breed for disease resistance the VI cluster based on the ratio of gea variance to sea variance for the trait plant height it was found that the character is governed by additive and non-additive gene action. Hence, breeding procedure of population improvement by reciprocal recurrent selection is suggested. The characters like leaf area, PDI after 6 days and PDI after 12 days were found to be governed by additive gene action. Hence, breeding procedures like synthetic breeding, composite breeding and population improvement by recurrent selection is suggested. The line, IIHR selection A1 showed positive and significant gea effects for all characters. Among the testers, Tropical showed positive and significant gea effects for 5 characters. Hence, IIHR selection A1 can be used as best general combiner for all the characters followed by Tropical. Among the crosses, the cross P X AO recorded significantly positive sea effects for 9 characters. So, the cross P X AO can be used as specific combiner for all the characters. The crosses where IIHR selection A1 was involved resulted in maximum spike length, leaf area, number of leaves and increased disease resistance over mid parent and check. Only three crosses (S x AO, T x AO and P x AO) exhibited significantly negative heterosis for disease resistance. DNA extraction yielded 40-1450 ug of DNA per gram fresh weight of leaf. High RAPD polymorphism was observed in the present material. Out of 110 decamer primers screened notably 6 primers (OPB 01, OPB 02, OPB 10, OPB 13, OPB 18 and OPB 20) have generated one or more polymorphic DNA markers and the frequency of polymorphic markers was as high as 74.80 per cent. From the results obtained about molecular markers for *Xanthomonas* resistance from the bulk segregant analysis, it was found that a marker OPB 01 at 600 bp, OPB 02 at 1200 bp, OPB 10 at 250 bp, OPB 13 at 750 bp and OPB 20 at 250 bp which is linked to bacterial blight resistance in *Anthurium* can be successfully used for rapid screening and identification of genotypes resistant to bacterial blight of anthurium. A dendrogram based on Squared Euclidian Distances grouped into two major subgroups.

The first cluster consisted of resistant parent IIHR selection A 1 and resistant bulk which arose from same node in the dendrogram while second cluster consisted of susceptible parent Pistache and susceptible bulk placed together in adjacent to the first cluster. This cluster grouping shows that resistance in F₁ hybrids has inherited from the parent. Based on the RAPD data, Pair wise Squared Euclidian Distances was calculated for all the hybrids. The Pair wise Squared Euclidian Distances ranged from 13 to 48. A1 and A2 had a distance of 34. A10 and A12 hybrids had minimum Pair wise Squared Euclidian Distances of 13.

Ph.D

Title : **Generation of transgenic plants resistant to tospovirus** (2011)

S.Rashmi, Kuvempu University, Shimoga, Guide : Dr.Akella Vani

Tospoviruses are the plant disease causing pathogenic viruses, causing huge losses to crops depending on the stage at which infection occurs. They are found all over the world on many plant species, which are economically important. Research work is being carried out very seriously all over the globe to manage diseases caused by tospoviruses on different economically important crops. However, control of these diseases, is still far from satisfaction. Source of resistant gene(s) is lacking in almost all cases for use in breeding program to develop resistant varieties. Thrips are the only known vectors of this group of viruses, and the disease is transmitted even by a brief probing. Therefore management of this disease by controlling thrips is not a solution. The present investigation was carried out to explore the possibilities of developing transgenic watermelon through recombinant DNA technology to develop resistance to Watermelon Bud Necrosis Virus (WBNV). Watermelon Bud Necrosis Virus, which belongs to serogroup IV of tospovirus, was reported very recently from India for the first time and is known to be spread by insect vector namely *Thripsplami*. There is no known source of resistance to the virus in the watermelon germplasm. In order to develop transgenics, cultivar Arka Manik, a popular watermelon variety, developed by Indian Institute of Horticulture, Hesaraghatta, Bangalore was used. This variety is reported to be highly susceptible to Watermelon Bud Necrosis virus. Attempt was made in the present study to achieve resistance through either a partial nucleocapsid protein or through its m-RNA which was predicted to be involved in RNA mediated gene silencing. Therefore, studies were carried out in the present investigation using a 583 bp of 3'partial WBNV- Δ N-gene with a high homology to published sequence. From this study, we were able to successfully produce transgenic watermelon plants using the Direct DNA uptake method namely electroporation. Transgenic plants produced in the present study were evaluated for the presence of transgene, its inheritance pattern in different generations, and were scored for resistance to the bud necrosis disease. The method of transformation permits us to obtain primary transformants which are in T₁ generation. 175 T₁ plants were tested and 68 were positive for the presence of complete cassette. In T₂ generation, out of 14 plants tested, 6 plants were positive for the cassette. In T₃ generation, 24 plants were positive out of 26 plants. The PCR products of these transgenic plants were subjected to Dot Blot

hybridization analysis using the transgene specific DNA probe. Plants containing the transgene were selfed and homozygous plants were obtained in T₂ as evidenced by PCR of T₃ plants. The progenies of 2 events in T₂ and T₃ plant population containing complete cassette were further analyzed by Southern blot hybridization studies using the labeled DNA probe of WBNV-N-gene for studying the copy number. One event (543-4-36-6) had a single copy and the second event (543-4-30-6) had 2 copies. Transgenic plants containing the complete cassette were studied for resistance to watermelon bud necrosis virus (WBNV) by challenge inoculation with viruliferous thrips collected from infected watermelon. There was a variation in their response to the level of infection in selfed transgenic plant populations. The reasons for variations in resistance have to be studied further. PCR analysis of event 543-4 and 542-12 across different generations showed that the transgene was inherited in a Mendelian fashion and stable homozygous line was obtained in the T₂ segregant 543-4-36. T₂ plants selections namely 543-4-30 and 543-4-36 and their T₃ progeny showed resistance till fruit set, indicating stability of the trait and that the inheritance of pattern of resistance was stable.

M.Sc.

Title : Studies on direct DNA uptake by citrus (*Citrus aurantifolia* Swingle) nodal buds through in vivo electroporation (1998)

Krishnarao Desai, UAS, Bangalore, Guide : Dr. Akella Vani

Direct DNA uptake into immature floral buds in the size range of 2.5 mm was shown to be possible through electroporation of plasmid DNA either naked or complexed with spermine or lipofectin. This is a first report in the world of DNA being taken up by a mature and highly differentiated tissue such as a floral bud. Two reporter genes were used viz., uidA gene of E.coli which codes for beta glucuronidase and *gfp* the gene for green fluorescent protein. Transient expression was observed 20-30 minutes after electroporation with plasmid DNA containing the coding sequence for *gfp*. The green fluorescence was visible with the help of a fluorescence microscope attached with FITC filters. All parts of the flower including the ovary and the pollen have taken up and expressed the GFP protein indicating that it should be possible to generate transgenic citrus through this technique. R1 progeny have been raised from seeds obtained from electroporated flowers.

M.Sc.

Title : **Transformation of geranium with glucanase-chitinase encoding genes using *Agrobacterium tumefaciens* (2000)**

M.K.Prakasha, UAS, Bangalore, Guide : Dr.Sukhada Mohandas

Geranium (*Pelargonium X hortorum*) is a popular floricultural crop. Conventional breeding of *Pelargonium X hortorum* is hampered by its low fertility. The crop is attacked by various fungi like *Fusarium oxysporum* var. *Radolens*, *Botryodiplodia theobromae*, *Rhizoctonia solani*, *Phythium sp.*, *Botryosporia obtusa* and *Phytophthora spp*, which causes wilt, and *Gleosporium spp* causes Tip rot of geranium. Though these losses could be controlled to some extent using chemical pesticides the hazards posed by these chemicals to the environment prompted us to use genetic engineering techniques which help in stable integration of the gene into the plant and impart resistance. Hence the present investigation was undertaken to develop suitable protocols for regeneration of ornamental seed geranium (*Pelargonium X hortorum* cv. Scarlet) and to develop *Agrobacterium* mediated gene transformation system using Glucanase -Chitinase gene. Geranium hypocotyl when cultured on MS medium containing different concentration of thidiazuron (TDZ) formed somatic embryos, the somatic embryogenesis initiation started after two to three weeks of incubation. The highest number of somatic embryos (12.60) were produced in MS medium containing 1.5 μ M TDZ and somatic embryogenesis initiation was achieved in 14 days. Highest number of shootlets (10) were rooted on MS medium containing 0.1 mg/l of NAA in 21 days. Explants after Co-cultivation were put to regeneration media where selection pressure was imposed with kanamycin (100 mg/l) and cefotaxime (600 mg/l). The Co-cultivated explants on kanamycin supplemented medium showed somatic embryos formation, the untransformed and the control plants turned white and later died on kanamycin supplemented medium. The transformation efficiency was 45.23%. The putative transformed shoots were transferred to the best rooting medium (MS+ 0.1mg/l NAA) containing kanamycin (100 mg/l) and cefotaxime (600 mg/l)). PCR analysis of putative transformed plants (pBIN AR) showed the presence of 820 bp *npt-II* gene. A rapid screening of the total genomic DNA isolated from putative transformed plants and control was done using DIG labelled glucanase probe to identify the transformed plants. All the putatively transformed plants showed hybridisation with the probe. All the transformants expressed high glucanase activity compared to control plants.

M.Sc.

Title : Development of microsatellite markers and molecular analysis in okra (*Abelmoschus esculentus* (L.) Moench) (2001)

Sujata.C.Hebballi, UAS, Bangalore, Guide : Dr.K.V.Ravishankar

Okra (*Abelmoschus esculentus* (L.) Moench) an annual, often cross-pollinated crop belonging to the family *Malvaceae*, is an important crop of the tropics and subtropics of the world. Simple sequence repeats (SSR's) or microsatellites are useful DNA markers in plant genetic research. Microsatellite-enriched library was constructed using DNA from Arka Anamika. A total of 71 clones were sequenced. Fourteen simple sequence repeat (SSR) loci were characterized using 10 okra genotypes. Genetic analysis showed a total of 26 alleles with an average of 1.86 alleles per SSR locus. Polymorphic Information Content (PIC) values ranged from 0 to 0.375 and the observed (H_o) and expected (H_E) heterozygosity values varied from 0 to 0.111 and 0 to 0.526, respectively. Another objective of this study was to investigate the transferability of cotton SSR markers to okra because of the availability of a large number of cotton SSR markers. Ninety cotton SSR primer pairs were used to amplify okra genomic DNA. The results showed that only 26 cotton SSR primer pairs tested in this study could amplify okra genomic DNA. Among these transferable SSR markers, 50 per cent of them detected polymorphism in okra genotypes. We obtained a total of 26 alleles with an average of two alleles per SSR locus and values of polymorphism information content (PIC) varying from 0 to 0.3750 and the observed (H_o) and expected (H_E) heterozygosity values varied from 0 to 0.52 and 0.080 to 1 respectively. Identification of transferable markers would help in okra genome research by providing additional DNA markers and also helps in comparative genome mapping study with cotton.

M.Sc.

Title : **Agrobacterium mediated transformation of African violets (*Saintpaulia ionantha*) with glucanase chitinase gene (2001)**

Narendra Ram, UAS, Bangalore, Guide : Dr.Sukhada Mohandas

African violet (*Saintpaulia ionantha* H. Wendland) is one of the most important ornamental plants used in indoor decoration, gardening and landscaping. These plants are attacked by *Fusarium oxysporum*, *Phytophthora* sp., and *Pythium* sps which cause Crown Rot and by *Botrytis* sp. which causes Botrytis Blight. Present work was envisaged to incorporate the genes producing chitinase and glucanase which impart resistant to these diseases. Transgenic African violets were produced via *Agrobacterium tumefaciens* mediated transformation. To start with regeneration protocols were standardised through multiple shoot bud production from leaf and petiole explants using growth regulators BAP and NAA. BAP at 2.5 mg l⁻¹ and NAA at 1 mg l⁻¹ gave the highest number of shoot buds (40) in leaf explants. In petiole explants, BAP at 0.5 mg l⁻¹ and NAA at 0.1 mg l⁻¹ gave the maximum number of shoot buds (22). Rooting of these shoot buds was found to be maximum with NAA at 2 mg l⁻¹. Leaf explants were inoculated with the strain LBA4404 of *Agrobacterium tumefaciens* harbouring the binary pBINAR carrying Glucanase-chitinase genes and nptII selectable marker. Regenerants obtained on the selection media containing Kanamycin (70 mg l⁻¹) and cefotaxime (800 mg l⁻¹) were excised and rooted on the media containing NAA. Integration of the transgenes in the plant genome was confirmed by PCR analysis and Southern hybridization. Mean glucanase activity in the transgenic plants was 44220 mu ml⁻¹ while that in control plants it was 27060 mu ml⁻¹. The crude protein extracts of transformed plants showed zones of inhibition when tested on *Fusarium oxysporum* and *Pythium* while control plants did not show any such antifungal activity.

M.Sc.

Title : *Agrobacterium* mediated transformation of chilli (*Capsicum annuum* L.) with glucanase and chitinase gene (2002)

S.T.Shivegowda, UAS, Bangalore, Guide : Dr.J.B.Mythili

Chilli is one of the most important vegetable crop which is susceptible to several fungal diseases which cause huge losses in crop yield. Genetic engineering through the introduction of genes coding for defense proteins viz., chitinase and β , 1, 3 – glucanase via *Agrobacterium* is one of the approaches for developing disease resistant variety of this crop. Development of an efficient regeneration system is a pre-requisite for any genetic transformation studies. Keeping this in view, the investigation was carried out with the objective of developing efficient regeneration and transformation of chilli with glucanase and chitinase genes. An efficient and reproducible regeneration protocol for cultivar Pusa Jwala and G4 was developed using cotyledon explants. MS media supplemented with BAP, GA₃ and IAA gave rise to multiple shoot buds while the presence of Zeatin & GA₃ in the media gave rise to well formed shoots which could be rooted in IBA containing medium. Cotyledons of cv. Pusa Jwala were transformed with *Agrobacterium tumefaciens* at C 58 containing plasmid PBZ 100 having chitinase and glucanase genes and another *Agrobacterium* culture carrying binary vector PVG 1040, containing GUS gene. The presence of npt II in both the cultures, as selectable marker under the constitutive expression of CaMV35S promoter facilitated the selection and regeneration of transformed plants on a medium containing 100 mg l⁻¹ kanamycin. The presence of the transgene was confirmed indirectly through PCR amplification of *npt* II gene and by histochemical assay of GUS gene. Of the 5 transformants obtained, 3 tested positive for PCR amplification of *npt* II gene.

M.Sc.

Title : ***In vitro* regeneration and transformation in carnation (*Dianthus caryophyllus* L.)** (2004)

H.M.Kallesh Prasad, UAS, Bangalore, Guide : Dr.J.B.Mythili

Carnation (*Dianthus caryophyllus* L. is one of the most important commercial flowers in the world. The commercial varieties are grown mainly through cuttings. Breeding methods have focused on development of varieties with novel characteristics. As an alternative to the classical breeding programmes attempts have been made to develop transformation system using *Agrobacterium tumefaciens* based gene vectors. However, transformation in carnation is still far from routine and can show variable rate of success. Keeping this in view, the present investigation was carried out with the objective of developing efficient regeneration and transformation of carnation with reporter gene. An efficient and reproducible regeneration protocol for carnation genotypes IIHRS-1 and IIHRP-1 has been developed from leaf and stem explants. The explants did not show any significant difference in their regeneration response. However, significant differences in regeneration potential were observed with leaf explant exhibiting higher regeneration potential (5.5) as compared to stem explant (4.9). The best regeneration response and maximum regeneration potential was obtained in MS medium supplemented with NAA (0.1 mg/l) and TDZ (1.0 mg/l) for both the explants and both genotypes used. This medium also proved suitable for shoot elongation of regenerated shoots. The shoots could be rooted in MS medium supplemented with IAA (1.0 mg/l). Leaves of genotype IIHRS-1 were transformed with *Agrobacterium tumefaciens* strain LBA4404 with binary vector pROK2 containing baculovirus chitinase gene under the control of 35S promoter and *npt* II serving as selectable marker under control of *nos* promoter. Inoculation time for 20 min. with the *Agrobacterium* culture followed by co-cultivation for 3 days in total darkness and 16h photoperiod for 2 days proved to be optimum. Putative transformants were regenerated at a frequency of 28.9% in selection medium supplemented with kanamycin (75 mg/l). Few shoots at random were tested for transgenic integration. Out of the three shoots tested for *npt* II amplification two shoots tested positive. The presence of transgene was thus indirectly confirmed through PCR amplification of *npt* II gene.

M.Sc.

Title : Detection and identification of covert endophytic bacteria associated with *in vitro* cultures of papaya (*Carica papaya* L.) (2004)

Sima Kumari, UAS, Bangalore, Guide : Dr.Pious Thomas

The experiments were carried out using papaya cv. Surya, employing axillary shoots from field grown one year old plants. There were four major experiments namely (i) culture establishment *in vitro* and monitoring the incidence of cultivable endophytic bacteria,(ii) culture indexing for cultivable endophytic bacteria, (iii) isolation and identification of cultivable bacteria employing 16S rDNA sequence based molecular approach and (iv) molecular screening of index-negative culture for non-cultivable bacteria. Papaya shoot tips harbored a series of endophytic bacteria which gained entry in the micropropagated cultures through the explant. Visible fungal and bacterial contamination in tissue culture medium was seen in 0-16% 19-43% of cultures in two batches. Out of the 65 visibly clean cultures of Batch-I, 26% (17 cultures) revealed covert bacterial association during medium/tissue-indexing and in Batch-II, 14% of such clean cultures showed up bacterial presence during the first or second *in vitro* cycle and other clean cultures remained index-negative on both medium/tissue-indexed plates during the next four *in vitro* cycles. Some of these endophytic bacteria showed active growth in the tissue culture medium and were highly detrimental to the *in vitro* cultures. These included *Microbacterium esteraromaticum*, *Pantoea* sp., *Echium* sp., *Brevundimonas aurantiaca*, *Sphingomonas* sp., *Methylobacterium podarium* and *Rhizobium* sp. Some endophytes displayed slow or inconspicuous growth in tissue culture medium resulting in gradual culture degeneration. They were identified as *Paenibacillus* sp., *Ralstonia mannitolilytica*, *Sphingomonas* sp. and *Bacillus fusiformis*. Most of the shoot tips showed the association of only one bacterial type. About 70-75% of the endophytes belonged to Gram-negative group. Visibly clean and index negative cultures, after five - six *in vitro* cycles revealed the presence of non-cultivable bacteria during PCR based molecular screening to the tune of 56.25% - 80% in two batches. The index-negative cultures upon transfer to proliferation medium after five to six *in vitro* cycles showed satisfactory growth. No clear distinction could be made between non-cultivable bacteria harboring and other clean cultures based on their growth or proliferation. Endophytic bacteria, thus appeared to be integrally associated with papaya tissue-culture with varying side-effects.

M.Sc.

Title : Genetic transformation of drought tolerant tomato cv. Arka Meghali with pathogen resistance genes (2004)

Ashoka, UAS, Bangalore, Guide : Dr.Sukhada Mohandas

Tomato (*Lycopersicon esculentum* Mill) is the world's largest vegetable crop cultivated for its fleshy fruits. The crop is attacked by various fungi like *Fusarium oxysporum*, *Alternaria solani* etc., which cause wilt and blight diseases and cause serious economical losses to the yield. Though these losses could be controlled to some extent using chemical pesticides, the hazards posed by these chemicals to the environment prompt us to use genetic engineering techniques which help in stable integration of the gene into the plants and impart resistance. The present investigations were carried out with the objectives of developing transgenic plants of tomato cv. Arka Meghali over expressing glucanase – chitinase genes. An efficient and reproducible regeneration protocol for tomato cv. Arka Meghali was developed. Among the various plant growth regulators combinations tried for regeneration, the best regeneration response was obtained in two treatments, one with 1.0 mg/l zeatin + 0.5 mg/l IAA and the other with 2.0 mg/l BAP + 0.1 mg/l IAA. In addition to shoot regeneration, these media produced sufficient elongation of the regenerated shoots. Rooting of *in vitro* formed shoots was induced in the MS media supplemented with different concentration of IBA and the maximum rooting occurred in media containing 2.5 mg/l IBA. Transformation was carried out using the *Agrobacterium* strain LBA4404 harbouring a binary vector pBinAR with *glucanase-chitinase* genes and *npt II* as the selectable marker gene driven by CaMV35S promoter. It was found that kanamycin at 50 mg/l inhibited regeneration totally in non-transformed explants. Therefore a kanamycin concentration of 75 mg/l was used for selection of transformants. Inoculation for 15 minutes with overnight grown *Agrobacterium* culture (0.4 OD at 600 nm) and co-cultivation for 2 days followed by transfer to cefotaxime media (600 mg/l) for 4 days before transferring to selection medium containing kanamycin (75 mg/l) was found to be optimum for effectively checking the bacterial over growth and retention of green colour of the explants. The presence of the transgene was confirmed indirectly through PCR amplification of the *npt II* gene and a transformation frequency of 4% was recorded. All the transformants tested expressed high glucanase activity compared to non-transformed plants.

M.Sc.

Title : *Agrobacterium* mediated transformation of African Violets (*Saintpaulia ionantha*) with *gus* reporter gene (2004)

T.Jyoti, UAS, Bangalore, Guide : Dr.Sukhada Mohandas

African violet (*Saintpaulia ionantha*) is a perennial potted plant mostly used in indoor decoration and gardening. African violets do not produce seeds, so the only means of propagation is by tissue culture. This crop is attacked by various fungi like *Fusarium* sp., *Pythium* sp., *Botrytis* and *Phytophthora* sp. Though these losses could be controlled to some extent using chemicals, genetic engineering techniques will help in stable integration of the resistant genes into plant. The present investigation was undertaken to develop suitable protocols for the regeneration of African violets (*Saintpaulia ionantha* cv. Sailors delight) and to develop *Agrobacterium* mediated gene transformation system using glucanase-chitinase gene. It was also felt necessary to confirm the integration of the gene through PCR and southern blot analysis and to study the gene expression in plants. Regeneration through multiple shoot production from leaf and petiole explant was standardized using BAP and NAA. BAP (2.5 mg l⁻¹) and NAA (1 mg l⁻¹) were found to be the best treatment with maximum number of shoot buds (40) while, BAP (0.50 mg l⁻¹) and NAA (0.1 mg l⁻¹) were found to be the best treatment with maximum number of shoot buds (22) with petiole explants. It was observed that NAA (2 mg l⁻¹) was the best for the rooting of multiple shoot buds obtained from both leaf and petiole. A suitable transformation system was also standardized using leaf as explant. *Agrobacterium* carrying the PKIWI plasmid with GUS as reporter gene and *npt-II* as selectable marker was used in the transformation procedure. Histochemical Gus assay was conducted for confirmation studies and the characteristic blue staining patterns confirmed the expression of the transgene.

M.Sc.

Title : Studies on the influence of cytokinin independent (ckil) gene on shoot regeneration through its overexpression in tomato cv. Arka Vikas (2005)

D.K.Narasimha Murthy, UAS, Bangalore, Guide : Dr.J.B.Mythili

Gene expression associated with specific hormonal treatments during adventitious shoot bud formation from explants cultivated *in vitro* is poorly characterised. Attempts to identify the genes have led to the isolation of a cytokinin independent gene (CKI1) which has been implicated to have a role in shoot regeneration. The present study was undertaken with the objective of studying its role in shoot regeneration through its overexpression by *Agrobacterium* mediated transformation in tomato cv. Arka Vikas under inductive i.e., shoot inducing (SIM) and non inductive i.e., callus inducing (CIM) treatments. Combination of BAP 2mg/l and IAA 0.1mg/l and BAP 2mg/l and NAA 0.1 mg/l were identified as shoot inducing medium (SIM) and callus inducing medium (CIM) respectively. Two gene constructs pMON530 with CKI1 gene and pCAMBIA2301 (without CKI1 gene) were used for transformation. For both the gene constructs, kanamycin was used as a selectable marker. Over expression of CKI1 gene resulted in regeneration of putative transformants to the extent of 8.0% in shoot induction medium (SIM) while there was no regeneration in callus induction medium (CIM) and in the medium devoid of cytokinin. CKI1 gene was also found to influence transformation frequency as evidenced by increase in the number of putatively transformed shoots (8.0%) with CKI1 gene as compared to 2.1% with gene construct without CKI1 gene. The presence of transgene was confirmed by PCR amplification of *npt II* gene and CKI1 gene specific primers. 3 out of the 4 transformants showed amplification of *npt II* band of expected size 750bp and 3700bp for the CKI1 gene. The results of the present study suggest that CKI1 gene may have a major role in perceiving endogenous cytokinin signals than the presence or absence of exogenous cytokinin per se.

M.Sc.

Title : Factors influencing somatic embryogenesis in mango (*Mangifera indica* L.) for application in genetic transformation (2005)

Subhasis Samanta, UAS, Bangalore, Guide : Dr.J.B.Mythili

Mango (*Mangifera indica* L.), the king of fruits, is a prized summer fruit crop of India and Asia. The use of conventional plant breeding approaches for mango improvement has largely been ineffective because of its long life cycle, allogamous and allotetraploid nature. The present investigation was carried out with the objectives of developing suitable and efficient protocols for regeneration through somatic embryogenesis and to study the feasibility of transformation of mango cv. Vellaikolumban using a reporter gene. Young fruits of 25-30 days of age was found to be ideal for culture initiation. Among the various media tried (MS, B5 and RO) for initial nucellar culture establishment, the best proliferation response was obtained in MS medium supplemented with 2.5 mg/l, 2, 4-D. Induction of somatic embryos from nucellar culture was optimized using B5 medium supplemented with 20% (v/v) coconut water and 250 mg/l of casein hydrolysate. Maturation of somatic embryos of 1.0-1.5 cm. length was obtained best in M3 medium composed of B5 salts, L-glutamine (400 mg/l) and ABA (1 mg/l). The faciation and necrosis of embryogenic cultures could be controlled through the use of salicylic acid at a concentration of 0.1 mg/l. Germination of mature somatic embryos with well-developed roots and shoots was achieved best in semi- solid medium (B5) supplemented with 3.0 mg/l GA₃. During Kanamycin sensitivity test, It was found that kanamycin at 200 mg/l inhibited regeneration totally in non co-cultivated embryogenic callus derived from nucellus. Among various stages of nucellar culture tried, it was found that embryogenic callus is amenable for transformation. Among various treatment tried, 150 µl acetosyringone activated bacterial culture and a period of 3 days co- cultivation was found to give highest percent transformation response (75%). The presence of transgene was confirmed by GUS assay.

M.Sc.

Title : Development of seedless grape hybrids through embryo rescue and their characterization using Molecular markers (2005)

K.P.Raghavendra, UAS, Bangalore, Guide : Dr.Leela Sahijram

Investigations on “Development of seedless grape hybrids through embryo rescue and their characterization using molecular markers” was carried out at the Indian Institute of Horticultural Research, Bangalore, from Aug 2004-Aug 2005. The main objectives of investigation were to carryout controlled crosses between cultivar Thompson Seedless and downy mildew resistant male parents, in ovulo/ ex ovulo embryo culture and molecular characterization to confirm hybridity using molecular markers. Crossing of cultivar Thompson seedless (TS) with downy mildew resistant male parents would be helpful in obtaining hybrids having characters desirable from both the grower's and the consumer's point of view. Using conventional breeding procedures, it is not possible to obtain hybrid progeny from seedless x seedless crosses. Besides, using the traditional method even seeded x seedless cross may produce only up to 10% seedless plants. Most seedless varieties are stenospermocarpic. Through *in vitro* methods it is possible to rescue the developing embryo before it aborts and seedless hybrid progeny can be obtained. In ovulo embryo culture prior to embryo abortion provides an attractive alternative to conventional method by allowing the recovery of hybrid from the otherwise abortive ovules of seedless x seedless or seedless x seeded crosses.

Molecular characterization to confirm the hybridity was done with ISSR marker. Each cross was found to have best time of ovule explanting at different week post pollination indicating that pollen donor parent and genotype also contribute to ovule and embryo formation rates. Two hundred and forty four hybrid plantlets were recovered from 1166 (20.96%) embryos cultured which were excised from 1402 ovules cultured. The utility of ISSR marker in determining hybridity of the progenies of crosses TS X SV 18402 and TS X SV 12309 has been successfully demonstrated. By employing embryo rescue technique hybrid plants have been obtained from various crosses involving Thompson Seedless' as female parent and 6 different downy mildew resistant male parents.

M.Sc.

Title : **Molecular studies in drought tolerance of banana** (2008)

N.Chandrashekar, UAS, Bangalore, Guide : Dr.K.V.Ravishankar

The present study examines the genetic variation in drought tolerance among AA and BB genomic groups of banana using two characteristics i.e., leaf water retention capacity and carbon discrimination and in this study AA genotypes recorded relatively higher water use efficiency than BB genotypes. BB genotypes had higher leaf water retention capacity (77.73%) compared to AA genotypes (69.3%). From earlier studies two contrasting genotypes, *M. acuminata* ssp *burmanicoides* commonly recognized as 'Calcutta-4' and 'Bee hee kela' BB were used for physiological and molecular studies during water stress. The per cent reduction in photosynthetic rate (PN) between control and stressed plants was 45.28% for 'Calcutta-4' and 36.01% for 'Bee hee kela', transpiration rate (E) was 30.24 (%) for 'Calcutta-4' and 22.36% for 'Bee hee kela', and stomatal conductance (gs) was 60.30% for 'Calcutta-4' and 56.1% for 'Bee hee kela', indicating BB genotypes are tolerant to water deficit conditions. Leaf water potential was higher in 'Bee hee kela' both in watered (-0.913MPa) and under stress (-1.518 MPa) situations when compared with 'Calcutta-4' (AA) control (-1.35 MPa) and stressed (-1.824 MPa) plants. Malondialdehyde content was estimated to be high in 'Calcutta-4' than that of 'Bee hee kela' indicating higher degree of membrane damage in Calcutta-4. The two antioxidant enzymes namely superoxide dismutase and catalase activities were found to be higher in 'Bee hee kela' stressed samples than 'Calcutta-4' indicating better oxidative damage with standing capacity. 'Bee hee kela' with higher water potential, gs and antioxidant enzyme (SOD and catalase) activities. 'Bee hee kela' genotype is more drought tolerant than 'Calucutta-4'. Gene expression study using selected gene primers and cDNA revealed that drought not only changes the expression pattern of drought inducible genes but also changes the expression levels of growth and metabolism related genes.

M.Sc.

Title : Identification of DNA markers linked to bacterial blight disease in pomegranate (2009)

K.N.Avinash, UAS, Bangalore, Guide : Dr.K.V.Ravishankar

Pomegranate (*Punica granatum* L.) is one of the oldest known edible fruit of tropical and subtropical regions belongs to the family Punicaceae. Bacterial blight caused by *Xanthomonas axonopodis* pv. *punicae* is one of the severe disease limiting crop yield and productivity thus, affecting the cultivation. In Indian Institute of Horticultural Research, Bangalore, attempts are being made to incorporate resistance to popular cultivars through plant breeding methods. 'Ganesh' is a popular variety (susceptible to bacterial blight disease) and 'Daru' which is a resistant genotypes are being used as parents in breeding programme. A total of 80 F₂ populations derived from a cross between 'Ganesh' and 'Daru' were used to identify molecular markers linked with the resistant trait. Initially we screened ISSR (Inter Simple Sequence Repeats), RAPD (Randomly Amplified Length Polymorphism), SRAP (Sequence Related Length Polymorphism), RGA (Resistance Gene Analogues) and a few designed primers for determining polymorphism among the contrasting genotypes. A total of 41 molecular markers, including 40 RAPD and one ISSR markers were selected. These primers were then used to amplify segregating F₂ s from cross 'Ganesh x Daru' to develop a preliminary linkage map in *Punica granatum* L. using Haldane mapping function. In linkage analysis, 35 markers were mapped on 8 linkage groups. The linkage map length varied from 3.3 cm to 39.8 cm. The map covered a total length of 146.3 cm with an average marker density of 24.38 cm between the two adjacent markers. The maximum number of markers, 8 were found on the linkage groups LG2 and LG6. This linkage map developed forms a basis for development of high density mapping in pomegranate. An attempt was also made to identify marker linked to resistance by following Bulk Segregant Analysis. The primer OPD11 amplified band of approximately 1kbp size in resistant bulk and resistant parent 'Daru'.

M.Sc.

Title : Development of seedless grape hybrids through Embryo rescue and confirmation of hybridity by Molecular markers (2009)

K.S.Bhaskara Reddy, UAS, Bangalore, Guide : Dr.Leela Sahijram

A study on development of seedless grape hybrids through embryo rescue and confirmation of hybridity by molecular markers was carried out with the objective of rescuing embryos in crosses involving Thompson seedless as the female parent and four downy mildew resistant lines (SV12309, SV23501, SV12364, SV18315) as the pollen parents, to identify hybrids resistant to downy mildew (fungal) pathogen *Plasmopara viticola* and to develop molecular markers for grape hybrids so generated. Using conventional breeding procedures, it is not possible to obtain hybrid progeny in grape crosses involving seedless (stenospermocarpic) female parents. Such crosses can, however, be salvaged using sequential embryo rescue and hybrids can be obtained. For culturing ovules, berries of various crosses were collected at 8, 9, 10 and 11 Weeks Post Pollination (WPP). Initiation of growth and maintenance of ovules was done on Emer and Ramming semi solid medium supplemented with casein hydrosylate (50 mg l^{-1}) + Myoinositol (50 mg l^{-1}) + L- cysteine (211.6 mg l^{-1})+morpholino ethane sulphonic acid (1000 mg l^{-1}). At 8 weeks from *in vitro* incubation, embryos were excised from ovules and sub-cultured on semi-solid Woody Plant Medium (WPM) supplemented with benzyl adenine (BA) @ 0.25 mg l^{-1} . In four to eight weeks, the embryos started germinating and subsequently developed into full-fledged plantlets in liquid medium. Hybrid plantlets were then transferred to polybags containing soilrite (75% peat moss + 25% perlite). A total of 122 hybrid plantlets were recovered from 955 embryos sub-cultured (which were excised from 1698 cultured ovules). The true hybrid nature of these hybrids was confirmed by using ISSR (UBC-807, UBC-817, UBC-825, UBC-828) markers.

M.Sc.

Title : Transformation of pomegranate with Antimicrobial peptide gene to confer resistance against bacterial blight and testing its expression (2009)

Nungshi Lepdon, UAS, Bangalore, Guide : Dr.Sukhada Mohandas

Pomegranate is a popular fruit crops and is of considerable economic importance. The bacterial blight of pomegranate is becoming a serious problem in major pomegranate growing area in India. All conventional ways and means of controlling this disease have been failed. In pomegranate, existing protocols have shown slow response on regeneration and less works has been reported on transformation works. Hence, in the present study, a systematic investigation was carried to standardize an efficient *in vitro* regeneration protocol from different explant of pomegranate cv. Bhagwa, find out the best treatment for faster regeneration and transforming it with AMP gene. As a result, a reliable and efficient regeneration and transformation protocol was standarised. *Agrobacterium tumefaciens* carrying gene pCAMBIA construct with the constitutive CaMV35S promoter, AMP gene terminator and nptII selectable marker (Kanamycin resistance), was used for transformation of explants. Putative transformants were identified on selection medium containing kanamycin at different concentration. Transgene insertion and expression at various levels were confirmed using PCR. Out of four putative transformants analyzed, three transgenic plants showed PCR +ve with AMP gene specific primer.

M.Sc.

Title : **Development of transgenic banana resistant to *Fusarium* wilt** (2010)

S.Pavithra, UAS, Bangalore, Guide : Dr.Sukhada Mohandas

Banana is one of the most important fruit crop, especially of the tropics. Banana cultivation and production are threatened by many pests and diseases. By far the most serious disease is *Fusarium* wilt which is caused by the soil borne hypomycete, *Fusarium oxysporum* f. sp. *cubense* (Foc). It is a serious disease, causing devastation of two important cultivars namely Rasbale AAB (syn. Rasthali) and Elakkibale AB (syn. Neypoovan) in Southern India. In the present study transgenic plants of both cultivars were developed by transformation with the antimicrobial peptide (AMP) gene cloned from onion seeds and with constructs developed in pCAMBIA 2301. Apical meristems from *in vitro* micropropagated plantlets were microwounded with naked gold particles, followed by co-cultivation with *Agrobacterium* with binary vector pCAMBIA 2301 having nptII (Neomycin phosphotransferase-II) as a selectable marker gene and AMP as a resistant gene. Transformants were rigorously selected on the selection medium (Genticin/G418 50 mg/l). The integration of AMP gene was confirmed by PCR and RT-PCR in cultivar Rasbale and by PCR technique in cultivar Elakkibale. Out of 11 putative transformants of Rasbale 4 transformants confirmed the integration of AMP gene by PCR and 2 by RT-PCR. In Elakkibale, out of 12 putative transformants 6 showed amplification of AMP gene by PCR analysis. Therefore, the method standardized in the present study can be successfully used for transformation of banana.

M.Sc.

Title : **Identification of Molecular markers linked to bacterial wilt in brinjal** (2010)

Subhada Pattanayak, UAS, Bangalore, Guide : Dr.C.Aswath

Eggplant is an important vegetable in India and is grown throughout the tropical, sub tropical and warm temperate regions of the world. Bacterial wilt caused by *Ralstonia solanacearum* is a severe soil borne vascular disease commonly occurring in the warm, humid tropics. An investigation was conducted to identify molecular markers linked to bacterial wilt resistance in brinjal in the F₂ mapping population developed by cross between a bacterial wilt resistant variety IIHR-7 with susceptible variety IIHR-108. 255 F₂ plants were phenotyped by artificial root infection with *Ralstonia solanacearum* L. (3:1) ratio of resistance susceptibility was observed in F₂ and the genetic ratio indicated the resistance trait controlled by a single dominant gene. 39 EST-SSRs, 119 genomic SSRs and 100 RAPDs were used to genotype parents, F₂ population through bulk segregant analysis (BSA). 29 genomic SSRs and 17 RAPDs had shown polymorphism in parental lines and were further used to screen the mapping population. No polymorphism was observed in the F₂ population. Thus, no marker linked to bacterial wilt resistance in brinjal was identified in the present F₂ population under study. Further, linkage analyses are to be performed to identify the genomic SSRs and RAPDs using more primers that are linked to the resistance trait in a larger population and integrated into a molecular marker assisted breeding programme of eggplant to breed bacterial wilt resistant varieties.

M.Sc.

Title : Genetic diversity analysis and DNA fingerprinting of tuberose (*Polianthes tuberosa* L.) (2010)

Khandagale Kiran Shahaji, UAS, Bangalore, Guide : Dr.C.As swath

Polianthes tuberosa, ($2n = 30$) which is native to Mexico, is one of the most important among the bulbous ornamental. Fifteen RAPD and twenty ISSR primers were used to assess genetic diversity among ten tuberose varieties. Both RAPD and ISSR primers revealed 53% and 73% polymorphism which generated 59 and 95 polymorphic markers respectively. Polymorphic Information Content and Resolving Power for RAPD was found to be ranging from 0.35 – 0.46; 0.8 – 3.6 respectively and that of ISSR was 0.36 – 0.49; 0.91 – 4.55 respectively. The dendrogram generated by UPGMA methodology using Jaccards co-efficient as distance matrix for RAPD and ISSR grouped the varieties into two major clusters and combined RAPD-ISSR cluster analysis grouped the 10 cultivars into 3 major clusters, which have been further grouped into sub-clusters based on their genetic relatedness/variation. The results of spatial arrangement of these 10 cultivars by Principal Component Analysis (PCA) using NTSys pc software were in congruent with earlier dendrogram analysis. Mantel's test indicated very good correlation with $r = 0.86$ for the combination of ISSR and RAPD-ISSR. To facilitate identification of tuberose cultivars, we developed a cultivar identification diagram (CID) in which seven ISSR loci can differentiate all ten cultivars taken in the study. Molecular fingerprints for five IHR released cultivars using 57 polymorphic loci generated by 11 ISSR primers. The sizes of these loci were ranging from 2.2kb to 252bp. These fingerprints can be used as standard reference source for quick cultivar identification.

M.Sc.

Title : Induction of somatic embryogeny activity in Pomegranate (*Punica granatum* L.) cultures of mature origin (2010)

A.S.Harsha, UAS, Bangalore, Guide : Dr.Leela Sahijram

A study on including somatic embryogenic activity in pomegranate was carried out by using explants of mature origin viz., petal, leaf and anthers/stamens and molecular profiling of the embryogenic callus issued from these explants was carried out by using RAPD markers with an objective objective to developing standardized protocol for regeneration of pomegranate, to develop cultivars resistant to bacterial blight pathogen (*Xanthomonas axonopodis* pv. *Punicae*). Using conventional breeding procedures, it is difficult to develop resistant cultivars due to time and space constraint. Hence, somatic embryogenesis offers viable protocols since it produces both root and shoots meristems necessary for complete plant growth. For inducing somatic embryos, explants of field origin were collected. Initiation of growth and maintenance of explants was done on MS and WPM semi-solid media. Callus initiation was seen after 3 and 8 weeks of inoculation from petal and leaf explants respectively and somatic embryos were obtained. Response of anthers/stamens was seen positively which produced embryogenic callus. Shoot apex formation was seen from petal and leaf derived embryogenic callus 22 weeks of inoculation. Callus issued from petal and anther was subjected for RAPD marker analysis. 12 different primers OPG -03 OPG -05 OPG -08 OPG- 13, OPG -16 OPG -18, OPI-01, OPI -03, OPI -10, OPI -12, OPI -14 and -18 screened revealed clear amplification between petal derived and another derived callus from which it was strongly believed that the another derived callus is of sporophytic origin.

M.Sc.

Title : Identification of DNA Marker Linked to Rus Resistance in French Bean (*Phaseolus vulgaris* L) (2010)

S.Soumya, UAS, Bangalore, Guide : Dr.K.V.Ravishankar

French bean is one of the most important leguminous vegetables grown for its tender pods either for fresh consumption or for processing as canned, frozen dried product. Diseases are one of the most important production constraints for the successful cultivation of beans. Among diseases, rust caused by *Uromyces appendiculatus* has become epidemic in bean growing areas. In this study, the investigation was carried out using three resistant (IIHR-79, IIHR-31 and Arka Anoop) and two susceptible (IIHR-55 and Arka Suvidha) parents along with F₂ segregants from cross IIHR-31 x IIHR-55, to identify marker linked to rust resistance. A total of ten SCAR primers available from literature (SK14, SA14, SI19, SBC6, SAD12, SAE19, UR11-GT2, KB126, SF10 and SBA8) were used for screening for contrasting parents. Out of ten selected SCAR markers, three *viz.*, SA14, SK14 and SF10 showed polymorphism between resistant and susceptible parents. For markers, SA14₈₀₀ and SK14₆₂₀ polymorphic band was observed between resistant parent IIHR-31 and susceptible parents (IIHR 55 and Arka Suvidha). Where as, for the marker SF10₁₀₇₂ polymorphic band was observed between resistant parent IIHR-79 and susceptible parents (IIHR 55 and Arka Suvidha). Identified markers SA14₈₀₀ and SK14₆₂₀ were again validated in segregated population of F₂ cross IIHR-31 x IIHR-55 by BSA method. Simultaneously, 350 RAPD markers were screened for polymorphism for rust resistance. Out of 350 markers, OPA041150 marker showed distinct polymorphism for rust resistance in bulks of F₂ segregants. But, the attempt made to convert it into a SCAR marker was not successful.

M.Sc.

Title : **Development of Molecular Marker for Pulp Colour in Guava (*Psidium Guajava* L.)** (2010)

Sheetal Nandgav, UAS, Bangalore, Guide : Dr.Pious Thomas

Guava (*Psidium guajava* L.) is a highly heterozygous perennial fruit tree with a long juvenile phase which comes in the way of crop improvement through breeding. Molecular markers provide a tool for early assessment of desired traits allowing considerable saving in time. Pink pulp colour in guava is a preferred trait over white colour which is imparted by lycopene. This study was taken up with the objective of developing molecular marker(s) for pink pulp colour in guava through PCR based approaches namely Random Amplified Polymorphic DNA (RAPD) and Inter Simple Sequence Repeat (ISSR) and the candidate lycopene gene sequence based-approach. In all, 64 RAPD primers were used in order to identify polymorphism that specifically to pink-pulp genotypes. The two genotypes each from white-pulp and two pink-pulp types were taken up for the initial biparental RAPD screening. The primers OPB 5, OPB 9, OPC 8 and OPH 9 yielded consistent results in repeated trials allowing the identification of white/pink pulp colour types. Twenty ISSR primers were employed in biparental screening of which one primer UBC 818 showed a polymorphic band. A set of 20 additional genotypes including 10 from red and 10 from white-pulp categories were used for validation of the short-listed RAPD primers and ISSR primer. The polymorphic bands did not seem working across all the genotypes of one or the other pulp category. In the candidate gene approach, three pairs of lycopene-gene targeting degenerate primers were designed using the lycopene β cyclase gene sequence information. Among the nine primer combinations tried, four of them (FP1/RP1, FP1/RP2, FP2/RP2 and FP3/RP1) yielded some polymorphic bands which proved promising for further detailed analysis.

M.Sc.

Title : **Stable integration and expression of chitinase in Transgenic tomato** (2010)

Shailesh Yadav, UAS, Bangalore, Guide : Dr.J.B.Mythili

Tomato is an important vegetable crop and various fungal diseases cause extensive yield losses. Conventional breeding for resistance to fungal diseases has met with limited success. Therefore transformation of crop plants with gene encoding pathogen cell wall degrading enzyme chitinase has been tried in various crops. The present study was carried out to identify homozygous line with stable and high transgene expression from primary transformants of tomato cv. Arka Vikas engineered with *Trichoderma harzianum chitinase* gene. 139 plants progenies of different 12 T₀ lines were screened by using both the partial length and full length gene specific primer of *T.harzianum chitinase* gene. 15 T₁ plants were short listed based on PDI, plant morphology, similarity to parent phenotype and visual disease symptoms and vigour for forwarding to T₂ generation. 20-25 seedlings of each individual T₁ line was raised and analysed for the presence of transgene. The Progeny of two T₁ homozygous lines viz., N3-5 and N8-4 did not segregate for the transgene in PCR analysis suggesting that they are homozygous lines. Gene expression analysis for chitinase was carried out in randomly chosen 2-3 plants from the progeny of two T₁ homozygous lines N3-5 and N8-4 and one T₁ heterozygous line N13-1 along with control through relative RT PCR(Multiplex RT PCR) using a 18 S as internal control. The chitinase gene expression in plants of two homozygous lines was 2.5 to 4.0 X more than that of hemizygous lines. The homozygous lines were also screened for disease expression by *in vitro* leaf bioassay as well as challenge inoculation with *Alternaria solani*. Disease incidence in the leaves in the form of leaf spot was less severe in homozygous transgenic line than control.

M.Sc.

Title : Development of transgenic tomato with *Polygalacturonase inhibitor protein gene constructs for Fungal resistance* (2011)

Chidanand Ullagaddi, UAS, Bangalore, Guide : Dr.J.B.Mythili

Tomato is one of the most widely grown vegetable in the world. However, great yield losses are reported due to various fungal diseases. In this study, polygalacturonase inhibitor protein (PGIP) has been identified as a suitable candidate for development of transgenics resistant to fungal diseases. PGIP acts by interfering with the metabolism of the pathogen and thus disable the ability of the pathogens to gain entry into the plant. Tomato cv. Arka Vikas was transformed with PGIP gene (derived from chilli) constructs in two different orientation for resistance to fungal pathogens especially *Alternaria solani*. In the first orientation, the transcription of PGIP gene and *nptII* gene were in opposite direction, while in orientation II, the transcription of PGIP gene and *nptII* gene were in the same direction. Differential response of the explants to the PGIP gene orientation was observed with higher (15.3%) regeneration of putative transformants upon transformation with PGIP (orientation II) as compared to (7.1%) putative transformants with PGIP(orientation I). The presence of transgene was confirmed through PCR and RT-PCR of PGIP gene. Preliminary results of *in vitro* bioassay for expression of resistance to *A. solani* did not reveal any significant difference in the expression between controls (untransformed) and transformed plants with PGIP gene. In another study the role of PGIP gene on improving the regeneration frequency was investigated by comparing transformation with PGIP gene with transformation with *Trichoderma harzianum*(Th) chitinase gene construct along with pCAMBIA 2300 vector with *nptII* gene (control vector).The results of the experiment revealed that transformation with PGIP gene construct resulted in highest (65.9%) of explants giving rise to shoot initiation, followed by transformation with control vector with (40.0%) explants giving rise to shoot initiation and the least (15.0%) responding explants was obtained upon transformation with Th chitinase gene construct.

M.Sc.

Title : **Studies on Somatic embryogenesis in Papaya cv. Surya with reference to Endophytic Bacteria** (2011)

Prabir Kumar Das, UAS, Bangalore, Guide : Dr.Pious Thomas

Papaya (*Carica papaya* L.) is an important fruit crop world over. Micro propagation of shoot buds approach has not been very successful for commercial propagation purpose. Feasibility of somatic embryogenesis from immature zygotic embryos is also suggested in papaya. A protocol has now been optimized for somatic embryogenesis from immature zygotic embryos of papaya cv. Surya. Immature zygotic embryos were established on half-strength MS medium with supplements (MS vitamins, 6 per cent sucrose, 10 mg l⁻¹ 2, 4-D, 400 mg l⁻¹ glutamine and 0.8 per cent agar (pH 5.7) giving high frequency and repetitive embryogenesis after 3-4 subculture passages. Continuous proliferation of somatic embryos was achieved on maturation and regeneration medium containing half-strength MS constituents, 3 per cent sucrose, 400 mg l⁻¹ glutamine, 0.2 mg l⁻¹ BAP and 0.1 mg l⁻¹ NAA and 0.8 per cent agar. Medium containing a combination of 0.5 mg l⁻¹ IAA and 0.5 mg l⁻¹ IBA was ideal for root development. Endophytes are generally known to originate from the rhizosphere or phyllosphere and seeds are generally considered to be free from endophytes. Tissue and medium indexing on visibly clean embryogenic cultures initiated from immature seeds showed the association of cultivable bacteria in a small section (1.4 per cent) of cultures after three subculture passages. One bacterium was isolated from such cultures, which is identified as *Brachybacterium rhamnosum* based on 16S rRNA gene sequence homology analysis. PCR-screening of visibly clean and index negative cultures using universal bacterial 16S rRNA gene primers indicated the presence of non-cultivable bacteria in index-negative cultures. This was confirmed by microscopy of tissue homogenate revealing viable bacteria in considerable number.

M.Sc.,

Title : **Development of transgenic pomegranate cv. Bhagwa for bacterial blight (2011)**

H.G.Swetha, UAS, Bangalore, Guide : Dr.Sukhada Mohandas

Pomegranate is an economically important species of the tropical and subtropical regions of the world, due to its delicious edible fruits, pharmaceutical and ornamental usage. Pomegranate cultivation and production are threatened by many pests and diseases. By far the most serious disease is bacterial blight which is caused by the air borne bacteria *Xanthomonas axanopodis* pv.*punicae*. It is a serious disease, causing devastation in the pomegranate growing areas. In the present study transgenic pomegranate plants of variety Bhagwa were developed by transformation with the antimicrobial peptide (AMP) gene cloned from onion seeds and with constructs developed in pCAMBIA 2301. Explants like nodes, leaf, petals and cotyledons from polyhouse were micropropagated in different combination of hormones and the *in vitro* plantlets were co-cultivated with *Agrobacterium* with binary vector pCAMBIA 2301 having nptII (Neomycin phosphotransferase-II) as a selectable marker gene and AMP as a resistant gene. Transformants were rigorously selected on the selection medium (kanamycin 100 mg/l). The integration of AMP gene was confirmed by PCR. Out of 4 putative transformants 3 transformants confirmed the integration of AMP gene by PCR. In nodes, out of 2 putative transformants 1 showed amplification of AMP gene by PCR analysis. Therefore, the method standardized in the present study can be successfully used for transformation of Pomegranate.

M.Sc.

Title : Co-Transformation of Tomato cv. Arka Vikas with Chitinase and *Pgip* Genes for Enhanced Resistance to Early and Late Blight Pathogens (2012)

C.Guruprasad, UAS, Bangalore, Guide : Dr.J.B.Mythili

Tomato is one of the most widely grown vegetable in the world. Diseases are important economic factors limiting its production. Tomato is a host to many of the diseases and is majorly affected by blights (early and late) caused by *Alternaria solani* and *Phytophthora infestans* respectively. Genetic engineering approach to develop fungal resistant tomato using a single antifungal gene has met with limited success. Therefore, multiple gene transfer approach through co-transformation of two antifungal genes viz., polygalacturonase inhibitor protein (PGIP) and chitinase with different mode of action has been used in this study as a powerful approach to enhance the fungal disease resistance in tomato in comparison to transformants obtained with either PGIP or chitinase gene. Three different gene constructs were used in this study viz., pCAMBIA2300 containing PGIP gene isolated from chilli along with *nptII* gene as selectable marker, Chitinase gene isolated from *Trichoderma harzianum* in pBIN and pCAMBIA vector with *nptII* and *hptII* gene as selectable marker respectively. Transformation with single gene (either chitinase or PGIP) gave rise to significantly higher transformation efficiency of 20% and 80% respectively as compared to co-transformation with both the genes which gave a co-transformation efficiency of 6.2%. Out of 16 co-transformants regenerated, 7 and 1 plants tested positive for the presence of PGIP and chitinase gene respectively and 1 plant tested positive for both the genes. Transformants were obtained only when the gene constructs were used with *nptII* as a selectable marker, Selection with hygromycin adversely affected the regeneration of transformants. *In vitro* bioassay against early and late blight pathogens were carried out only for transgenic plants with single gene and not for the co-transformants. Transgenic plants with single gene (chitinase or PGIP) have shown resistance against early and late blight pathogens.

M.Sc.

Title : Development of Transgenic Pomegranate with Disease Resistant Gene for Control of Bacterial Blight (2012)

M.H.Akshata, UAS, Bangalore, Guide : Dr.Sukhada Mohandas

Pomegranate (*Punica granatum* L.) is an economically important species of the tropical and subtropical regions of the world due to its delicious edible fruits, pharmaceutical and ornamental usage. The bacterial blight of pomegranate is becoming a burning problem in major pomegranate growing areas in India. As the causal organism is air borne, the conventional ways and means of controlling this disease have failed. Evolving a resistant genotype using resistant variety through conventional breeding may be a way out but it is a time consuming process. Transgenic approach appears to be promising to minimize the losses caused by disease. In the present investigation efficient protocols were developed to get healthy and well-formed plants from juvenile and mature-origin explants of the pomegranate cv. 'Bhagwa' and transformants with PFLP gene. Different treatment combinations of hormonal concentrations were taken for leaf, petal, nodes and cotyledonary explants to standardize an efficient *in vitro* regeneration protocol and find out the best treatment for faster regeneration. *Agrobacterium tumefaciens* carrying gene pCAMBIA construct with the constitutive CaMV35S promoter, PFLP gene, terminator and *nptII* selectable marker (Kanamycin resistance), was used for transformation of explants. Putative transformants were identified on selection medium containing kanamycin at different concentration. Integration of transgene and expression at various levels were confirmed using PCR. Out of 4 putative transformants analyzed, 3 plants showed amplification for PFLP gene specific primer and further screening is going on using different molecular techniques.

SECTION OF MEDICINAL & AROMATIC CROPS.

Ph.D

Title : **Pachytene analysis, interspecific hybridization and response to chromosomal boubling in two steroids-bearing *Solanum species-Solanum viraum* Dunal (1983)**

D.L.Maheswar, UAS, Bangalore, Guide : Dr.R.Krishnan

In steroids-bearing *Solanum viraum* Dunal (Syn. *Khasianum* var. *Chatterjeeanum*) upgradation of solasodine content in berries and incorporation of resistance to wilt are major breeding objectives. Towards the former goal, autotetraploidy holds promise. Steroids-bearing *Solanum mammosum* Linn. could be a donor for genes conferring wilt resistance. The thesis provides cytogenetic basis for the above objectives through-cytomorphological study of induced autotetraploids in *S. viraum* and study of interrelationship of *S. viraum* and *S. mammosum* based on crossability, comparative pachytene karyology and homology (in interspecific hybrid), response to chromosomal doubling and distribution of leaf flavonoids. All the 12 differentiated pachytene chromosomes of haploid complement of *S. viraum* (n=12) were identified and characterized. They differ from the undifferentiated pachytene bivalents of *S. mammosum* (n=11) which have uniformly stained chromosomes along their entire length. Induced autotetraploids of *S. viraum* contain higher content of solasodine in berries (2.16%) than diploids (1.83%) with nearly normal meiosis. Diploids of *S. mammosum* and *S. viraum* were crossed successfully unidirectionally with former as pistillate parent. Reciprocal cross and crosses with reciprocal species grafts and induced autotetraploids (within and across ploidy) failed. Differential response to autotetraploidy between *S. viraum* and *S. mammosum* was evident in morphological and yield attributes as well as in meiotic behavior *S. mammosum* autotetraploids showed poor fruit set and high meiotic abnormalities. The results support potential value of autotetraploidy in *S. viraum* and provide comprehensive informations on species inter-relationships and underlying barriers to gene transfer in the two species.

Ph.D

Title : Evaluation of diploids and induced autotetraploids of *Solanum viarum* Dunal for effects of growth regulators, single plant progeny yields and chromosome number dunal (1984)

P.R.Ramanjini Gowda, UAS, Bangalore, Guide : Dr.R.Krishnan

A programme on the evaluation of induced autotetraploid varieties in *Solanum viarum* Dunal for three aspects, namely: (i) Effects of Growth Regulators, (ii) Evaluation of Single Plant Progenies, and (iii) Cytomorphic study of C₃ generation plants. Effects of GA₃ (250, 500 and 1000 ppm), CCC (400, 800 and 1600 ppm) and kinetin (25, 50 and 100 ppm) applied at 45 and 75 days on field planted diploids and autotetraploid were studied. Dry berry yield per plant in diploid and tetraploid was reduced in all treatments. Solasodine content was increased in diploid in 250 ppm GA₃ and in tetraploid in 250 and 1000 ppm GA₃, 1600 ppm CCC and 50 ppm Kinetin treatments. Single plant Progenies of 17 diploids and 18 C₂ generation autotetraploid were evaluated Six autotetraploid lines were on par with the high (dry) berry yielding diploids. Autotetraploids excelled in berries per node, berry wall weight and 100 seed weight. They were inferior to diploids in dry weight perberry, seed number and weight per berry. Autotetraploids produced adequate seeds (12,571 to 1,16,127 per plant) to permit their propagation on a commercial scale. Significant positive association between number of berry bearing nodes per plant and number of berries per node was unique to autotetraploids that permit simultaneous improvement in these components of total berry yield. The presence of aneuploids with 2n=46, 47, 49 and 50 was detected for the first time, which offer direct proof for transmission of gametes with 23 and 25 chromosomes. Chromosomes association in euploids and aneuploids consisted predominantly of quadrivalents (four to nine) and bivalents (4 to 14), besides trivalents (0 to 2) and univalent (0 to 4). Presence of hexavalent and pentavalents in euploids (2n=48) and aneuploids provide direct proof for participation of gametes with unbalanced chromosomal constitution. Among 15 different types of chromosomal distribution to gametes, n=24 was predominant (57.37%), favouring promotion of euploids (2n=48) in progenies. Seed number per berry was identified as criterion for distinguishing tetraploids from aneuploids in the field.

Ph.D

Title : **Intervarietal hybridization and induction in autotetraploids in steroid-bearing *Solanum* species** (1984)

D.Nandakumar, UAS, Bangalore, Guide : Dr.R.Krishnan

Solanum viarum Dunal (syn. *S. khasianum* Clarke var. *Chatterjeeanum*) is commercially exploited in India for preparation of steroid drugs. *Solanum incanum* Linn, an indigenous species, has similar potential. The thesis presents results of investigation on intervarietal hybridization in both these species and induction of autotetraploids in *S. viarum*. Intervarietal hybridization in *S. viarum* is reported for the first time and involved three morphologically different types. Using generation mean analysis, the mode of gene action was studied for solasodine yield, solasodine content, berry yield and its components and leaf spininess. Significant differences were observed for number of berries per node, fresh and dry berry weight, dry matter in berries and number of spines per leaf. In view of the predominance of epistatic gene action for all these characters and the presence of additive and/or dominant gene action in them, reciprocal recurrent selection is suggested for improvement of this crop. Linear association of characters was also studied. A useful new recombinant combining high berry yield and solasodine content with fewer spines was isolated. Autotetraploids were induced in the three parents, their hybrids and backcrosses using colchicine. The production of less spiny autotetraploids is reported for the first time. Delayed flowering of autotetraploids could be partly traceable to delayed branching and protracted vegetative phase. A comparative study of diploid progenitors and their autotetraploids showed that differences in specific leaf weight, pollen fertility. Pollen size and hundred seed weight constituted diagnostic characters for identification of autotetraploids. Character interrelations were not altered by chromosomal doubling. In *S.incanam* intervarietal hybridization generated marked variability. Mode of inheritance of contrasting characters of parents such as stem, spine, flower and fruit colours was elucidated based on the study of parents, F₁,F₂ and backcross generations. Solasodine content in *S.incanum* unlike *S. viarum* increased with berry maturity.

Ph.D

Title : Growth analysis and nitrogen uptake studies on autotetraploids and diploids of *Solanum viarum* Dunal (1984)

G.Sreekantan Nair, UAS, Bangalore, Guide : Dr.R.Krishnan

Induced autotetraploids of *Solanum.viarum* (syn. *S. khasianum* Clarke var Chatterjeeanum) excel diploids in solasodine content in berries and constitute the only successful means of enhancement of solasodine content. In the present study the prospects of autotetraploids as commercial varieties was evaluated in two experiments. A total of 51 characters which included solasodine content, berry yield, its components, morphological characters and growth parameters were studied. In the first experiment three autotetraploids (differing in spine characters), their diploid progenitors and four promising varieties were compared. The three autotetraploids proved superior to diploids in solasodine content and were on par in berry (dry and fresh) and solasodine yields as well as most of the morphological and growth characters. Yield architecture differed in the two ploidy groups. Higher expression in number of fruits per node, berry wall weight, 100 seed weight and seed volume characterized tetraploids. Superiority in berry dry weight, dry matter, seed weight and seed number marked diploids. These characters, besides slow initial growth in tetraploids in distinguishing diploids and autotetraploids. In the second experiment, response of less spiny diploid and its autotetraploids to added nitrogen (@0, 30, 60 and 120 kg/ha) was assessed. Diploid and autotetraploid responded similarly and favourably in most of the characters including berry yield with increasing doses of nitrogen solasodine content also recorded increase with higher nitrogen doses in autotetraploids but decreased in diploid. Consequent to simultaneous increase in berry yield and solasodine content, autotetraploid recorded six fold increases in solasodine yield at 120 kg N as compared to control. The experiments demonstrated the superiority of autotetraploids over diploids in solasodine content and response to added nitrogen besides parity in berry yields.

Ph.D

Title : Progeny performance and microsporogenesis in eutetraploids and aneuploids of *Solanum viarum* Dunal (1987)

K.Lila Mathew, UAS, Bangalore, Guide : Dr.R.Krishnan

Evaluation of progenies of C₃ generation eutetraploids and aneuploids for solasodine content, berry yield and other characters, and comparative study of male gametophytic development of diploids, induced eutetraploids and aneuploids was carried out in *Solanum viarum* syn. *S. khasianum* var. *Chatterjeeanum*). Progenies of ten eutetraploids and 13 aneuploids were evaluated for their performance as parents and to estimate frequency of aneuploids in populations. Despite a wide range, solasodine content in eutetraploid and aneuploid lines was on par. Similarly for dry berry yield (economic character) and vegetative/reproductive characters, aneuploidy and eutetraploid were on par. Despite differences in chromosome number, eutetraploids and aneuploids appear to perform similarly as parents. Linear association among 22 characters was worked out. Solasodine content was not correlated with any character. Thirteen characters, associated with dry berry yield accounted for 99.5% of variation. The study of histological changes associated with microsporogenesis and male gametophyte development revealed an overall similarity among diploids, eu-and aneuploids. Differences were observed for cell size. RNA and starch accumulation. Excessive accumulation of starch in wall layers of eu-and aneuploidy anthers is also indicative that non-utilization, than non-availability of nutrients underlies the sterility of eutetraploids and aneuploids.

Ph.D

Title : Evaluation of plant densities and single plant progeny of less spiny diploid and advanced generation induced autotetraploids of *Solanum viarum*. Dunal (1988)

G.Subbi Reddy, UAS, Bangalore, Guide : Dr.R.Krishnan

In *Solanum viarum* (syn.S. khasianum var. chatterjeeanum) a spiny species in which berries are supplementary industrial source of steroids in India, previous studies on development of less spiny diploid and induced autotetraploids paved the way for realization of higher berry and solasodine yields adopting higher plant densities and scope for selection among diploid and autotetraploid progenies. In the present study, evaluation of (i) diploid and autotetraploids under a wide range of plant densities and (ii) single plant progenies of diploid and C₆ generation autotetraploid for berry yield, its components, morphological characters and/or solasodine content was undertaken. Evaluation of diploid and autotetraploids for plant densities was carried out in two experiments. In the first experiment where nine spacing combinations of 60,90 and 120 cm row/plant spacings with population ranging from 6900 to 27,300 plant per hectare were evaluated, favourable effects of higher plant densities on berry and solasodine yields were observed. Rectangular spacing gave higher berry yields than square spacing. Solasodine content in berries was not affected by plant density differences. Rectangular spacing of 60 x 120 cm with wider spacing in East-West direction is suggested as optimal for realization of higher berry and solasodine yields without hindering cultural and harvesting operations. This spacing accommodates 14,000 plants per hectare as against 7000 plants in commercially adopted 90 x 150 cm spacing.

In the second experiment on plant density evaluation, three plant densities of 17789,27778 and 49382/ha arising from square spacings of 75,60 and 45 cm, respectively, were compared. Berry and solasodine yields in both ploidy types increased with closer spacing but solasodine content was not affected. High density planting appears to be suitable for seed crop. The second experiment also brought out the spacing for practicing selection in diploid and C₆ generation autotetraploid for berry yield components. Seed fertility was not improved with advancing generation. In addition to confirmation of several morphological, physiological and berry yield characters for distinguishing diploid from autotetraploid, leaf transpiration and leaf temperature were the new characters identified. Character interrelationships were affected by plant density and diploid differed from autotetraploid.

Ph.D

Title : **Studies on hybridization, chromosomal boubling, grafting and leaf anatomy in *Coleus forkohlii* Brig.** (1993)

K.M.Naniah, UAS, Bangalore, Guide : Dr.R.Krishnan

In *Coleus forkohlii* Brig., an important medicinal plant both in Ayurvedic and modern medicines, four experiments were conducted at IIHR, Bangalore. In the first experiment, varietal crosses involving all three possible combinations among crossability, reciprocity and heterotic effects. Fifteen inter varietal hybrids were evaluated both as seedlings and after vegetative propagation. Hybrids of tuberous accessions exhibited positive heterobeltiosis for morphological and yield characters. In crosses involving tuberous x non-tuberous and non- tuberous x non- tuberous accessions, both positive and negative heterobeltiosis was observed for these characters. Hybrids AB and DA which combine higher harvest index and tuber yield hold promise for commercial utilization. In the second experiment autotetraploids were induced in three tuberous and three non- tuberous accessions using aqueous colchicine solution. Visual differences in leaf size and thickness increase in size of pollen grains and pollen sterility aided in identification of tetraploids. Autotetraploids and their diploid progenitors were evaluated both in pot and field. Field grown plants ere vigorous. Ploidy differences in the expression of tuber characters were similar in pot and field grown plants. In diploid and induced autotetraploid of accession 'K' graded does of potassium failed to evoke response in dry matter production and other characters probably due to the high levels of native potash in soils. In the third experiment, graft compatibility of six tuberous and four non- tuberous accessions was assessed through reciprocal grafts in a total of 45 graft combinations. Graft take differed in different accessions. Stock-scion interaction was observed in the expression of various characters including tuberization. The profusely flowering non- tuberous accession 'E' hold promise as stock in studies on induction of flowering in non0flowering agronomically superior tuberous types. In the fourth experiment and comparative of leaf anatomy in accessions, tetraploids and hybrids, differences in relative abundance and distribution of starch grains in the mesophyll tissues were observed. Genetic control in the expression of these characters is reduced

Ph.D

Title : **Intervarietal hybridization and autotetraploidy in *Coleus forskohlii* Briq.**
(1993)

Prakash, UAS, Bangalore, Guide : Dr.R.Krishnan

In *Coleus forskohlii* Briq., an important plant, four experiments were conducted at IIHR, Bangalore. In the first experiment, through controlled pollination, two hybrids *viz.*, DXC and DXI; a double cross involving AXD and AsXC hybrids and a back cross to male parent of the cross AsXB were produced and evaluated. In the second experiment, in order to broaden the genetic base for autotetraploidy breeding, autotetraploids were induced in an accession G, and three hybrids, HXB, HXC and AXG using aqueous colchicine solution. Autotetraploids were identified based on pollen size and fertility. Autotetraploids were inferior to their diploid progenitors in the expression of several morphological, growth and yield characters. In the third experiment, an interploidy cross was produced by crossing autotetraploid of A with diploid A. the only plant obtained was morphologically distinct from either parent. In the fourth experiment, a comparative evaluation of 19 diploid and 22 induced autotetraploids of accession/intervarietal hybrids with standard check K as control was carried out both under pot and field conditions. Genotypic differences among the entries are obtained. Hybrids DxA under pot; AXB and CXA under field conditions exhibited standard heterosis for tuber yield to the extent of 25.5, 79.19 and 64.18%. these hybrids can be promoted as cultivars as the crop is vegetatively propagated. In pot experiment, AsXD, CXA, DXA, AxB4n, AsXD4n, and DXE4n and in field experiment, CXA, DXA, DXA4n, and KXA4n exhibited high standard heterosis values for harvest index over standard control. Genetic analysis of various characters showed a high heritability for most of the characters. Path co-efficient analysis brought out the positive or negative direct and indirect effects of five characters on dry weight of tubers/roots. The number of tubers/roots had very high direct and positive effect on yield without appreciable antagonistic indirect effects through the characters.

Ph.D

Title : Studies on fertility, storage and microsporogenesis in diploids and induced autotetraploids of *Catharathus roseus* L. (G) Don (1993)

N.Swami Rao, UAS, Bangalore, Guide : Dr.R.Krishnan

In *Cathranthus roseus* L (G) don, two experiments were conducted at IIHR (i) Pollen productivity, storage and fungicidal sensitivity. The ten single plant selections differed for or more morphological character such as root yield, fruit and seed characters. Average female fertility ranged from 74.7 to 98.5% and pollen productivity anther from 18133 to 330453. Protocol was worked out for in vitro pollen germination. 20% sucrose gave 100% germination. Pollen tube length variations had no relation with seed germination. Pollen stored in liquid nitrogen for 240 days gave very poor *in vitro* germination and that too in only seven selections. Stored pollen size was smaller than fresh pollen, but pollen size was not related *in vitro* germinability of stored pollen. Among the six fungicides, Dithane Z-78 at lower concentrations did not affect pollen germination, but Sulfex and Captan inhibited germination. Bavistin at lower concentration improved germination. A close relationship was observed between pollen tube growth the pollen germination. Autotetraploids (4n) induced by treating seeds with 0.2% colchicine for 12 hours were identified bases on larger pollen size and reduced fertility. Root dry weight of 4n was higher than diploids (2n). Pollen productivity in 4n was lower than 2n. Stainability and *in vitro* germinability of 4n pollen was not related. In vitro pollen germination was lower in 4n. Pollen tube growth in 2n excelled 4n. In 4n ovules/ovary, seeds/follicle and follicles/branch were lower than 2n. (ii) Microsporogenesis and male gametophyte development in diploid and induced autotetraploids. The histological and histichemical changes during microsporogenesis in 2n and 4n were similar. But differences were observed in the size of various tissues. Pollen size and individual cell size were larger in 4n than in 2n. Reduction in the number of dyads and tetrads, PCM's and pollen grains was observed in 4n as compared to 2n. Polysaccharide content was similar in diploid and autotetraploids during microsporogenesis.

Ph.D

Title : Evaluation of less spiny diploid and autotetraploids varieties of *Solanum viarum* Dunal and genetics of spine character (1993)

M.Lakshmi Narayana Reddy, UAS, Bangalore, Guide : Dr.R.Krishnan

Five experiments were conducted using less spiny diploid (Arka Sanjeevini) and/or induced autotetraploid (Arka Mahima) varieties. Yield performance of Arka Sanjeevini was evaluated using five selected plant spacing viz., 30x30, 15x60, 30x120 and 60x120 cm with 90x150 cm control at three locations i.e., V.N. Pura, Solur and IIHR farms. The soil type in the three farms were sandy loan, sandy clay loam and sandy clay. Based on mean dry berry yield the three locations can be classified in descending order as IIHR>Solur> V.N.Pura. yield stability analysis using Finlay and Wilkinson method (1963) suggest suitability of 30x30 cm for sandy clay soils with high input facility. For adverse environments spacing of 30x120 cm is suitable. For locations, where data on soil type and other conditions are not available, 30x60 and 15x60 cm spacings are suitable. Diploids (Arka Sanjeevini) and autotetraploid (Arka Mahima) varieties were evaluated under 16 different planting density and/or arrangements resulting from combinations of 15,30,60 and 90 cm row and plant spacings. Planting densities ranged from 12,300 to 4,44,000 plants per hectare, Dry berry yield in diploid ranged from 2,589 to 6,716 kg per hectare. While in tetraploid from 1032 to 2,953 kg. berry yield under square planting increased with increasing planning densities. In diploid in the six rectangular spacings, berry yield plotted against increasing planning densities was bimodal in wider East-West spacings, unimodel when North-South spacings were wider. In autotetraploid reverse pattern was detected. Berry yield differences among planting arrangements were evident on comparisons across spacing treatments. Redundancy in planting densities on yield was observed in both the ploid types. On this basis, 15x90 cm spacing proved promising over 30x30 and 15-60 cm spacing for achieving higher yields. Yield performance of Arka Sanjeevini and Arka Mahima across season was assessed. Highest dry berry yield was recorded in November planting of diploid and June planting of autotetraploid. Yield disparity between the two ploidy types was narrower in June planting. Diploid was more stable than autotetraploid for berry yield across seasons. Yield variations in autotetraploid across planting dates are traced to variations in berry number and dry matter percentage in berries. Autotetraploid also showed wider variations in seed weight and seed number per berry than diploid.

Ph.D

Title : Studies on germplasm evaluation, induced autotetraploidy and hybridization in *Coleus forskohlii* (willd) Briq. (Syn.C. *Barbatus benth.*) (1993)

Laxminarayan Hegde, UAS, Bangalore, Guide : Dr.R.Krishnan

Roots of *Coleus forskohlii* (Lamiaceae) yields forskolin used in the treatment of glaucoma, congestive cardiomyopathy and certain cancers. Experiments were conducted at the central farm of IIHR, Bangalore, on (i) the evaluation of varietal collections (ii) induction and evaluation of autotetraploids with a broad genetic base, and (iii) Production and evaluation of intervarietal hybrids using diverse genotypes. Thirteen collections were evaluated in three trials for 30 morphological, growth and yield characters. Wide genetic variability was observed for all characters. Metroglyph analysis enabled classification of tuberous and non-tuberous accessions based on number of leaves and branches. Promising accessions identified were: 'K' for tuber yield. 'D' for harvest index and photosynthetic efficiency (by virtue of lower LAD-TDM ratio): 'G' and I for high total dry matter per plant. Varietal differences in crop duration among tuberous collections were observed. The observed high positive correlation between root volume and fresh weight of roots vs dry weight of roots (economic yield), could be exploited for screening accessions for high dry tuber yield. Genetic analysis indicated additive genic control of harvest index, fresh weight of roots and total dry matter by virtue of their high heritability and genetic advance (% of mean) values. For induction of autotetraploids, seed and shoot apex treatment methods using aqueous colchicine (0.1 or 0.25%) were standardized in three tuberous and three non-tuberous accessions. These accessions differed in the expression of characters on chromosomal doubling. The autotetraploids 'K' has potential use as cultivar, while other autotetraploids can be used as parents for production of triploids. Intervarietal hybridization using tuberous and non-tuberous accessions revealed lack of crossability barriers. Heterobeltiosis for economic character viz., tuber yield was observed in two of the hybrids involving tuberous accessions, viz., $A_s \times B$ and $A_s \times D$. None of the hybrids involving crosses between tuberous and non-tuberous accessions were promising for tuber yield. Hybrids of $A_s \times G$ and $A_s \times I$ were on par in dry matter production with the male parents, which are the highest dry matter producing accessions.

Ph.D

Title : Effect of planting density, mepiquat chloride, mode of pollination and or selection methods in diploid and colchiploid of *Solanum viarum* Dunal. (1998)

K.N.Srinivasappa, UAS, Bangalore, Guide : Dr.R.Krishnan

In steroid-bearing *Solanum viarum* Dunal. Using diploid (Arka Sanjeevini) and C11 generation induced autotetraploid (Arka Mahima), four experiments were conducted. In the first experiment on the effect of three planting densities, the highest dry berry yield of 9.95 tonnes/ha was obtained for diploid under the highest planting density obtained from adoption of 30 x 30 cm spacing. Among the berry yield components, number of berries per plant increased with decreasing planting densities but dry weight per berry was not affected. Diploid and autotetraploid responded differently to the different spacings adopted in the expression of several morphological and yield characters. In the second experiment, the effect of nine treatment combinations of Mepiquat chloride on the growth and yield characters of diploid and autotetraploid was evaluated. Interploidy differences in character response to MC application was evident in several growth and yield characters. No beneficial effect of MC treatments was recorded in both ploid types. In the third experiment on female fertility, mode of pollination was found to affect seed number per berry and seed germinability. Higher seed set and germination were obtained in berries from open pollinated flowers followed by berries from flowers selfed with and without emasculaton. Inter-plant crosses involving one or two artificial pollinations recorded least number of seeds per berry. In the fourth experiment, evaluation of source population of autotetraploid revealed wide variation for morphological, growth and yield characters. Progeny testing using both single plant and bulk seeds showed that, as a selection method single plant selection (SPS) was more effective than bulking for improving higher fresh berry yield per plant and seed yield per plant. Contributing characters for higher fresh berry yield in SPS were number of berry-bearing nodes/plant and number of berries/plant.

M.Sc.

Title : Studies on induced autotetraploids of *Solanum viarum* and *Solanum mammosum* and Somatic chromosomes of their diploid progenitors (1986)

B.K.Kumaraswami, UAS, Bangalore, Guide : Dr.R.Krishnan

Evaluation of induced autotetraploids was carried out in *Solanum viarum* and *S. mammosum*. In the first experiment, 14 C₅ generation induced autotetraploids of 'Glaxo' variety were compared for 31 characters relating to morphology, growth and berry yield with their diploid progenitor and four diploid, less spiny lines developed at IIHR. Varietal differences were observed for 17 characters. The four diploid IIHR entries exhibited parity with 'Glaxo' variety in dry berry yield and its components, absence of spines on stem and petiole and seed production potential. But they excelled 'Glaxo' variety by virtue of fewer vestigial curved (laminary) spines unlike straight well developed spines of 'Glaxo'. The presence of early maturing autotetraploid is a significant observation for which *S. mammosum* autotetraploid differed from those of *S. viarum*. Intra – plant variation for berry size in autotetraploid of *S. mammosum* was also seen and it could be due to the presence of aneuploids as in the case of *S. viarum* autotetraploid. C₂ autotetraploid of *S. mammosum* were inferior for stem diameter, berry volume, length and diameter, berry wall weight, seed weight per berry, dry weight and number of seeds per berry. Somatic chromosomes of *S. mammosum* were studied for the first time and their number confirmed as 2n=22. A somatic chromosome of *S. viarum* was also studied. In chromatin contented. This confirmed our earlier studies on pachytene karyology and homology.

M.Sc.

Title : Floral biology and seed character in diploids and induced autotetraploids of *Solanum viarum* (1986)

B.Sridhar, UAS, Bangalore, Guide : Dr.R.Krishnan

Studies on floral biology of diploids and Induced autotetraploids, and seed characters of diploids, autotetraploids and aneuploids were carried out in *Solanum viarum*, Dunal. In floral biology studies, time of anthesis, time of another dehiscence, pollen production, in vivo pollen germinability, pollen fertility, pollen shape, pollen tube growth, stigma receptivity and crossability across ploidy and species levels of diploid and autotetraploid, were compared. In both diploid and autotetraploids, anthesis was delayed in tetraploid. Pollen production in autotetraploids of wild, Glaxo and IIHR varieties was lesser than diploid progenitors, but not in BARC autotetraploids. Seeds of diploid, euploids and aneuploids of *S. viarum* fractioned into six categories using five concentration of common salt solution were compared for their number, percentage contribution to total seed number, seed diameter, hundred seed weight and seed germinability. Differences were observed among diploids, euploids and aneuploids.

M.Sc.

Title : **Studies on *Coleus forskhlii*** (1997)

M.Ravi Kumar, UAS, Bangalore, Guide : Dr.R.Krishnan

In the endangered forskolin-yielding *Coleus forskhlii* Briq. Three experiments were conducted at the IIHR, Bangalore. In the first experiment promising F₁ hybrids exhibiting standard heterosis were evaluated for their yield potential and rate of propagation. Yield evaluation of F₁ hybrids AB and CA against standard check K was carried out at three planting densities of 27, 778, 17,778 and 12,346 plants per hectare. Fresh tuber yield increased with planting density. F₁ hybrids out yielded standard control to the extent of 70.50% (AB) and 62.30% (CA). Variety x spacing interaction was observed. In the second trial under the same experiment establishment of terminal, middle and basal cuttings of three F₁ hybrids (AB, CA & DA) was compared with standard control K. Varietal differences were observed for sprouting in basal and middle cuttings. In the second experiment hybrids and backcross resulting from hybridisation between non-tuberous and tuberous parents were evaluated for agronomic characters as well as root histochemistry. The high dry matter productivity of the non-tuberous parent was shared by both F₁ and backcross. The comparative anatomical and histochemical studies in the above material brought out differences in the content of various root tissues and in the accumulation of carbohydrates, proteins and nucleic acids in them. In the third experiment diploid progenitor and induced autotetraploid of inter varietal hybrids. As x D were compared for morphological, fertility and yield characters. Autotetraploid was inferior in all the seven morphological characters studied. However, only a marginal reduction in pollen fertility was recorded in autotetraploid. The decreased dry matter productivity of the autotetraploid was evident on all the four components.

SECTION OF SEED SCIENCE AND TECHNOLOGY.

M.Sc.

Title : **Studies on seed production and storage aspects in bell pepper (*Capsicum annuum* L.)** (2003)

K.C.Manjunatha, UAS, Bangalore, Guide : Dr.H.S.Yogeesha

Field and laboratory experiments were conducted on bell pepper cv. Arka Gaurav at the Indian Institute of Horticultural Research, Hessaraghatta, Bangalore during 2001-2002 to study the effect of mother plant fruit load as well as stages of fruit harvesting and post harvest ripening on seed yield and quality. Studies were also conducted on the seed storability as influenced by seed treatment with anti-oxidants and halogens under ambient and controlled conditions (15 ± 2 °C temperature and 45% RH). Regulating the fruit number per plant significantly affected the seed yield. Eight fruits/plant was found optimum with maximum seed yield (168.4 kg/ha) with better quality seeds. Stage of fruit harvesting had a profound influence on seed yield and quality in bell pepper. Harvesting fruits at full yellow was found the right stage. Post harvest ripening for five days under ambient condition had a positive effect on both seed yield and quality particularly when fruits were harvested at breaker and half yellow stage. Pre-storage of seed treatment with free radical quenching agents such as p-amino benzoic acid, p-hydroxyl benzoic acid, ascorbic acid, oxalic acid, as well as potassium iodide and sodium chloride effectively controlled seed deterioration and maintained significantly higher seed quality over untreated seeds at the end of twelve months of storage. Controlled storage condition was found better compared to ambient condition. Treatment with p-amino benzoic acid recorded maximum germination of 79.5% at the end of twelve months. All the treated seeds stored under controlled condition were superior over those stored under ambient condition.

M.Sc.

Title : Studies on Seed Maturity, Harvest and threshing methods on seed quality in onion (*Allium cepa* L.) cv. Arka Bindu (2006)

M.Ramya, UAS, Bangalore, Guide : Dr.H.S.Yogeesha

Field and laboratory experiments were conducted in onion cv. Arka Bindu at the Indian Institute of Horticultural Research, Hessaraghatta, Bangalore during 2004-2005 to study the physiological and biochemical changes associated with seed development, seed maturity and effect of threshing methods at different seed moisture levels on seed quality of onion.

During seed development and maturation, protein accumulation occurred till 35 days after anthesis (DAA) where as starch accumulation continued till 45 DAA imparting more dry weight to the seeds with advancement in maturation. Dehydrogenase activity increased progressively with advancement in maturation indicating the formation of more living tissue with the accumulation of seed reserves. The analyse activity was very low till 15 DAA and increased till 40 DAA and decreased thereafter at 45 DAA. With advancement of maturation and increase in polypeptide synthesis germination and vigour increased parallely. No germination was noticed till 20 DAA where polypeptide synthesis was very less. Harvesting the seeds at 40 and 45 DAA recorded higher seed yield/plant (4.84 and 5.57g, respectively) and number of seeds per umbel (473.33 and 469.2, respectively) compared to harvesting at early stages. Seeds harvested at 40 DAA had higher test weight (0.29g) and dry weight (0.27g) which remained almost constant after 40 DAA indicating that the seeds attained physiological maturity between 40 and 45 DAA. Among the different stage of harvesting, highly vigorous seeds were obtained when harvested at 40 and 45th DAA when compared to other stages. This was indicated by higher seedling vigour index (1456.4 and 1474.9 respectively) with higher germination percentage and first count. Manual threshing recorded higher first count (52.3%) and germination (81.9%) than that of beating with stick. Threshing the seeds at lower seed moisture levels (5±2%) recorded higher first count (58.4% and germination percentage (83.5%). Lowest was recorded at 11 ± 2% seed moisture. Similar trend was noticed for seedling root length, shoot length and vigour index. Seed with 5±2% moisture content recorded higher seed recovery percentage compared to other seed moisture levels.

M.Sc.

Title : **Studies on genetic diversity and sex linked markers in betelvine (*Piper betle* L.)** (2011)

Ganesh Navanath Khadke, UAS, Bangalore, Guide : Dr.K.Himabindu

Betelvine is one of the heritage crops of India. In spite of being an important cash crop very limited research has been carried out in this crop. Molecular marker assisted investigations were undertaken to study the genetic diversity of betelvine accessions and *Piper* species and to identify of sex linked markers in *P.betle*. Genetic diversity analysis was carried out by using Inter Simple Sequence Repeats (ISSR) markers in 38 accessions of betelvine and one accession each of *P. colubrinum* and *P. hamiltoni*. Out of 60 ISSR primers tested, 15 were selected based on high and consistent polymorphism. The 15 ISSR primers generated a total 82 bands of which 72 were polymorphic. The different band statistics and efficiency parameters showed that the primers *viz.*, UBC-822, 825, 826, 863 and ISSR-1, ISSR-15 were more efficient and UBC-828 the least efficient primer to study the genetic diversity. Studies UPGMA dendrogram and PCA plot revealed *P. colubrinum* to be the most distant of the three species. The Andaman accessions of betelvine clustered based on geographical origin and shared 70% similarity. Gender based clustering was also observed in the betelvine accessions. The study revealed that of ISSR primers were efficient in divulging the differences between *Piper* species and within *P. betle*.

ISSR markers were used to identify sex linked markers in dioecious betelvine. Female and male bulk DNAs were screened with 35 ISSR primers. Two primers *viz.*, ISSR-10 and UBC-852 produced male specific bands of size 459bp and 1250bp respectively. ISSR-23 amplified a female specific 636bp fragment. These primers were validated in the individuals of the bulks and showed a consistent sex specific expression. A sequence characterized amplified region (SCAR) was developed from the primer ISSR-23. The SCAR primers developed can further be utilized in sex identification in betelvine.

M.Sc.

Title : Studies on varietal characterization based on morphological and biochemical markers in vegetable soybean [*Glycine Max* (L.) Merrill.] (2011)

Dhananjaya, UAS, Bangalore, Guide : Dr.K.Bhanuprakash

The ability to distinguish and clearly identify varieties of cultivated species is fundamental for the operational aspects in the seed trade. In the present study nine vegetable soybean genotypes were characterized based on morphological and biochemical markers. Based on seed coat colour, vegetable soybean genotypes were grouped into two groups *viz.*, green and yellow. AGS-438 was grouped as yellow and remaining genotypes were grouped under green colour. The plant growth habit in vegetable soybean genotypes showed erect type in AGS-440 while, other genotypes were semi erect. Based on stem pubescence, the genotypes were distinctly grouped into two categories as present and absent. Pubescence is absent in GC-00209-4-1-1 and present in remaining genotypes. The leaf shape in vegetable soybean genotypes showed pointed ovate in AGS-440 while, round ovate in other genotypes. Nature of pod pubescence exhibited difference among the genotypes. The pubescence was absent in genotype GC-00209-4-1-1 but present in rest of the genotypes. Based on pod pubescence density genotypes were grouped as dense and sparse. The genotypes AGS-435 and AGS-440 were grouped as dense and rest were grouped under sparse category. Therefore, these distinct morphological traits could be used as DUS test criteria for determination of genetic purity in vegetable soybean.

Total soluble seed proteins by SDS-PAGE were fractionated into 15 bands, which showed heterogeneity among genotypes and could be able to identify all the genotypes. The electrophoresis separation of soluble seed protein zymogram indicated that, most of the tested genotypes could be easily distinguished in the Region B (66.0 to 97.4 KD), C (43.0 to 66.0 KD) and D (29.0 to 43.0 KD), since the banding pattern was quite distinct for each genotype in these regions. Similarly Esterase and Malate dehydrogenase isozymes produced marked differences in the banding pattern and their intensities could be used for the identification of vegetable soybean genotypes. The results of the study clearly suggested that biochemical markers could be able to give discrete differences among the genotypes within a short period of time and be successfully utilized efficiently for characterization, documentation and identification of vegetable soybean genotypes.

Ph.D

Title : Studies on genetic diversity and biochemical basis of bruchid resistance in ricebean (*Vigna umbellata*) genotypes (2011)

B.V.Pavithravani, UAS, Bangalore, Guide : Dr.K.Bhanuprakash

Pulses being rich in proteins and other edible constituents are considered as one of the important *staple foods* for a large population around the world. India is the world's largest producer and the largest consumer of pulses. However, their vulnerability to common storage pest *viz.*, bruchid (*Callosobruchus maculatus*) is causing huge economic losses due to loss of nutrition quality and seed viability. Although there are various ways of bruchid management, use of resistance sources is much sought after as it is environmental friendly and reliable (Cardona *et al.*, 1992). Rice bean, an underutilized pulse crop gaining more popularity in recent times due to its high nutritional value, is no exception to bruchid attack. Hence, an investigation was taken up in this direction in order to identify genotype(s) resistant to bruchid infestation in rice bean crop. One hundred ricebean genotypes were screened for resistance to bruchid based on bruchid assay. Results showed LRB238 (5% infestation) and JP1000304 (10% infestation) as bruchid resistant and LRB26 (75%) as susceptible genotypes. Dendrogram constructed using UPGMA clustered all these 100 genotypes into 3 distinct main clusters. Cluster I (44 genotypes) represented bruchid susceptible genotypes having higher mean values for damaged seeds, holes per seed, seed resource utilization, growth index, dead seeds, loss in seed weight, germination and seedling vigour indices. On the contrary, lower values were observed in cluster III (27 genotypes) showing bruchid tolerant genotypes. Cluster II consisted of 29 moderately bruchid susceptible genotypes. LRB26 was found superior in Cluster I and LRB238 and JP100304 in cluster III. Besides these studies, multivariate analysis revealed three PCs with an Eigenvalue >1 explained over 72.43 per cent of the total variation and also indicated number of dead seeds, decline in germination and SVI-I and II values as important components contributing to genetic divergence.

Further, AFLP markers were used to assess the level of genetic variation among selected 10 ricebean genotypes having varied level of resistance to bruchid infestation. Out of 44 AFLP primer combinations used for genetic analysis, 41 were found to be polymorphic and generated 482 polymorphic amplified products. The primer combinations, E-CGA/M-GGA and E-CTA/M-TCG which recorded highest polymorphic information content (0.60 and 0.51, respectively), effective multiplex ratio (34.38 and

26.88, respectively), marker index (11.45 and 8.48, respectively), resolving power (21.00 and 15.20) and average genetic diversity (0.33 both) can be efficiently employed in diversity analysis for bruchid resistance in ricebean genotypes. Since LRB26 showed highest genetic distance (0.39 and 0.28) with respect to JP100304 and LRB238, genotypes LRB26 could be used as bruchid susceptible and LRB238 and JP100304 as bruchid resistant parent in crossing programme.

To understand the biochemical basis of tolerance in tolerant genotypes, various biochemical assays were done in selected twelve ricebean genotypes having varied level of bruchid resistance. The resistant genotype LRB168 showed highest tannic acid and polyphenol content (17.36 and 51.25 mg/g, respectively) against susceptible genotype LRB26 (11.50 mg/g) in the seed coats. Similarly, bruchid resistant genotype LRB238, exhibited highest peroxidase and polyphenoloxidase activity (11.42 and 3.34 U/min/mg protein, respectively) and against susceptible genotype LRB26 (2.42 and 0.93 U/min/mg protein, respectively). With regard to α amylase inhibition activity which plays a protective role against bruchid infestation, genotype JP100304 showed highest inhibitory activity (33.40%) compared to susceptible genotype LRB26 (3.61%). All these biochemical constituents impairing tolerance to bruchid infestation were 60 to 80 per cent higher in resistant genotypes compared to susceptible genotypes. Moreover, all the biochemical components showed negative correlation with bruchid infestation. Peroxidase isozyme profile clearly showed presence of a prominent and high intensity band (R_m value 0.654) only in tolerant genotypes LRB238 and JP100304 but not in susceptible genotype LRB26. Thus, the present study revealed vital information with respect to diversity for bruchid resistance based on physiological, biochemical and molecular markers. The same information can successfully be utilised in the conventional and molecular breeding programmes to evolve bruchid resistant cultivars in ricebean.

Ph.D

Title : Studies on physiological, biochemical and molecular aspects of seed invigouration in cucumber (*Cucumis sativus* L.) (2012)

K.J.Sowmya, UAS, Bangalore, Guide : Dr.K.Bhanuprakash

Cucumber is a popular Cucurbitaceous vegetable and the ever growing demand of this vegetable throughout the year exerts challenge for continuous production even during off seasons. The present study was conducted to standardize the seed invigouration protocol, to know the physiological, biochemical and molecular changes due to seed invigouration, to test the performance of invigourated seeds under abiotic stress conditions and to test the storage potentiality of invigourated cucumber seeds. The crop specific efficacy of all the popular methods of priming *viz.*, hydropriming, osmopriming, chemopriming and biopriming, were standardized based on the performance of seed quality attributes. Results revealed that the best priming temperature was 25 ± 1 °C, the optimum duration of soaking was 48h, best osmotica was PEG 6000 @-1.5 Mpa, the best chemicals were KNO_3 @1% or Ethrel 1000 ppm followed by GA_3 @ 100 ppm, KH_2PO_4 @ 10^{-1} M, Thiourea @1% KH_2PO_4 @ 10^{-1} M, NaCl @ 10^{-1} M; and Oxalic acid @ 10^{-1} M in their order of merit and the best biological agents were Cowdung slurry followed by PSB, Vermiwash, *Trichoderma viridae* and *Azospirillum* in the order of performance.

All the physiological attributes such as first count germination, final count germination, Bartlett's Rate Index (BRI), Coefficient of velocity (CV) of germination, germination energy (GE), Mean seedling length, Mean seedling dry weight, Seedling vigour index -I and Seedling vigour index - II were significantly higher (91.67%, 92.33%, 0.544, 73.54%, 85.50% , 31.68 cm, 11.69 mg, 2929 and 1081, respectively) in KNO_3 primed seeds. KNO_3 primed seed recorded significantly higher Total dehydrogenase activity, total soluble protein, amylase activity, catalyse (CAT) activity, peroxidise activity (POX) and lower Electrical conductivity and total soluble sugars in the seed leach ate. The total soluble seed protein profile of native PAGE and SDS PAGE had revealed polymorphism with respect to appearance (total of 26 bands and 27 bands) and disappearance of peptides at specific Rm values (0.033 to 0.846 and 0.100 to 0.966, respectively) in primed and unprimed seeds. Priming induced proteins were expressed in all the priming treatments which can be employed as a markers for optimum

priming. Esterase and peroxidase isozymes expression also varied in primed and unprimed seeds. Primed seeds expressed specific is forms of isozymes compared to unprimed. At the end of 48 hr, primed seeds exhibited more amount DNA content *per se* due to advancement in cell cycle when compared to unprimed seeds.

Primed seeds showed better tolerance to temperature, moisture and saline stress by exhibiting advancement in germination, higher seedling vigour, higher fresh and dry seedling weight compared to unprimed seeds. Among priming treatments, higher (88.63%) FEM, BRI (0.479), PSP (86.13) and PDW (2.06 g) was indicated in seeds primed with KNO_3 @ 1% and it was lower (67.50%, 0.391, 53.13% and 1.77 g) in unprimed seeds (control). High vigour seeds primed with KNO_3 @1%, packed in super grain bag registered higher (89.00 and 94.50%, 86.00 and 93.50%, 2697 and 2902; 949 and 1091) germination, field emergence, SVI- I and SVI- II, at the end of the storage period of 80 days when stored under ambient and refrigerated condition, respectively. In addition to KNO_3 , cow dung slurry primed seeds were also recorded significantly higher seed quality attributes on par with KNO_3 treatment.

In order to test the longevity of primed seeds during storage, primed seeds were sealed in various packaging material and stored at ambient and refrigerated conditions. Various vigour parameters were compared with unprimed seeds at 20 days interval. Among storage treatments, seeds stored under refrigerated condition showed slightly higher germination and field emergence (82.25% and 80.58%) compared to ambient condition (81.67% and 79.50%), respectively. Results indicated primed seeds can be stored for a short period of 80 days under ambient conditions of Bangalore without significant reduction in seed quality attributes. However, refrigerated storage is advised for long term storage of primed cucumber seeds.

SECTION OF ECONOMICS AND STATISTICS.

M.Sc.

Title : **Investigation and development of non-linear statistical models for disease forecasting in grapes** (2010)

N.Vijay, UAS, Bangalore, Guide : Dr.R.Venugopalan

An attempt was made to develop nonlinear stochastic models for disease forecasting in Grapes. Grape (*Vitis* SPP.) is an important crop for the farmers for getting higher returns and with consumer for delicacy and as a medicinal fruit. Downy mildew is one of the most destructive vine diseases known leading to total crop losses. Thus, the remunerative and successful cultivation of grapes has been hampered. To avoid this, by understanding prevailing weather conditions which influence the onset, initiation and progression of disease, judicious need based control measures are the need of the hour. To this end, the present investigation was carried out to understand the role of weather factors on downy mildew incidence in Grapes (cv. Anab-e-Shahi) and disease progression over time epoch by developing suitable statistical models. Efforts were made to develop models individually for backward and fore pruning periods, resulting in meaningful interpretation to the researchers. Also, an attempt was made to investigate statistical considerations involved in the error structure and subsequent methodologies to be followed, while developing non-linear models. Using the nonlinear models developed, an index was also developed to compute quantitative information about the biological parameters concerning intrinsic infection rate and maximum mildew severity over time-epoch. Statistical models developed for backward pruning data (May-June) showed that maximum temperature, Evaporation and relative humidity at 7.30 hrs, observed with a time lag of one week, collectively explain about 89.4% of the variation in downy mildew incidence. Statistical models developed for fore pruning data (September-October) showed that minimum temperature, relative humidity at 7.30 hrs and 13.30 hrs, observed with a time lag of one week, collectively explain 88% of the variation in weekly downy mildew incidence. Logistic and Gompertz nonlinear stochastic statistical models developed expressed the disease progression to the extent of 97-99%. These models when used to compute quantitative information about the biological parameters concerning intrinsic infection rate and maximum mildew severity over time-epoch showed that, in general, for backward and fore pruning data, the rate of disease severity was maximum during the fourth- fifth week and fifth- sixth week after pruning, respectively. Hence,

appropriate management strategies for controlling the disease should be oriented within the period identified in the investigation, separately for backward and fore pruning. Resultant nonlinear models were used to compute the Area under Disease Progressive Curve (AUDPC). A perusal indicates that the values obtained by logistic and Gompertz are ranged from 48 to 84 and 25 to 65 respectively for backward pruning data. However, for the fore pruning data the results showed that AUDPC values were higher as it ranged from 78 to 86 and 61 to 65 respectively. These results indicate that the downy mildew rate of progression in Fore pruning is much severe than in backward pruning. SAS programming codes were generated for model building. The message arising out of this present investigation is that proper prophylactic measures, if taken by considering the model resulted significant weather factors along with knowledge about disease progression over time as depicted by nonlinear models, separately for backward and fore pruning, not only results in an efficient and economic management strategies for controlling downy mildew incidence in grapes (cv. Anab-e-Shahi) but also considerably reduce crop yield loss thereby providing better return to the farmers. The graphical representation of nonlinear models fitted is depicted as below.

M.Sc.

Title : **Statistical models for stability research in cucumber** (2011)

G.S.Ravi, UAS, Bangalore, Guide : Dr.R.Venugopalan

Crop improvement research is mainly aimed to exploit initially the genetic diversity available in the germplasm and culminate with identifying stable lines for release as variety. Its main aim is to estimate the average response of the genotypes and also to test the consistency of the yield responses over years/environments. The presence of genotype X environment interaction (GEI) makes it difficult to assess the genetic potential of a variety. In the present study, three different approaches were used to develop stability models for assessing the stability of 33 cucumber lines tested over three consecutive years in one location (Bangalore), based on eight yield and related biometrical traits. GEI was highly significant for all the traits and the genotypes had divergent response to environmental changes. Presence of significant linear GE interactions in both yield per plot (Kg.) and number of fruits per plot indicated that there is still more potential for crop improvement over years. Measures of stability when used to group the 33 genotypes into genotypes suitable for ideal environment, for favorable environment and for poor environment, fortified a distinct difference in their grouping using two approaches. percentage of misclassification was in the range of 20-100% due to the non-utility of Freeman-Perkins (FP) method. Parametric and non-parametric measures were computed to assess the extent of contribution of each of the 33 genotypes to GE interaction. It was observed that the lines CH-36-71-6 and CH-32-36-6 were most stable in yield character. Also, a combined index by giving desired importance to all the traits was developed to rank the genotypes. Results showed that CH-20-1-10, CH-1-42-10 and CH-32-36-6 under ER model and CH-28-32-6, CH-20-1-10 and CH-32-36-6 under FP model were top 3 stable genotypes. Finally, by considering relative performance of a genotype various non-parametric measures computed showed that CH-20-1-10 and CH-28-32-6 were found to be most stable. SAS programming codes and STAB-IIHR were generated for data analysis. Further, in any crop improvement research, as the breeders may expect that a genotype/variety should also possess desirable characters of other yield related traits. Hence, an index based on the combined ecovalance value and relative performance of a genotype as compared to others (for a character under study), using rank based non-parametric measures may be still more practically meaningful so as to come out with

stable lines either for release as variety or as a promising line in the ensuing crop hybridization trails.

M.Sc.

Title : **Evolving Statistical models for crop-logging studies in Brinjal (*Solanum Melongena* L.)** (2012)

R.Hanumanthaiah, UAS, Bangalore, Guide : Dr.R.Venugopalan

Crop yield forecast before harvest is likely to provide valuable information to farmers, policymakers/government on sales, storage, and export, price fixation, grading, and marketing for advance planning so as to ensure sustainable crop production during the years ahead.

Researchers are also interested to know explicitly by which stage of the crop, yield could be predicted more accurately and what are all the significant crop-logging parameters. Crop improvement research is also benefited, as selection can be made in the early stages based on the significant crop-logging parameters identified. To this end, statistical models were developed using Multiple Linear Regression (MLR) and Artificial Neural Network (ANN) methods.

Statistical models developed showed that Brinjal crop yield could be predicted well in advance as early as 26 Days After Planting (DAP) using three biometrical traits (plant height, plant girth and plant spread north south) to an extent of 71 %. As the DAP increases prediction of yield could be possible to an extent of 88 %. Identification and removal of outliers in the data set increased the prediction of MLR models in the range of 31 %, 33 %, 34 and 8% respectively across four crop growth stages. ANN approach which was also used to predict the yield resulted in R^2 values 83 % (stage 1), 89 % (stage 2), 88 % (stage 3) and 68 % (stage 4), which was high as compared to MLR (except for stage 4). Cross-validation of MLR and ANN models for all four stages, showed good results as the prediction power was in the range of 78 to 87 % R^2 for MLR and 64 % to 85 %- for ANN. Hence, it is recommended to study the role of outliers before developing crop yield forecasting models and also to exploit ANN approaches by capturing the inherent nonlinearity among biometrical traits.

