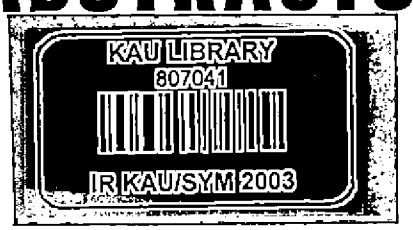
National Symposium on Recent Advances in Indian Floriculture

Nov. 12-14, 2003
Kerala Agricultural University
Vellanikara, Trichur

ABSTRACTS



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Dr. C.K. Geetha

Indian Society of Ornamental Horticulture
National Symposium on
Recent Advances in Indian Floriculture

Venue: Central Auditorium, KAU Date: 12-14 November 2003

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Indian Floriculture

INDEX

Session I

Production Technology

I-1. Effect of water soluble nutrients and growth regulators on plant characters of *Anthurium andreanum* var. Temptation

S. Anand and M. Jawaharlal
Department of Floriculture and Landscaping, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore- 641003.

An experiment was conducted at the Botanical Garden, Department of Floriculture and Landscaping, Tamil Nadu Agricultural, University, Coimbatore to study the effect of water soluble nutrients and growth regulators on plant characters of *Anthurium andreanum* var. Temptation. Plant height was influenced by the application of NPK 20:20:20 at 0.50 per cent along with BA 250 ppm concentration. Plant spread and leaf area were influenced by the application of NPK @ 20:20:40 at 0.25 per cent along with BA at 250 ppm concentration. Plants fertilized with treatment combination NPK @ 20:20:40 at 0.25 per cent along with BA 500 ppm gave the maximum number of leaves (11.95) per plant and leaf area was also high (975 cm^2. The number of suckers produced was highest in treatment receiving NPK @ 20:20:40 at 0.25 per cent along with GA_3 500 ppm.

I-2. Commercial flower production of tuberose (cv. Single) as influenced by various levels of nitrogen and phosphorus

Archana P. Kadu and Arvind S. Sable
Department of Horticulture, College of Agriculture, Nagpur, Dr.P.D.K.V. Akola

An investigation was conducted during the year 1996 to 1999 to find out the influence of various levels of nitrogen and phosphorus on growth, quality and yield of tuberose cv. Single. Four levels of nitrogen and four levels of phosphorus with constant potassium level were used in the experiment. Nitrogen 300 kg and Phosphorus 150 kg per hectare gave maximum spike length (105.64 cm), maximum number of spikes per hectare (3.99 lacks) and maximum yield of loose as well as cut flowers per hectare (14.85 tones). The treatment also influenced the early flower production and quantity of bulbs produced. The application of 200 kg Nitrogen and 150 kg Phosphorus ha was found economically beneficial for flower production of tuberose.

I-3. Pre and post harvest studies of tuberose cv. Single under Nagpur condition

Archana P. Kadu and Arvind S. Sable
Department of Horticulture, College of Agriculture, Nagpur, Dr.P.D.K.V. Akola

An investigation was carried out to find out the pre and post harvest methods for measuring longivity of tuberose flowers. The results revealed that the application of nitrogen 200 kg and phosphorus 150 kg ha enhanced vase life (6.72 days). The cut flowers should be harvested at 75 cm length with two lower whirls of florets open for better vase life (7.50 days). The various methods of packing of tuberose cut flower in box for sending to distant places were studied and it was observed that the flowers packed in news paper and wrapped with polythene and covered with neem leaves had more vase life (5.46 days).

I-4. Effect of nutrients and biofertilizer on the growth and yield of *Dendrobium* cv. Sonia 17

T. Arumugam, M. Jawaharlal, M. Vijayakumar and K. Rajamani
Department of Floriculture and Landscaping, Horticulture of College and Research Institute, Tamil Nadu Agricultural University, Coimbatore – 641 003

Studies were conducted to assess the combined effect of nutrients and bio fertilizers on growth and yield of *Dendrobium* cv. Sonia 17 at the Department of Floriculture and Landscaping, Tamil Nadu Agricultural University, Coimbatore- 641 003. The study comprised of eleven treatments with three replications in randomized block design. The results revealed that the maximum plant height of 41.7 cm was recorded due to application of NPK 10:5:10 @ 0.2 per cent + VAM followed by NPK 20:5:10 @ 0.2 per cent + Phosphobacterium (39.7 cm). The same treatment also recorded the maximum number of leaves per plant. Highest number of shoots (7.8) and spikes per plant (7) was recorded in plants supplied with NPK @ 10:5:10 (0.2%) + VAM followed by the (T9) with the treatment combination of NPK 10:5:10 @ 0.2 per cent + Azospirillum and VAM. Length of spike was highest in T9 which recorded 27.1 cm followed by T_5 (NPK 20:10:10 @ 0.2 per cent + Azospirillum and Phosphobacterium). Number of florets per spike also varied among the treatments. The maximum number of 14.5 florets per spike was recorded by the application of NPK 10:5:10 @ 0.2 per cent + Azospirillum + VAM followed by T9 (12.9).

I-5. Dry matter production and uptake in *Jasminum sambac* Ait

Asha raj, V.L Sheela and J.D Nirmalatha
Department of Pomology and Floriculture
College of Agriculture, Vellayani, Thiruvananthapuram 695 522

An experiment on "Nutrient requirement of *Jasmiumm sambac* Ait" was conducted at the Department of Pomology and Floriculture, College of Agriculture, Vellayani. The effect of major nutrients (50,100,150 kg ha^{-1} of N, P_2O_5 and K_2O) on dry matter production and uptake of nutrients was studied. Nitrogen application significantly influenced the dry matter production. The maximum dry matter production was obtained at 150 kg N ha^{-1}. The effect of phosphorus on dry matter production was significant and the level P3 (150 kg ha^{-1}) recorded the maximum value. Application of 150 kg K_2O ha^{-1} resulted in higher dry matter content. The results clearly showed that there was an increase in uptake of N, P and K by *Jasminum sambac* with application of graded doses of major nutrients, ie, 150 kg ha^{-1} of N, P_2O_5 and K_2O.

I-6. Effect of growth regulators on chrysanthemum

Balaji S. Kulliarni and B. Sathyanara Reddy
K.R.C.College of Horticulture, Arabhavi-591310
(University of Agricultural Sciences, Dharwad), Belgawn, Kamataka

An experiment was conducted in the farmers' field of Sanganakere village near K.R.C. College of Horticulture, Arabhavi during 2000 and 2001 (two years) on chrysanthemum cv. Karnool to know the effect of growth regulators, viz., GA (50-200 ppm), Paclobutrazol (50-400 ppm), Mepiquat chloride (250- 750 ppm) and Brassinosteroid (0.25 -0.75 ppm).

Application of GA at 100 ppm and Brassinosteroid at 0.75 ppm to pinched plants increased the plant height. These two treatments and Mepiquat chloride at 250 ppm exhibited excellent plant architecture (spread), relatively higher number of branches and increased leaf area, which in turn resulted in higher flower production. GA (100 ppm) induced early flowering, whereas Paclobutrazol at 400 ppm, and mepiquat chloride at 500 and 750 ppm levels delayed the flowering. The flower yield increased in plants pinched and sprayed with GA at l00 ppm (17.0 t/ha), Brassinosteroid at 0.75 ppm (16.39 t/ha (16.26 t/ha). The control plants yielded 12.99 t/ha.

I-7. Studies on substrate suitability for self rooted cuttings of chrysanthemum under high-tech nursery

Balraj Sing, M.C. Singh, M. Hasan and N.P.S. Sirohi
Indo-Israel Project, Indian Agricultural Research Institute, New Delhi-110 012

The experiment was conducted under high-tech nursery equipped with fertigation and climate control systems to standardize the soil less substrates, viz., cocopeat, perlite and vermiculite for self rooted cuttings in standard *Chrysanthemum morifolium* var. "Snowdon White" in different proportions (coco peat as C6, C8 and C10, perlite as P0, P1, P2 and P4 and vermiculite as V0, V1, V2 and V4) as ratio. It was noted that the substrate mixture of C6: P2: V2 served best to produce highest survival (83.77%) of self-rooted cuttings followed by the substrate mixture of C8: P1: P1 (73.05%). However, the highest mortality of about 43.87 per cent was observed in the substrate made without perlite (C6: P0: V4). The different substrate showed critical differences in establishment and time taken by the self rooted cuttings and it was observed that the cuttings raised in the mixture of coco peat, perlite and vermiculite in C6: P2: V2 ratio took minimum time of 23 days to produce rooted cuttings ready for transplanting followed by the substrate mixture of C8: P1:V1 (26 days). However, the mixture of C6:P0:V4 showed poor growth and took longest time (35 days) for transplanting. The root area was also found to be the highest (32.05 sq. cm) in the cuttings raised in substrate mixture of C8:P1:V1.

I-8. Standardization of production technology of rose under partially protected condition

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Studies were carried out to find out the standard package of practices for rose cv. First Red under partially protected condition. The longest plant (112 cm) was observed from the growing media containing 2soil:1compost:1sand, supplemented with 150 ppm N + 200 ppm K through fertigation under the irrigation regime of 20 kPa. Bud appearance was hastened (60 days) in the growing media comprising of 2soil:1compost:1sand as well as 2soil:1compost:1saw dust fertigated with 150 ppm N + 200 ppm K, maintaining the soil moisture at 40 kPa. Growing media comprising of 2soil:1compost:1cocopeat supplemented with 150 ppm N + 200 ppm K through fertigation keeping the irrigation regime of 20 kPa could produce longest bud (3.33cm). Plants grown in media 2soil:1compost:1sand supplied with 150 ppm N + 200 ppm K through fertigation together with spraying of BAP 50ppm + GA_3 50 ppm (from Sept.-Jan.) under the irrigation regime of 20 kPa resulted in producing largest flower (6.94 cm). Flower yield / m^2 was highest from the plants grown in 2soil:1compost:1cocopeat fertigated with 150 ppm N + 200 ppm K and soil moisture at 40 kPa, during the months of June-Sept. vase-life of cut flower was highest (8 days) when the flowers were harvested from the growing media 2soil:1compost:1sand applied with VAM + Azospirillum + phosphate solubilizing bacteria +150 ppm N + 200 ppm K as well as spraying of plants with poly feed + micronutrients (2g/l - Sept.-Jan.) under the irrigation regime of 20 kPa. However, during Oct. – Jan., it was remarkably improved (14 days) in the same media and irrigation regime supplemented with 150 ppm N+ 200 ppm K.

I-9. Production potential of blue daisy (*Aster amellus* L.)

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A field experiment was carried out during *Kharif* season 1996 at the Department of Horticulture, Main Research Station, Dharwad, to find out the optimum plant density and nutritional requirement for profitable cultivation of daisy (*Aster amellus L.*) for cutflower production. There were eighteen treatments included in the study which consisted of three levels of fertilizers (F1- 50 % < RDF, 180:120:60 kg NPK/ha, F_2- RDF,

F_3- 50% > RDF) and six levels of plant geometry *viz* S_1- 30x15, S_2- 30x30, S_3- 30X45, S_4- 15 x15, S_5- 15x30 and S_6- 15x45cm. Among three treatments the fertilizer dose 270:180:90 kg NPK/ha with 30x15 cm spacing was found ideal for cut flower production of daisy.

I-10. Effect of planting time on growth and flower yield in gaillardia (*Gaillardia pulchella* Foug.)

C. Basavarajeshwari, Patil and U.G. Nalawadi
University of Agricultural Sciences, Dharwad

Though gaillardia can be grown throughout the year, the climate has its own effect on plant growth and production of flowers. Therefore, the experiment was conducted to know the month of planting gaillardia crop for its better performance and higher yield on red soil. The variety DGS-1 was used for the study with twelve treatments (months of a calender year) and three replications laid out in randomized block design.

Growth parameters, viz., plant height, number of branches, number of leaves and dry weight of plant were highest in January followed by December planting. The leaf characteristics viz., leaf area, LAI and LAD differed significantly between treatments and the values were highest in January followed by December planting. Flower initiation and fifty per cent flowering were early in plants of January and December planting. Similarly, flower quality in terms of flower diameter, number of flowers per plant and flower yield were found to be maximum in the gaillardia crop planted in January followed by December months. This may be due to the fact that plants of January and December planting remained photosynthetically active for more time and captured more light energy which was converted into chemical energy which, in turn diverted to the reproductive parts.

I-11. Influence of split application of nitrogen at different stages on growth and flower production of gaillardia on black soil

C. Basavarajeshwari, Patil and U.G. Nalawadi
University of Agricultural Sciences, Dharwad

A study was conducted to know the effect of split application of nitrogen on growth and flower yield in gaillardia on black soil at Dharwad. The variety DGS-1 was used for the study with seven treatments consisting of nitrogen (150 kg/ha) applied in the form of urea in different splits and constant levels of phosphorus (80 kg/ha) as single super phosphate and potassium (60 kg/ha) as muriate of potash and three replications laid out in randamised block design.

Growth parameters, viz., plant height, number of branches and number of leaves were highest in the treatment consisting of nitrogen @ 150 kg per hectare applied in two splits i.e., 50 per cent as basal dose and 50 per cent at initiation of flowering. Further, higher flower yield per hectare with application of nitrogen @ 150 kg per hectare in two splits i.e. 50 per cent as basal dose and 50 per cent at initiation of flowering could be related to the increased flower yield per plant which may be again attributed to the sequential differences in the yield components like number of flowers per plant, flower size and weight of ten flower. This may be due to split application of nitrogen at different stages of growth, which has increased meristamatic activity and uptake of nitrogen at relevant time by the plant intensified the vegetative as well as reproductive parameters.

I-12. Effect of spacing and pinching on flowering and yield of chrysanthemum cv. Flirt

B.S. Beniwal, V.P. Ahlawat and D.P. Deswal
Department of Horticulture, CCS Haryana Agriculture University,
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To standardize the proper spacing and pinching time for better flower production in chrysanthemum, a field experiment was conducted at CCS Haryana Agricultural University, Hisar for two years (1999-2000 & 2000-01). Three spacing (20 cm x 20 cm, 20 cm x 30 cm and 20 cm x 40 cm) and four times of pinching

(no pinching, 25, 35 and 435 days after transplanting) where applied in split plot design with three replications. Minimum days for bud initiation, flowering and maximum size of flower, flower weight and flower yield (3.79 kg/plot and 3.89 kg/plot) were observed when planted at closer spacing (20 cm x 20 cm) and pinched at 25 days after transplanting during both the years. But maximum number of buds/plant, number of flowers/plant were observed when crop planted in 20 cm x 30 cm spacing and pinched at 25 days after transplanting during both the years. Therefore, for better flower production the spacing of 20 cm x 20 cm and pinched at 25 days after transplanting should be practiced.

I-13. Effect of nitrogen and phosphorus levels on flowering and yield of chrysanthemum (*Chrysanthemum morifolium*) cv. Flirt

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A field experiment was conducted during 1999-2000 and 2000-01 at CCS Haryana Agricultural University, Hisar, India to study the optimum requirement of nitrogen and phosphorus for better flower production in chrysanthemum cv. Flirt. Four levels of nitrogen (0, 10, 20 and 30 gm^{-2}) and three levels of phosphorus (0, 10 and 20 gm^{-2}) along with a common dose of potassium @ 20 gm^{-2} were applied in a randomized factorial design with three replications. Application of nitrogen and phosphorus each @ 20 gm^{-2} significantly increased the flowering (days to first flowering, duration of flowering and number of buds/ plant) and yield parameters of chrysanthemum (number of flowers/plant, size of flower and flower yield/ plot).

1-14. Effect of different combination of biofertilizers on growth and yield of African marigold *(Tagetes erecta* L.) cv. Pusa Narangi

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Department of Horticulture, Institute of Agricultural Sciences
Banaras Hindu University, Varanasi.

A field experiment was conducted to study the effect of different combinations of biofertilizers on growth and yield of African marigold. cv. Pusa Narangi at research farm of Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during 2001- 2002. The treatments were control (Bo), Phosphate solubilizing Bacteria (PSB) (BU, PSB and Azotobacter (B2), PSB and Azospirillum (B3) and PSB, Azotobacter and Azospirillum (B4). It was found that a combined application of PSB, Azotobacter and Azospirillum (B4) showed a significant influence on growth and yield characters of marigold. The maximum plant height (85.62 cm) and maximum number of branches (15.65) were obtained with B4. A significant increase was also obtained with size of the flower (6.25 cm), number of flowers per plant (49.47) and flower yield (24.45 t/ha). Therefore it can be concluded that application of biofertilizers in combination is better than single applications.

I-15. Effect of paclobutrazol and *Azotobacter* on growth and flowering of potted geraniums *(Pelargonium* x *hortorum)*

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Dept of floriculture and landscaping,
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Experiments were carried out during 1999-2000 to study the effect of paclobutrazol and *Azotobacter* on growth and flowering of potted geranium cvs. 'Selection Red' and 'Selection Pink'. Rooted cuttings were

potted in a sterilized media containing soil: sand:FYM (1 : 1: 1, v/v) and a week later, *Azotobacter* inoculated FYM was added @ 250 g/pot. Nitrogen application in graded levels was done 5 days after inoculation. Two drenchings with paclobutrazol @ 10 ppm and 20ppm were given 70 and 135 days after transplanting. Effects of the treatments on some of the parameters, like shoot length, days to flower bud formation, length of the inflorescence stalk, flower diameter and the overall presentibility have been discussed.

I-16. Quality flower production in chrysanthemum (*Dendranthema grandiflora* tzvelev) as affected by plant growth regulators

Bhaskarjyoti Sarma*, Madhumita Choudhury Talukdar and Sangita Das
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An experiment was undertaken with two spray chrysanthemum cultivars Charming and Purple Decorative with seven growth regulator treatments including control, *viz.*, GA_3, (40, 60 and 80 ppm) and CCC (4000, 5000 and 6000 ppm). The growth regulators were applied 35 days after planting. The experiment was laid out in Factorial Randomized Block Design with three replications. The treatment with 80 ppm GA_3 was found better in terms of plant height (70.00 cm) and earliness to flowering (70.67 days). But, 6000 ppm CCC was found as the best treatment in terms of plant spread (55.33 cm), flower number (88.33), flower size (10.70 cm), blooming period (54.33 days), vase life (15.67 days) and yield (6.50 kg/m²). In these regards CCC at 5000 ppm also exhibited promising results. Purple Decorative was found as better cultivar in terms of plant height (71.59 cm), plant spread (51.74 cm), earliness to flowering (72.33 days), flower size (11.70 cm), flower number (67.00), blooming period (49.24 days), vase life (16.05 days) and yield (6.44 kg/m²), whereas in terms of leaf number, (241.29) cv. Charming performed better. Spraying with CCC at 6000 ppm may be done to get quality flower in chrysanthemum.

I-17. Influence of *Azospirillum* on growth and flowering of *Dendrobium* cv. Sonia 17

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Department of Pomology and Floriculture, College of Horticulture, Vellanikkara

A study was conducted during 2002-2003 in the Department of Pomology and Floriculture to evaluate the effect of biofertilizer, *Azospirillum* on the growth and flowering of *ex-vitro* established one-month old tissue culture plants of *Dendrobium* cv. Sonia 17. *Azospirillum* (40%) was treated along with three levels of N (0,10,20 ppm), three levels of P (0,5,10 ppm P_2O_5) and level of K (10 ppm K_2O) per plant at 0.2 per cent concentration. The results clearly revealed that the treatment combination of NPK 10:5:10 at 2 per cent concentration along with *Azospirillum* proved to be very effective in improving the vegetative characters like plant height, number of leaves, number of shoots with levels and girth of shoot, whereas NPK 20:10:10 at 2 per cent concentration along with *Azospirillum* was found to improve the floral characters like days to first flowering, number of flowers per spike and spike length.

I-18. Effect of Nitrogen and Phosphorus on growth and flowering of gaillardia (*Gaillardia pulchella* Fong)

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Chandra Shekhar Azad University of Agriculture and Technology, Kanpur – 208 002

The experiment was carried out to study the effect of nitrogen (0, 100, 200, 300 kg/ha) and phosphorus (0,100, 150 kg/h) on growth and flowering in gaillardia (*Gaillardia pulchella*, Fong) in randomized block

design, in the Horticulture garden of C.S.A University of Agriculture and Technology, Kanpur during 2000-2003. Application of 300 Kg N and 150 kg P/ha proved to be the optimum dose for vegetative growth and flowering, viz., plant height, no. of branches, length of branch, diameter of branch, size of leaf, spread of the plant, days to first flower appearance, duration of flowering, no. of flowers per plant, diameter of flower, fresh weight of flower, yield of flower per plant and per hectare.

I-19. Response of planting months in propagation of *Cestrum nocturnum* and *Thevetia nerifolia* by hardwood cuttings

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Queen of night (*Cestrum nocturnum*), commonly known as *Raat-ki-Rani* and Yellow Oleander (*Thevetia nerifolia)* also known as *Pili-Kaner* are popular flowering shrubs. With a view to find out the optimum planting month for propagation of above-mentioned shrubs, their hardwood cuttings were planted at monthly intervals throughout the year for two years, in open field.

Queen of night: The maximum survival of cuttings was obtained during January (92%) planting, followed by December and February (81%) plantings. On the other hand, April to July plantings gave only 2 to 10% of survival. The maximum number of leaves on longest sprout (19.82%) and per cutting (37.12), length of longest sprout (40.53 cm) and diameter of thickest sprout (0.67 cm) per cutting was recorded from February plantings. The maximum root development in terms of number of primary (18.79) and lateral (75.75) roots, length of longest root (40.95 cm) and diameter of thickest root (0.50 cm) per cutting was obtained from January planting. The least development of all studied parameters was reported during July planting.

Yellow Oleander: None of the hardwood cuttings of *Thevetia nerifolia* expressed root initiation and vegetative bud growth through the present method.

I-20. Response of planting month in propagation of poinsettia (*Euphorbia pulcherrima*) through soft wood cutting

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[2]Division of Floriculture and Landscaping, I.A.R.I, New Delhi-110 012

A study was conducted to find out the optimum month of planting for the propagation of poinsettia (*Euphorbia pulcherrima*) through softwood cuttings. Cuttings were planted at monthly intervals in whole year under open field condition. The maximum survival of cuttings was noticed during February planting (67%), followed by March and April (51 and 50%, respectively) plantings. Hundred per cent mortality of cuttings was reported during May to August plantings. The maximum number of sprouts (2.58), leaves per cutting (17.37), length of longest sprout (35.88%) and diameter of thickest sprout (0.66 cm) per cutting was reported during February planting. Root development parameters viz. number of primary (15.13) and lateral (36.48) roots, length of longest root (36.48 cm) and diameter of thickest root (0.38 cm) per cutting were reported superior during April planting. The present study inferred that poinsettia can be propagated by means of softwood cuttings during February to April months with 50-60% survival of cuttings.

I-21. Effect of ethrel on growth and flowering of gladiolus

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G.A.U. Navsari – 396 450

The effect of ethrel was studied by spraying 0.125 m1/l, 0.250 ml/l, 0.375 m1/l, 0.500 m1/l and 0.625m1/l. at 4 and 6 leaf stages of gladiolus cv. Sancerree at Floriculture Research Scheme, ASPEE College of Horticulture and Forestry, Gujarat Agricultural University, Navsari, during the year 2001-2002. The experiment was replicated thrice. Ethrel at 0.250 ml/l was proved to be the best for increased plant height and dry matter production, early spike emergence, more production of spikes, maximum florets per spike and also for higher corms and cormels production, while spraying of ethrel at 0.125 ml/l proved beneficial for obtaining maximum leaf area, spike length and size of florets. Ethrel at 0.375 ml/l showed best results regarding weight and diameter of corms.

I-22. Influence of plant density and nitrogen on *Jasminum arborescencs*

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An experiment was carried out during the year 2001-2002 with the objective to develop production technology of *Jasminum arborescencs* L. cv. Local at Regional Horticulture Research Station, Gujarat Agricultural University, Navsari. The treatment combinations consisted of two spacings viz. wider i.e. 100 cm x 100 cm and narrow i.e.100 cm x 75 cm. and five levels of nitrogen, viz. 0, 10, 20, 30 and 40 g /plant. The experiment was replicated thrice. It was found that wider spacing and heavy dose of nitrogen (40 g/plant) favour the growth parameters of plant, such as, plant height, plant spread, number of primary and secondary shoots and leaf area as compared, to narrow spacing. Likewise, yield attribute characters such as number of flower buds per bush, weight of flower buds, length of flower buds and marketable flower buds were also significantly influenced by wider spacing and higher dose of nitrogen. From the economic point of view, planting of *Jasminum arborescencs* L. cv. Local at 100 cm x 100 cm spacing with an application of nitrogen at 40 g/bush was found most profitable.

I-23. Performance of gerbera and carnation under open field condition at Deffla Hills

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Gerbera and carnation are grown in open condition at the College of Horticulture and Forestry, Pasighat, Arunachal Pradesh. Five varieties of gerbera were grown in the container with two parts of locally available sandy loam soil plus one part of compost and seven colours of spray carnations were grown in soil. Planting was completed in November 2002. The growth and flowering performance of the crops was excellent except the performance of few varieties. The stem length, size and keeping quality was good and almost equal to the international standards.

I-24. Effect of CCC and B-9 on growth and flowering of chrysanthemum

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Studies on effect of CCC (2000 and 3000 ppm) and B-9 (2000 and 2500 ppm) on growth and flowering of thirty cultivars of chrysanthemum were conducted in natural season crop in the Department of Floriculture and Landscaping, Dr.YS Parmar University of Horticulture and Forestry. Rooted cuttings of these cultivars were transplanted on 26th June 2001 in 10 cm earthen pots (one/pot) in soil, FYM and sand (1:1:1, v/v) media and standard cultural operations were followed. The trial was replicated thrice using CRD factorial. Growth retardants were sprayed until runoff when the side shoots attained a height of 4 to 6 cm (after 33 days of pinching) using hand sprayer. In general, all the growth retardant treatments reduced plant height and spread over control. However, B-9 (2500 ppm) produced minimum plant height and CCC (3000 ppm) was found to be a par with B-9 (2500 ppm). CCC (3000 ppm) was found best for reducing plant spread over control. The effect of growth retardants varied depending upon cultivar. Maximum height reduction of 22.64 per cent was observed in "Snowball" with CCC (3000 ppm) while, minimum (0.17%) with B-9 2000 ppm in cultivars "Surf". Number of side shoots per plant, flower size, duration of flowering and pot presentability were increased with all growth retardant treatments. Peak flowering was delayed with all growth retardant treatment while number of flowers per plant was reduced.

I-25. Screening of chrysanthemum cultivars for off- season flowering: Effect of artificial lights and blackout on growth and flowering

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Studies were conducted to screen out chrysanthemum cultivars for off-season flowering in the Department of Floriculture and Landscaping of Dr. Y.S. Parmar University of Horticulture and Forestry during 2000-2001. Thirty cultivars (both standard and spray) were planted on 26th October 2000 in 10 cm earthen pots (one plant/pot) containing sand, soil and FYM (1:1:1, v/v). The plants were grown under natural as well as artificial photoperiodic conditions. Artificial lighting treatment (provided through incandescent lamps) was given from planting to 24th March 2001, which was followed by artificial short days from 25th March to 26th June. The results revealed that only seven cultivars flowered under controlled photoperiod as compared to none under natural conditions. Plants under controlled photoperiod were taller as compared to natural photoperiod. Among seven cultivars, which flowered under controlled photoperiod 'Majoor Bosshardt Wit' took minimum number of short days (82.60 days) while Ajay the maximum (108.90 days).

I-26. Effect of corm size on growth and flower production in gladiolus

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The experiment was conducted at Floriculture Research Scheme, ASPEE College of Horticulture and Forestry, Gujarat Agricultural University, Navsari, during the year 2001- 2002 with an objective to find out suitable size of planting corms for proper growth, flowering, corms and cormels production of the gladiolus plant cv. Sancerree. The treatments comprised of large (above 4.5 cm diameter), medium (3 to 4.4 cm

diameter) and small (below 3 cm diameter) size corms. The experiment was replicated thrice. The results revealed that gladiolus planting with large size corms showed early corm sprouting, maximum plant height, more production of leaves, maximum leaf area, highest dry matter production, early spike emergence, production of more spikes, maximum spike length and florets per spike, increased size of florets, maximum flowering duration and vase life of spikes as well as higher corms and cormels production as compared with that of planting medium and small size corms.

I-27. Effect of treatment of terminal cuttings with auxins on rooting in *Chrysanthenum morifolium* Ramat. cv. Snowball

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In *Chrysanthemum morifolium* Ramat. cv, Snowball, the treatment of terminal cuttings with IBA 400mg / l was the most effective with respect to rooting (88. 70%), number of roots (8.67) and plantlet weight (5.37g). The treatment of cuttings with IBA 50 mg/i + NAA 50 mg/l resulted in the maximum root length (0.95cm). The minimum mean number of roots (3.00), average root length (0.45cm) and plant weight (2.93g) resulted in the control. Further, the time of planting of cuttings, i.e., 1st week of, June and 1st week of July, had non significant effect on per cent rooting and number of roots per cutting, however, the average length of roots and plantlet weight were more in the cuttings planted in 1st week of July than 1st week of June. In the present findings, I-hc treatment of cuttings with IBA 400mgll was the best in difficult root.

I-28. Effect of spacing and levels of nitrogen and phosphorus on growth, flower and seed yield of China aster (*Callistephus chinensis* Nees) cv. Kamini

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An investigation was carried out during kharif season of 2000-01 to deduce the effect of spacing and levels of nitrogen and phosphorus on growth, flower and seed yield of China aster cv. Kamini. The experiment was laid out in split plot design with three replications and 15 treatment combinations consisting of three levels of spacing (30x40, 30x30 and 30x20 cm) with five levels of nitrogen and phosphorus (90:60:60, 135:90:60, 180: 120:60, 225:150:60 and 270: 180:60 kg ha^{-1}).

The results of the experiment showed higher flower yield (5.42 t/ha) and seed yield (3.90 q/ha) in 30x20 cm spacing. In respect to fertilizer application, the dose of 180:120:60 kg NPK per hectare recorded higher flower yield (5.62 t/ha) and seed yield (3.98 q/ha). Among different interactions, 30 x 20 cm spacing and 180:120:60 kg of NPK per hectare contributed more flower yield (6.32 t/ha) and seed yield (4.57 q/ha). The better flower and seed quality with more shelf and vase life was noticed in 30 x40 cm spacing and 135:90:60 kg of NPK per hectare. The higher net returns (Rs. 45859) and higher C: B ratio (2.72) were observed in the interaction of 30 x20 cm spacing and 135:90:60 kg of NPK per hectare.

I-29. Performance of china aster varieties at different dates of planting under north eastern dry zone of Karnataka

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A study on the performance of aster varieties at different dates of planting on growth and flower yield was undertaken during the year 1999. The experiment was laid out in factorial RBD with three replications and 12 treatment combinations formed by three varieties (Kamini, Aster Purple and Aster White) and four dates of planting (Second week of August, First week of September, Fourth week of September and Third week of October).

The results of the experiment revealed higher flower yield in second week of August planting (5.22 t/ha) which was followed by fourth week of September planting (4.96 t/ha). Flower yield also varied significantly with the varieties. Kamini and Aster Purple recorded higher flower yield (4.91t/ha), while Aster White produced lesser flower yield (4.24 t/ha). With respect to interactions, the variety Aster Purple planted at second week of August recorded higher flower yield (6.28 t/ha), while Aster White and Kamini produced more flower yield at fourth week of September planting (5.21 and 5.16 t/ha, respectively). In vase life studies for different varieties, the variety Kamini lasts longer (10.8 days) as compared to Aster Purple (9.2 days) and Aster White (8.4 days) at one per cent sugar solution.

I-30. Effect of seasons on the stalk length of carnation

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Carnation is one of the valuable cut flowers grown commercially in many parts of the world. in an export oriented cut flowers like carnation, the quality of the flowers in meeting the export standard is of prim consideration. Lengtheir flower stalk is most important factor for flower production. Climatic conditions play an important role in increasing the stalk length. Therefore a trail was conducted at Horticultural Research Station, Kodaikanal to find the suitable season for cultivating the carnations of export standards. Cutting of Arthur sim variety of carnation were planted in five season viz., November, December, January, February and March and it was found that the stalk length was more in the month of March and least in the month of December at Kodaikanal condition.

I-31. Effect of bio fertilizers on growth and flowering in Anthurium (*Anthurium andreanum* Lind) cv. Temptation

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Investigations were carried out at the Department of Floriculture and Landscaping, Tamil Nadu Agricultural University, Coimbatore to study the effect of bio-fertilizers on growth and flowering in anthurium (*Anthurium andreanum)* cv. Temptation. The experiment was conducted with the bio-fertilizers viz., Azospirillum, Phosphobacterium and VAM and growth regulators GA_3 with inorganic fertilizers (nitrogen, phosphorus and potassium) at six different concentrations, replicated thrice in a completely randomized design. The results indicated that NPK @ 30:10:10 at 0.2 per cent + GA_3 200ppm in combination with Azospirillum, Phosphobacterium and VAM each @ 2g per plant given as a root dip treatment by preparing slurry significantly influenced the plant growth, flowering and vase life of flowers.

I-32. Effect of photoperiod on growth and flower yield of chrysanthemum (*Dendranthema grandiflora*) under Coimbatore condition

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Uniform suckers of chrysanthemum variety Co.1 collected from Floriculture Unit, were utilized for this study. The plants were provided with artificial long day condition by using 60 watts incandescent lamps (1 light per m^2 placed above 80 cm from plant tip) during the night for different durations starting from 12 mid night onwards. These treatments were imposed on the plants grown during August, October and December months. Artificial short day condition was created by using semi-circular mini tunnel shaped 100 gauge black polythene sheet placed over the potted plants. The covering was continued up to the stage till 60-70 per cent of the buds showed colour. Short day treatments were given to the plants grown during February, April and June months. Extending two hours light with 60 watts incandescent lamps found to be effective on plant growth and flower yield during all the three short day months viz., August, October and December plantings. By providing artificial short day condition with semicircular mini tunnel shaped 100 gauge black polythene sheet proved to be the best for better plant growth and flower yield during the long day months, viz., February, April and June plantings

I-33. Influence of nutrient and growth regulators in anthuriums

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An experiment was conducted to study the response of the plant to various combinations of inorganic nutrients such as nitrogen, phosphorus, potassium, calcium and magnesium and growth regulators like benzyl adenine and gibberellic acid and to standardise the nutrition requirement for anthurium so as to increase the yield and quality of flowers.

The plants of anthurium cv. Lady Jane were sprayed with different combinations of NPK, Ca and Mg. The number of leaves, flowers and suckers per plant were the highest in the treatment NPK 20:20:20 + Ca + Mg followed by NPK 20:20:40 + Ca + Mg. The highest stalk length, spathe length and width and spadix length were registered in the plants sprayed with NPK 20:40:40 + Ca + Mg.

The plants of anthurium cv. Verdun Red were sprayed with BA 50, 100, 150, 200 and 250 ppm GA_3, 50, 100, 150 and 200 ppm with water spray as control. There was significant variation in the yield and quality of flowers due to the appliction of growth regulators. The highest number of leaves was recorded in GA_3 200 ppm and 150 ppm. The same treatments registered the highest number of flowers. The stalk length of the flowers was the greatest in BA 250 ppm followed by GA_3 200 ppm. The spathe length and width were the highest in BA 250 followed by BA 200 ppm.

I-34. Role of organic mulches and foliar nutrition on the growth and yield of tuberose (*Polianthes tuberosa* L.)

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The present investigation on the yield improvement in tuberose was carried out in the Department of Horticulture, Faculty of Agriculture, Annamalai University. The experiment was laid out in a split plot design with three main plot treatments and four sub plot treatments. The treatments in main plots consisted of application of sugarcane trash mulch at 10 cm thickness, application of paddy straw at 10

cm thickness and control. The sub plot treatments included control, 1:5 dilution vermiwash spray, 0.1 per cent humic acid spray and 0.5 per cent amino acid spray. Significant effects due to application of mulches and foliar sprays and their interactions were found in the growth and yield parameters of tuberose. The highest response to growth and yield characters was recorded in the interaction, sugarcane trash mulching along with 0.1 per cent humic acid spray. It was closely followed by application of sugarcane trash mulching along with 0.5% amino acid spray.

I-35. Comparison of dates of planting and growing conditions on growth and flowering of african marigold *(Tagetes erecta)*

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An investigation was carried out at the Experimental Farm, Dept. of Horticulture, Assam Agricultural University, Jorhat, during 2001-2002 with a view to study the effect of dates of planting on growth and flowering of African Marigold cv. Giant Double African Orange. The treatments comprised of 4 planting dates, namely, 15 January, 15 April, 15 July and 15 October and two growing conditions (in open field and under plastic rainshelter). The experiment was laid out in Factorial Randomised Block Design replicated thrice. Among the different dates of planting, 15 October planting resulted in the highest survival percentage (100), plant spread (54.89 cm) and number of branches (40.67), followed by 15 January planting. 15 April planting recorded maximum plant height at 30, 45, 60 DAT (72.97, 104.64 and 117.93 cm, respectively) followed by July planting. The maximum number of flowers/plant (46.93), flower size (7.04 cm), longer shelf life (8.84 days), days to fading (91.49), flower fresh weight (8.35 g) and dry weight (0.81g/flower) as well as flower yield/plant and flower yield/ha (32.69 t/ha) were recorded under October planting (72.57 days), while the minimum was recorded under January planting (52.83 days). Almost all the dates of planting exhibited significantly better growth and flowering under plastic rainshelter as compared to open field conditions.

Thus, October planting in open field condition and July planting under rainshelter can be considered as the best treatment combinations for the winter and rainy season, respectively.

I-36. Effect of growth regulating chemicals on growth and flowering in calendula

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A field trial was conducted at Floriculture Section, Department of Horticulture, G. B. Pant University of Agriculture and Technology, Pantnagar during 2001-2002 to study the beneficial effect of plant growth regulators. Plants of *Calendula officinalis* were sprayed with various chemicals i.e. GA_3 at 100 and 200 ppm, BA and ethrel both at 50 and 100 ppm at 30 and 60 days after transplanting to run-off stage. Control plants were sprayed with distilled water in the same manner. All the plants received uniform cultural practices. Experiment was laid out in a randomized block design with three replications. GA_3 at 100 ppm significantly increased fresh weight of leaf and diameter of flower, which was at par with GA_3 200 ppm. However, maximum fresh and dry weight of leaf biomass, leaf area index, number and weight of flowers were conspicuously increased due to GA_3 200 ppm spray. Early flower bud initiation and flowering were observed in the plants treated with 50 ppm ethrel but these parameters were at par with ethrel 100 ppm and GA_3 100 ppm treatments. All the chemicals failed to give any spectacular effect on number of branches/ plant.

I-37. Effect of fertilization on growth, floral characters and essential oil yield of henna (*Lawsonia inermis* L.)

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Henna (*Lawsonia inermis* L.) is an ornamental garden shrub or hedge plant of Indian origin. The flowers of henna have a strong aroma and yield an essential oil of brown or dark brown colour and a strong fragrance suggestive of tea rose and mignonette. Henna oil has been used in perfumery and also possesses medicinal value. It is commercially cultivated in Rajasthan, Haryana, Punjab, Gujarat and Madhya Pradesh. In Rajasthan, it is cultivated chiefly in the Pali, Sojat, Marwar and Jaitaran tehsil of Pali and Medta tehsil of Nagaur in an area of 15402 ha.

The research work was conducted at Rajasthan College of Agriculture, Udaipur during two consecutive years 1994-95 and 1995-96 with the view to study plant growth, floral characters and essential oil yield of henna as affected by the application of nitrogen and phosphorus. The crop was fertilized with four levels of nitrogen, viz., 0, 40, 80 and 120 kg ha^{-1} and three levels of phosphorus, viz., 0, 30 and 60 kg ha^{-1}. The experiment was laid out in factorial randomized block design with three replications. The crop fertilized with nitrogen at 120 kg ha^{-1} and phosphorus at 60 kg ha^{-1} showed significantly increased plant height, number of branches per plant, number of inflorescences per plant, weight of flowers per plant, essential oil content in flowers and yield of essential oil per plant. It was further noticed that interaction effect between nitrogen and phosphorus was also significant on growth and yield characters. Nitrogen at 120 kg ha^{-1} along with phosphorus at 60 kg ha^{-1} recorded the maximum plant height, number of branches per plant, number of inflorescences per plant, weight of flowers per plant, essential oil content in flowers and yield of essential oil per plant, which were significantly higher over rest of the treatments.

I-38. Effect of slow release and organic fertigation on pot mum production

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Studies on the effect of slow release and organic fertigation on pot mum production *(Chrysanthumum morifolium* Ramat) were carried out in naturally ventilated green house at Annamalainagar with three varieties and seven levels of nutrients. The nutrients included N_1 - constant liquid fertilizer (CLF) 20: 10: 10 NPK applied @ 300 mg $litre^{-1}$ at each irrigation, N_2 -alternate liquid fertilizer (ALF) 20:10:10 applied @ 600mg $litre^{-1}$ alternated with tap water irrigation; N_3- slow release resin coated fertilizer (SRR) Agrobloom (20: 10: 10) applied @ 10g pot^{-1} ; N_4- slow release resin coated fertilizer (SRR) Agrobloom @ 20g pot^{-1}; N_5- slow release osmocote tablets (OC) (10:10:10) applied @ 5g pot^{-1}; N_6 -constant organic liquid feeding (OLF) with Zymosol applied at each irrigation and N_7- granular feeding applied at 1.4 g each of N,P and K pot^{-1}. The three varieties included were Sun Gold (V_1), Beautiful Lady (V_2), Wilson's White (V_3). Effect of 21 factorial combinations were studied on the rate of plant height, number of leaves, leaf area, chlorophyll content, stem girth, dry weight, days taken for first flowering, stalk length, flower diameter, period of flower retention and vase life. Among the liquid feeding treatments, constant liquid feeding with an organic fertilizer, Zymosol showed good quality plants and flowers. Of the three slow release fertilizers, Agrobloom @ 20g pot^{-1} was found to be superior. Among the twenty one treatment combinations the variety Beautiful Lady at constant organic liquid feeding with Zymosol showed good quality plants and flowers with a stalk length of 53.33 cm and diameter of 7.1 cm.

I-39. Effect of nitrogen on growth performance of two lawn grass species

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A field trial was carried out on two lawn grass species (doob grass and bahia grass) with 5 levels of nitrogen to see their growth performances under Jorhat, Assam conditions. The observations on shoot length, fresh weight of clipping, chlorophyll content of leaf and per cent nitrogen content of shoot tissues were recorded at monthly interval. The result revealed that the increase of nitrogen levels from 0-40 g/m^2 increased the average shoot length (12.07 cm, 11.02 cm), fresh weight of clipping (287.17 g/m^2, 232-12 g/m^2, chlorophyll content of leaf (1.70 mg/g, 1.40 mg/g) and per cent nitrogen content of shoot tissues (3.32, 1.84). The dry weight percentage of clipping gradually decreased with an increase in the levels of nitrogen. The highest dry weight percentages were obtained during the month of February in both the grass species. Irrespective of grass species the maximum shoot length, fresh weight of clipping and chlorophyll content were observed in the month of July whereas, the highest percentage of nitrogen content of shoot tissue was observed in the month of February.

I-40. Effect of plant growth regulators on yield and vase life of gaillardia (*Gallardia pulchella*) cv. "Lorenziana"

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The effect of plant growth regulators on flower yield and vase life of gaillardia (*Gaillardia pulchella*) var. "Lorenziana" was studied at the College Nursery, B.A. College of Agriculture, Gujarat Agricultural University, Anand Campus, Anand during the summer season of 1998. The treatments comprised of three different concentrations of GA_3 (50, 100 and 150 ppm). MH (50, 100 and 150 ppm), CCC (1000, 2000 and 3000 ppm) and ethrel (250, 500 and 750 ppm) including control (water spray) and absolute control (without water spray). The treatments were laid out in a Randomized Block Design with 14 treatments replicated thrice.

The results revealed that significantly highest flower yield was recorded in GA_3 150 ppm (11.18 t/ha) followed by GA_3 100 ppm (9.90 t/ha) and CCC 3000 ppm (9.67 t/ha), which were statistically at par. Lowest flower yield was recorded in MH 150 ppm (5.25 t/ha) which was statistically at par with control (6.27 t/ha) and absolute control (6.24 t/ha). From the vase life point of view, it could be inferred that CCC 3000 ppm ranked first (39.40 hrs) followed by CCC 2000 ppm (38.45 hrs) and CCC 1000 ppm (37.55 hrs.) in improving the vase life of gaillardia.

I-41. Effect of different growing environment on growth and flowering of gerbera (*Gerbera jamesonii* L.)

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Three hybrid varieties of gerbera namely Safrom, RH_1 and RH_2 were grown in sub-tropical plains of West Bengal under five growing environments, viz., open condition, low cost polyhouse and 25, 50 and 75 per cent shades at the Horticultural Research Station, Mondouri, BCKV, West Bengal during 2000-2003. The various growth and flowering characters were evaluated under different growing conditions. The plant height was the maximum (31.0 cm) in cv. RH_2 under 25 per cent shade. The number of flowers was

improved under 25 per cent shade irrespective of varieties grown (7.33 in Safrom, 7.00 each in RH_1 and RH_2). Stem length was not affected statistically by the shade levels but by the varieties or shade x variety interactions. The cultivar RH_1 grown under low cost polyhouse had the longest stem (48.0 cm) followed by cv. RH_2 under 50 per cent shade (47.33 cm). All the cultivars produced thicker stems under open conditions (0.68 cm in safrom; 0.62 cm in RH_1 and 0.60 in RH_2) as compared to other shade conditions. The diameter of the flower was the maximum (9.41 cm) under 25 per cent shade, followed by the same variety under open condition (9.04 cm). The formation of the first flower was hastened in cv. Safrom under 75 per cent shade (223.33 days) followed by the same cultivar under 25 per cent shade (239.66 days). The flowers of cv. RH_2 remained fresh for a longer time in the field (29 days) under low cost polyhouse followed by cv. Safrom (28.16 days) under 75 per cent shade.

I-42. Influence of potting media on acclimatization and growth of *in vitro* developed plantlets of *Cymbidium* hybrids

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Studies on the effect of different substrates, viz., coco pith, coco pith + leaf mould, coco pith + leaf mould + tree fern, coco pith + leaf mould + tree fern + brick pieces, coco pith + leaf mould + tree fern + bricks pieces + charcoal, coco pith + sand and leaf mould on establishment and growth of tissue culture regenerated plants were carried out to find out the suitable media for *ex vitro* hardening of *in vitro* raised plantlets of *Cymbidium* hybrids. The experiment was laid out in Randomized Block Design and replicated thrice. The results showed that the plantlets grown in coco pith resulted in maximum increase in shoot length (15.02%) with broad leaf, whereas the plantlets grown in coco pith along with sand resulted in maximum increase in leaf number (42.31%) and leaf length (32.24%). Better growth of plantlets in respect of vegetative parameters in coco pith and coco pith along with sand medium may be attributed to proper drainage and aeration, which is a requisite for better establishment of *in vitro* raised plants. Plantlets grown in leaf mould resulted in maximum mortality, due to water logging and fungal infection. Thus, coco pith alone and in combination with sand is best suitable for the acclimatization of *in vitro* raised seedlings of *Cymbidium* hybrid Lunavian Atlas, Golden Girl and *Cymbidium lowianum* X Showgirl.

I-43. Effect of urea and boron on growth, flowering and bloom quality of rose

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The experiment was carried out to study the effect of urea at 0.5, 1.0 and 1.5 per cent and borax at 0.05, 0.10 and 0.20 per cent on the growth, flowering and bloom quality of rose cv. 'Super Star'. The vegetative growth was significantly enhanced by urea at 1.5 per cent but flowering characters were good with urea at 1.0 per cent although longevity of flowers in the field and keeping quality of cut flower in vase were reduced with increasing doses of urea. The longevity of flowers in the field as well as keeping quality of cut flowers in vase were found to be maximum with borax at 0.1 per cent.

I-44. Performance of *Lilium* under Bangalore conditions

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Four exotic cultivars of *Lilium* namely Navona, Pollyanna, Elite and Brunello were planted in pots and evaluated for two consecutive seasons under open conditions in Bangalore. During both the seasons, cent per cent establishment was observed in all the cultivars. Vegetative growth attained a peak after 45 days of planting, after which first flower bud initiation was visible in the leaf whorl. Flowering was observed after 60 days of planting, after which the bulbs entered a period of dormancy. Low temperature treatment was required for breaking dormancy. The number of flowers per inflorescence was reduced during the second season in all the cultivars. During the first season the number of flowers per inflorescence ranged from 2-6 in Navona, 2-4 in Pollyanna and 2-3 in Elite and Brunello. During the subsequent season, the number of flowers was reduced to 1-3 in Navona, 2-3 in Pollyanna, and 1-2 in Elite and Brunello.

I-45. Effects of major nutrients on growth and yield of jasmine cv Udupi mallige

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A field investigation on requirement of major nutrients of jasmine c.v. Udupi mallige was carried out consecutively for three years from 1999 to 2002 at Zonal Agricultural Research Station, Brahmavar, Udupi District, Karnataka.

The trial consisted of eight treatments replicated thrice in a randomized complete block design. The study revealed significant variations among the treatments with respect to canopy spread, number of branches, flower yield and 100-flower weight. The treatment 120 (75% GNC*+ 25% Urea): 240:240 NPK g/bush/year recorded significantly higher flower yield than the rest of the treatments. However, this treatment was at par with the treatment 120 (75% GNC*+ 25% Urea): 240:240 NPK g/bush/ year with regard to the canopy spread and 100-flower weight. The flower attributes viz., length of flower bud, flower diameter and corolla tube length did not show any significant variation among the treatments. Of the total production, 74.68 per cent was realized during the months March to June and 25.32 per cent was realized during the months from November to February and there were absolutely no flowers during the months from July to October.

I-46. Growth, yield attributes and yield of California poppy as influenced by plant growth regulators

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A field experiment was conducted during 2001-2002 at Floriculture Section, Department of Horticulture, G. B. Pant University of Agriculture and Technology, Pantnagar to evaluate the effect of plant growth regulators on growth parameters and seed yield in California poppy. Plants were treated with different concentrations of various plant growth regulators i .e., GA_3 at 100 and 200 ppm, BA and IAA both at 50 and 100 ppm and control (distilled water). Treatments were given twice at 30 and 60 days after transplanting as spray to run-off stage. Experiment was laid out in a randomized block design with three replications. GA_3 at 100 ppm resulted in significant increase in number of branches/plant, fresh weight of leaves,

number of seeds/ capsule, whereas maximum leaf area, fresh and dry leaf biomass/ plant, early ripening of seeds and seed yield/ plant were recorded with GA_3 200 ppm treatment. Spray of IAA at 100 ppm was found beneficial for production of maximum weight of seeds/capsule and heavier seeds, followed by GA_3 at 200 ppm application in California poppy.

I-47. Influence of different levels of N, P and K on growth, flowering and shelf file of tuberose (*Polyanthes tuberosa* L.) (cv. Double)

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Field and lab experiment study were carried out at ARS, Kathalagere, UAS, Banglore to know the effect of different levels of N, P and K on growth, flowering and post harvest characteristics of tuberose (cv. Double). The plants provided with 150:50:50 kg of N, P and K/ha ($N_3P_2K_2$) recorded significantly highest plant height (52.80 cm) and more number of leaves (51.10). The plants fertilized with 150:75:25 kg of N, P and K/ ha ($N_3P_2K_2$) took minimum number of days (208), to emergence of spike and also first floret opening (16). The highest level, 150:75:75 kg NPK/ha ($N_3P_2K_2$) recorded the highest number of florets per spike (54.7) where as the minimum number of florets per spike (43.10) was found with 50:50:25 kg NPK/ ha ($N_1P_2K_1$). The higher dose of NPK had significant effect on longevity of spike. The treatment 150:75:75 kg NPK/ha ($N_3P_3K_3$) registered maximum longevity of spike (46 days). The number of bulbs produced per plant was maximum (19.3) in the plants provided with 150:50:50 kg NPK/ha ($N_3P_2K_2$) where as the highest number of bulblets (36.0) were recorded in the plants supplied with 150:50:50 kg NPK/ha ($N_2P_2K_2$) and bulb number was minimum (6.2) in plants provided with 50:25:25 kg NPK per hectare ($N_1P_1K_1$), and the minimum number of bulblets (10.2) obtained in 50:25:75 kg of NPK ($N_1P_1K_3$). The maximum vase life period (18.0) was noticed in the plants supplied with N,PK of 150:50:50 kg per hectare ($N_3P_2K_2$) and the minimum vase life (7.0) was observed from the plants supplied with NPK of 50:25:50 kg ($N_1P_1K_2$) per hectare.

I-48. Effect of frequency of irrigation and its influence on pre and post harvest physiology of tuberose (*Polyanthes tuberosa* cv. Double.)

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The experiment was carried out at ARS, Kathalagere, to know the effect of frequency of irrigation on growth, flowering and vase life of tuberose cv. Double. The results of the trial revealed that the plants irrigated at lower interval of once in 5 days recorded minimum number of days (206.56) for emergence of flower spike. The maximum length of spike (110.34 cm), length of rachis (42.58 cm), and number of florets per spike (58.78), were recorded in the plants provided with 5 days irrigation interval. Maximum percentage of open florets per spike (74.70) and the longevity (31 days) were also recorded in the plants irrigated at 5 days interval. The plants provided with irrigation once in 5 days registered highest number of bulbs (6.24) and bulblets (20.64). The maximum weight of the bulbs (86.64g) and bulblets (35.56 g) were also noticed in the plants received 5 days irrigation interval. Vase life of spike was maximum (13.40) at the plants irrigated at lower intervals of once in 5 days when compared to other longer irrigation interval.

I-49. Effect of vermicompost and bio-fertilizers on growth and yield of gerbera (*Gerbera jamesonii* L.) cv. Local

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Investigation was carried out to study the effect of vermicompost and biofertilizers along with different levels of inorganic fertilizers on growth, yield, vase life and economics of gerbera cv. Local. Application of vermicompost and biofertilizer along with reduced dose of chemical fertilizers had beneficial effects compared to application of inorganic fertilizers alone.

Maximum plant height, number of leaves and suckers were obtained in plants treated with vermicompost 15 tonnes per hectare plus 75 per cent recommended NPK. Least number of days taken for first bud appearance, first flower opening and 50 per cent flowering were recorded in plants treated with *Azospirillum* plus VAM plus 50 per cent NP plus recommended K.

Maximum flower yield, flower diameter and stalk length were recorded in treatment vermicompost 15 tonnes per hectare plus 75 per cent recommended NPK. Flowers harvested from treatment *Azospirillum* plus VAM plus 50 per cent recommended NP plus recommended K recorded highest vase life. Application of vermicompost 10 tonnes per hectare plus 75 per cent recommended NPK, recorded the maximum benefit cost ratio.

I-50. Studies on the growth and flowering behaviour of *Phlox drummondii* as affected by foliar sprays of cytozysme and nephthalene acetic acid (naa).

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An experiment was conducted to study the effect of growth and flowering behaviour of phlox (*Phlox drummondii*) as affected by foliar spray of cytozyme and naphthalene acetic acid (NAA) during the year 1996-97 at the R.B.S.College, Bichpuri, Agra, under pot conditions using mixture of sand, garden soil, and F.Y.M. in the ratio of 2:2:1. The experiment was laid out in randomized block design with four replications. In the treatment combinations comprising of three concentrations of cytozyme, viz. 0.0 (C_0), 0.1(C_1), 0.2 per cent (C_2) and four concentrations of NAA i.e., 0 (N_0), 25 (N_1), 50 (N_2) and 75 ppm (N_3). It was found that plant height and other growth parameters exhibited superior performance when the plants were sprayed with 0.2% cytozyme and 75 ppm NAA. The maximum number of leaves (121.58) per plant at the commencement of blooming, number of flowers per plant (108) and per bunch (10.16) were affected most significantly in the plants sprayed with C_2 (0.2% cytozyme). Considerable delay in the visibility of flower buds and flowering, was also noted in both cases, owing to the application of cytozyme at its various concentrations, and the delay was proportionate to the concentration of this chemical. Likewise, significant response on growth parameters was also observed in the plants sprayed with cytozyme and NAA concentrations.

1-51. Effect of GA_3 and NAA on growth and flowering of French marigold

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Studies were undertaken during 2002-03 to investigate the effect of GA_3 (0,150,300 and 450 ppm) and NAA (0,·50, 100 and 150 ppm) on the growth and flowering of French marigold. The results revealed that

GA_3 at 450 ppm proved very effective in increasing the plant height, number of branches, number of flowers and flower yield. Treatment with 100 ppm NAA proved very effective in increasing the flower weight.

I-52. Effect of fertilizer on growth and yield of tuberose (*Polianthes tuberosa* L.) cv. Single in the plains of West Bengal

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A field experiment was conducted at Horticultural Research Station, Mondouri, Nadia, West Bengal, India, to investigate the effect of nitrogen, phosphorus and potash on growth and flowering of tuberose (*Polianthes tuberosa* L.) cultivar Single in two consecutive years (1999-2000, 2000-01). The application of 20 g/m2 each of N, P2O5 and K2O recorded the highest plant height, number of leafs and spike length. However N, P2 O5 and K2O at the rate of 20, 15 and 20 g/m^2 respectively, improved spike weight and yield, and number of floret per spike for first year. Application of 15g each of N, P2O5 and K2O / m^2 improved plant height and leaf number in ratoon crop. However, N and P2O5 each at the rate of 15g/m^2 and K2O, 20g/m^2 improved spike length, weight and number of spike/m^2. Spike production was maximum with N, P2O5 and K2O at 20, 15 and 15g/ m^2 respectively, in ratoon crop. The lower doses of fertilizer produced poor quality plant and yield of flower. Thus N, P2O5 and K2O at the rate of 15, 15 and 20g/ m^2 per year, respectively, for two year crops produced good quality plant and improved the yield of flower spike.

I-53. Effect of extended lighting on growth and flowering of carnation (*Dianthus caryophyllus* L.)

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Studies on the effect of extended lighting on growth and flowering of carnation were condiucted in the Department of Floriculture and Landscaping of Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni – Solan (H.P.) during 2000-2001. Four commercial cultivars viz., 'Impala' and 'Super Star' among standards and 'Veleta' and 'Fantasia' among sprays were grown under three lightning regimes i.e. 6 hours, 4 hours and no extra lighting (control). The experiment was laid out in RBD with four replications. Studies reveal that all cultivars differed from one another with respect to pant height, number of cut stems per plants tem length and flower size. The plant of cultivar 'Impala' were tallest 76.89 cm) with maximum stem length (67.47 cm). However, flower size was maximum of 'Super Star'. Four hour extended lighting increased the plant height of all the cultivars most effectively except 'Fantasia'. Earliest flowering in all the cultivars was observed under six hour extended lighting regime.

I-54. Effect of different environments on growth and flowering of pot plants

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Under North Indian climatic conditions, pot plants exhibit variable response during different periods of the year. In order to ascertain their relative performance under different environments, an experiment was

conducted with two foliage pot plant species, i.e., *Codiaeum variegata* var. Spirale and *Schefflera venulosa* and two flowering pot plants *Begonia* x *Erythrophylla* and *Kalanchoe blossfeldiana* grown under four environments, i.e., open conditions (control), under trees, under net house and under polyhouse. Non-significant variation was recorded between foliage plant species for plant height, plant spread and number of branches. Maximum plant growth (33.33 cm), plant spread (28.75 cm), number of branches (2.00) and number of leaves (25.00) were recorded when the plants were grown under trees. In case of flowering pot plant species, Maximum number of leaves (55.17) and maximum number of flowers (7.17) were recorded under control i.e. open condition.

I-55. Effect of H_2SO_4 NaOH and auxin treatment on rooting of stem cuttings in *Juniperus chinensis*

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Basal dip treatment with H_2SO_4 and NaOH alone at all concentrations ranging from 2N to 10N failed to improve the rooting of cuttings in *Juniperus chinensis.* However, the treatment with H_2SO_4 followed by that with IBA 2000 ppm induced maximum rooting (90%), significant increase in root length (12.75 cm) and maximum number of roots (10.33). Hence, treatment with H_2SO_4 followed by IBA 2000 ppm has been rated the best treatment for rooting of stem cuttings of *Juniperus chinensis.*

I-56. Growth and flowering of gerbera (*Gerbera jamesonii* Bolus) as influenced by some plant growth regulators

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An experiment with three plant growth regulators viz., GA_3, NAA and CCC consisting of four concentrations each (GA_3 : 50, 100, 150 and 200 ppm; NAA : 100, 200, 300 and 400 ppm and CCC : 500, 750, 1000 and 1250 ppm) plus control was laid out in randomised block design replicated four times at Assam Agricultural University, Jorhat to study their effect on growth and flowering of gerbera cv. Popular. The results revealed that the maximum plant height was exhibited by spraying GA_3 200 ppm (41.68 cm) followed by NAA 400 ppm (41.36 m) and all other vegetative characters were enhanced by GA_3 150 ppm and NAA 300 ppm. All the vegetative characters were reduced by the highest concentration of CCC as compared to control. GA_3 150 ppm and NAA 300 ppm exhibited early flowering. Higher concentration of NAA (300 and 400 ppm) and CCC treatments produced the largest size of flowers (between 12.58 cm and 13.58 cm) as compared to control (9.62 cm). Higher concentrations of GA_3 and NAA produced the largest stalk length between 38.40 cm – 39.42 cm but CCC treatment produced shorter stalk length running from 26.50 cm – 28.53 cm as compared to control (36.49 cm). NAA 300 ppm (56.33) and GA3 150 ppm (54.35) produced the maximum number of flowers per plant whereas CCC treatments produced lower number of flowers (24.70 – 29.45) as compared to control (36.60). The CCC treatment above 1000 ppm increased the shelf life of flowers (24.50 days) as compared to control (20.25 days).

I-57. Response of nitrogen, phosphorus and pinching on growth and flower production of chrysanthemum (*Chrysanthemum morifolium* Ramat)

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A field experiment was conducted at Horticultural Instructional Farm, C.P. College of Agriculture, Gujarat Agricultural University, Sardar Krushinagar, during the years 1995 and 1996 to study the response of nitrogen, phosphorus and pinching on growth and flower production of chrysanthemum. Twenty seven treatments comprising of three levels each of nitrogen, viz., 100, 200 and 300 kg/ha; phosphorus 50, 100 and 150 kg/ha and pinching viz., no pinching, pinching at 30 and 60 days after planting were tested in Factorial Randomized Block Design with three replications.

Chrysanthemum crop fertilized with higher levels of nitrogen, viz., 200 and 300 kg/ha did not differ significantly, but recorded higher flower yield besides increasing all the growth and yield attributing characters. Number of flowers per plant and flower yield per plant and per hectare were found significantly higher at 100 kg P_2O_5/ha. Combined application of 200 kg N with 100 kg P_2O_5/ha significantly increased number of flowers per plant and flower yield per plant as well as per hectare.

Growth parameters such as number of branches per plant and plant spread significantly increased with plant pinched at 30 and 60 days after planting as compared to no pinching. Flower yield parameters, viz., number of flowers per plant and flower yield per plant and per hectare were significantly higher to pinching at 60 DAP as compared to pinching at 30 DAP and control.

For getting higher flower yield chrysanthemum crop should be fertilized with 200 kg N/ha and 100 kg P_2O_5/ha and pinching should be done at 60 days after planting under North Gujarat conditions, where soil is low in nitrogen and medium in phosphorus.

I-58. Rooting studies in *Jasminum sambac* with the aid of IBA under net house

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An experiment was laid out in factorial Complete Randomized Design having eight treatment combinations consisting of six levels of IBA, viz. 1000 mg l^{-1}, 2000 mg l^{-1}, 3000 mg l^{-1} 4000 mg l^{-1} and 5000 mg l^{-1} including control and three types of cuttings, viz.; hardwood, semi hard wood and softwood under white colour 50 per cent shade net house with an aim to obtain early and maximum root formation, performance of root growth and to standardize the type of cuttings and best concentration of IBA for large-scale multiplication of *Jasminum sambac* Ait. cv. Double Mogra at Regional Horticultural Research Station, Gujarat Agricultural University during the year 1999. Among the various levels of IBA, 4000 mg l^{-1} was proved to be the best for obtaining rooted cuttings, number of main roots, length and thickness of longest root, sprouting and number of shoots per rooted cutting as well as survival percentage of rooted cuttings. Hardwood cuttings were found most promising as compared with semi-hardwood and softwood cuttings.

I-59. Diagnostic survey for cultivation practices of flower crops

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The present investigation on diagnostic survey and appraisal of existing cultivation of flower crops under South Gujarat was carried out to know the existing cultivation practices of flower crops and to elucidate major constraints during the year 2000. The trends in cultivation practices involved in Hybrid Tea Rose,

Jasmin (Paras), marigold (African) and spider lily planted during rainy season while gaillardia, Deshi rose (*R. damascena*) and mogra *(J. sambac)* planted in winter season were studied. These are popular intercrops in lemon and sapota orchards and in cotton, tur and vegetables. It was found that majority of flower growers have introduced flower crops to obtain regular income. Marketing of flowers, labour, and their high wages, uneven supply of electricity, insect, pest and diseases, lack of irrigation facility and technical guidance were the main problems faced by flower growers. Majority of flower growers marketed their produce in nearby cities. Literature regarding flower crops and their cultivation technique, television programme, films about floriculture and demonstration plots at farmer's field were the important requirements emerged as findings of this study.

I-60. Effect of spacing and fertilizer levels on growth and flower production of annual chrysanthemum (*Chrysanthemum coronarium* L.) cv. Local White

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The present investigation was conducted at Department of Horticulture, B.A. College of Agriculture, Gujarat Agricultural University, Anand during 1997-98 with the objectives to develop production technology of chrysanthemum cv. Local White in respect of spacing and fertilizer requirements. Eighteen treatment combinatons consisting of three levels of spacing i.e. 45 x 15, 45 x 30 and 45 x 45 cm, three levels of nitrogen i.e. 100, 150 and 200 kg/ha and two levels of phosphorus i.e. 50 and 100 kg/ha were tried in split plot design with three replications. The closer spacing of 45 x 15 cm recorded significantly maximum plant height (142.22 cm) and flower yield per hectare (25.03 kg/ha) as compared to other treatments, while remaining growth parameters and flower yield/plant were significantly higher in wider spacing of 45 x 45 cm. The application of higher dose of nitrogen (200 kg/ha) and phosphorus (100 kg/ha) significantly increased all growth parameters and flower yield.

The results suggested that closer spacing S_1 (45 x 15 cm) and higher dose of nitrogen N_3 (200 kg N/ha) and phosphorus P_2 (100 kg P_2O_5/ha) are better for the higher flower yield (31.10 t/ha). However, for getting good quality flowers wider spacing (45 x 45 cm) with same dose of fertilizers is better.

I-61. Effect of CCC and B-9 on growth and flowering of off season chrysanthemum

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Studies on effect of CCC (2000 and 3000 ppm) and B-9 (2000 and 2500 ppm) on growth and flowering of thirty cultivars of chrysanthemum were conducted in off season flowering crop in the Department of Floriculture and Landscaping, UHF, Nauni during 2001-2002. Rooted cuttings of these cultures were transplanted on 26th April, 2001 in 10 cm earthen pots (one/pot), in soil, FYM and sand (1: 1: 1, v/v) medium. The trial was replicated thrice using CRD factorial. Soft pinching was done after 22 days of planting when plants attained a height of 8 to 9 cm. Growth retardants were sprayed until runoff, 28 days after pinching using hand sprayer when the breaks were 4 to 6 cm long. Control plants were sprayed with distilled water. After one week of retardant spray, short day conditions were provided by completely covering semicircular tunnel shaped metallic frames (3x1.5x1.65 m) with thick dark coloured tarpaulin for 16 hours daily (5 pm to 9 am). These covers were continued up to the stage till 60 to 70 per cent flower buds on plant showed colour. All growth retardant treatments reduced plant height and plant spread significantly over control. However, B-9 (2500 ppm) was found to be most effective and response varied

depending upon cultivar. Maximum reduction of 21.1 per cent was observed in "Snow Ball" with B-9 (2500 ppm). Number of side shoots per plant, number of short days for first flower opening, peak flowering and total number of days for peak flowering, duration of flowering and pot presentability were increased by all growth retardant treatments. Number of flowers per plant were also increased with all growth retardant treatments, except CCC at 3000 ppm.

I-62. Effect of plant growth regulators on gladiolus corms and cormel production

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The effect of various plant growth regulators on growth, corm and cormel production cv. Sancerree was studied during the year 2000-2001 at Floriculture Research Scheme, Gujarat Agriculture University, Navsari. The treatments comprised of three different concentrations of NAA (100,150, and 200 mg/l), GA_3 (100,150, and 200 mg/l), Ethrel (0.250, 0.375 and 0.500 ml/l) and water sprayed as control. The experiment was replicated thrice. The plants were sprayed at 4 and 6 leaf stages after planting. The results revealed that GA_3 at 100 mg/l produced the maximum plant height, number of leaves, leaf area and total dry matter. Likewise GA_3 at 100 mg/l also produced more number and heaviest corms and cormels with maximum diameter. From the results of the investigation, it could be inferred that spraying of GA_3 100 mg/l at 4 and 6 leaf stage after planting was most effective in improving the growth, corm and cormel production of gladiolus cv. Sancerree under South Gujarat conditions.

I-63. Effect of pant growth regulators on growth, flowering and quality of gerbera *(Gerbera jamesonii* Hook.) cv. 'Sangria'.

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The effect of various plant growth regulators viz., GA_3 (50, 100 and 150 mg/l), NM (50, 75 and 100 mg/l) and SA (50, 100 and 150 mg/l) on gerbera *(Gerbera jamesonii* Hook.) cv. 'Sangria' were studied in pot trial. Plants were sprayed with growth regulators twice, 40 and 60 days after transplanting. It was observed that GA_3 at 150 mg/l produced significantly maximum plant height, plant spread, leaf area, flower initiation, stalk length, stalk girth, flower diameter, number of flowers and weight of flower. SA at 100 and 150 mg/l is found more beneficial for vase life of flowers and number of leaves per plant, respectively. NM at all the concentrations delayed flowering.

I-64. Effect of different growth regulators on bulb scales of asiatic hybrid *Lilium* cv. Mercedes under *in vivo* conditions

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An experiment was conducted during 1999-2001 to study the effect of growth regulators on bulb scales of Asiatic hybrid *Lilium* cv. Mercedes under *in vivo* conditions. Three different concentrations (1, 10 and 100 ppm) of NAA, IBA and Kinetin were tried over the scales detached from outermost row of large sized bulbs (15 cm and above) in the month of October. The use of growth regulators was found to be beneficial for regeneration of microbulbs on lilium scales. Kinetin at 10 ppm resulted in maximum microbulb

production (3.02 per scale) and also resulted in maximum number (3.28) and length (12.72 cm) of leaves of these microbulbs. On the other hand, maximum number (3.83 per microbulb) and length (10.30 cm) of roots were observed with the treatment of scales with 10 ppm of IBA. As far as bulb parameters were concerned, Kinetin resulted in significantly higher bulb production (2.83 bulbs per microbulb) over NAA and IBA. However, the variations among various chemicals for bulb size and number and weight of bulblets were non-significant. Among various chemical concentrations, 10 ppm (cumulatively for all chemicals) resulted in significantly more size (8.35 cm) and weight (16.91 g) of bulbs as compared to control.

I-65. Effect of certain plant growth regulators on floribunda roses

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The effect of plant growth regulators on growth and flowering characters of floribunda rose cv. Iceberg was studied by spraying Gibberllic acid (100 and 200 ppm), Benzyle adenine (100 and 200 ppm), Salicylic acid (150 and 200 ppm) and Cycocel (1500 and 3000 ppm). The effect of growth regulators was significant on many parameters GA_3 200 ppm increased the shoot length and internodal length. Number of laterals and leaf area were maximum with Cycocel at 1500 ppm. More number of leaves per new shoot was observed in BA treatment at 200 ppm. Earliness in flowering and maximum number of flowers were recorded in Cycocel 1500 ppm. Maximum flower diameter and number of petals per flower were noticed with BA 150 ppm. Flower longevity was significantly more in BA 200 ppm treatment.

I-66. Effect of some growing media on production of *Anthurium andreanum* Lind. under Assam conditions

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Studies were undertaken in 2002-2003 in the Department of Horticulture, Assam Agricultural University, Jorhat with the objective of finding out the most suitable growing medium for *Anthurium andreanum*. The seven treatments consisted of two parts each of pine bark, water hyacinth, tephrosia, coconut husk, saw dust and rice husk in combination with one part of soil, one part sand, one part cowdung and half part charcoal and a control. Three anthurium cultivars namely, Agnihotri, Cherry Red and Sunset Orange were grown in these media in earthen pots kept in a bamboo frame agroshade net house with 80 per cent shading. At 360 days of planting, rice husk media produced the best vegetative growth (38.55 cm plant height, 26.16 cm leaf length, 12.52 cm leaf width and 10.97 leaves/plant) and good flower characters (3.31 flowers/plant, 5.27 cm spathe width, 32.04 cm stalk length), followed by pine bark, coconut husk and water hyacinth media. Coconut husk media produced flowers with maximum spathe length and took minimum time (25.24 days) to bloom from planting.

I-67. Gamma rays induced abnormalities in gladiolus cvs. Eurovision and Sylvia

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Gladiolus corms of cvs. Eurovision and Sylvia were irradiated with gamma rays from Co-60. Corms were treated with gamma radiations at 0-80 Gy. The plants produced a number of abnormalities during vegetative stage like brittle leaves, highly ribbed leaves, narrow leaves, stunted growth, branching of

spike and during flowering stage reduction in size of florets, number of florets per spike, shape of florets, change in floral aestivation, chimera formation, and changes in shape and number of anthers and stigma were observed. Cultivar "Eurovision" was found to be more sensitive to gamma irradiation.

I-68. Effect of gamma radiations (Co-60) on corm production in gladiolus

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Corms of gladiolus cultivars Eurovision and Sylvia were treated with gamma rays using Co-60 to study its effect on corm production. Number of cormels per plant, weight of cormels, size of corm and weight of corms were recorded after harvesting. High doses of gamma radiations at 60-80 Gy were found to be injurious to plants and had adverse effects on corm production. The corm size, weight of corms, number of cormels and weight of cormels reduced with increase in dose of gamma rays after an optimum dose. The corm weight was found to be maximum (99.9 g) at 40 Gy. Cultivar Eurovision was more responsive to gamma radiations than cv. Sylvia.

I-69. Effect of urea and gibberellic acid on growth and seed yield in petunia

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An experiment was carried out during 2002-2003 at Floriculture Section, Department of Horticulture, G. B. Pant University of Agriculture and Technology, Pantnagar to study the response of foliar spray of urea and gibberellic acid on growth and seed yield in *Petunia hybrida.* Plants were raised in nursery beds and one month old seedlings were transplanted to the main field. After 30 days of transplanting, plants were treated with urea (0.5, 1.0 and 1.5 %), GA_3 (50, 100 and 150 ppm) and control (distilled water) as foliar spray to run off stage. Second spray was given one month later of the first spray. Uniform cultural practices were adopted to all the treatments. Experiment was replicated three times in a randomized block design.

Number of basal branches per plant and plant height were significantly influenced. Maximum number of basal branches per plant was recorded with GA_3 100 ppm, whereas urea at 1.5% significantly increased plant height, which was on par with 100 and 150 ppm GA_3. GA_3 150 ppm resulted in minimum days to seed ripening whereas it was maximum with 1.5% urea. Maximum weight of seed and number of seed per pod were observed with higher concentration of urea (1.5%). However, weight of seed per plant and seed yield per square meter were noticed under 50 ppm GA_3 followed by 100 ppm GA_3.

I-70. Evaluation of coir pith as a growing medium for anthurium

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An experiment with the objective to evaluate the suitability of coir pith as a growing medium for anthurium was conducted using uniform plants of three varieties of *Anthurium andreanum viz.,* Lima White, Eureka Red and Hawaiian Red. The treatments included were T_1 - coarse sand + dry cowdung, T_2 - coarse sand + dry cowdung + coir pith, T_3 - coir pith alone, T_4 - coir pith + coarse sand, T_5 - coarse sand + dry cowdung + coconut husk bits, T_6 - coarse sand + coconut husk bits + coir pith, T_7 - coarse sand + dry cowdung + coconut husk bits + coir pith.

Study of physical properties of the growing media showed that the highest moisture percentage was in the medium containing sand, cowdung and coconut husk in equal proportions (16.05%). Water holding capacity was the highest in the growing medium of coir pith alone (267.76%), and the lowest, in the medium with sand and cowdung in equal proportions (35.70%).

In all the varieties, plant height, spread and leaf length varied significantly as influenced by the treatments. There was no significant variation in number of leaves and number of flowers.

In Lima White, plants were the tallest (54.67 cm.) in T_6 containing coarse sand + coconut husk + coir pith, which was on par with T_1 (coarse sand + dry cowdung), T_2 (coarse sand + dry cowdung +coir pith) and T_7 (coarse sand + dry cowdung + husk + coir pith). Similar trend was observed with respect to plant spread and leaf length. The results obtained in 'Hawaiian Red' were also the same.

In 'Eureka Red', plant height, spread and leaf length varied significantly among the treatments. Plants were the tallest in T_1 (56.75 cm.) containing coarse sand + dry cowdung which was on par with T_2 (coarse sand + dry cowdung + coir pith) and T_6 (coarse sand + coconut husk + coir pith). Plant spread and leaf length were also significantly higher in these treatments.

It was concluded that in anthurium, coir pith can be used with sand and cowdung as a growing medium. It can also substitute cowdung if used along with sand and coconut husk in equal proportions. Coir pith alone is not a good medium for anthurium because of the high water holding capacity.

I-71. Effect of potting mixtures on bulblet production from scales in asiatic lilies

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The effect of different potting mixtures, viz., moss, sand, garden soil, fresh sawdust, sand + soil + sawdust (1: 1: 1 v/v), sand + soil + moss (1: 1: 1 v/v) and sand + soil + FYM (1: 1: 1 v/v) on bulblet production from bulb scales of two cultivars of asiatic lilies, namely, Harmony and Jolanda was investigated. The outer bulb scales from these cultivars were placed in moist potting mixtures in sealed polythene bags and kept at low temperature in the month of November. Fresh sawdust was found to be the best potting mixture for bulblet production. In sawdust, 81.67 per cent bulb scales produced bulblet and the number of bulblet produced per scale (2.66) was highest. The largest bulblets (1.33 cm diameter) were produced when the scales were placed in the potting mixture of sand + soil + FYM (1: 1: I v/v). Cultivar Jolanda produced more number of bulblets than cultivar Harmony. However, cultivar harmony produced larger bulblets than cultivar Joianda.

I-72. Effect of shading and media on growth and flower production of *Gerbera jamesonii* variety Priyadarshi

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An experiment was conducted during 2002-03 to study the effect of shadings and media on gerbera variety Priyadarshi. Significant variations among different media and shadings were noted for number of leaves and flowers per plant, stalk length and diameter of flowers in the growing season of January to March. Among various media, leaf mould resulted in maximum number of leaves (6.1 per plant) along with maximum number (2.93/plant) and diameter (8.18 cm) of flowers. However, cocopeat resulted in maximum plant spread (32.86 cm) while maximum length (30.53cm) of stalk was observed in burnt rice husk. On the other hand, maximum number of leaves (5.73), plant spread (31.74cm), number of flowers (2.00), stalk length (31.84cm) and flower diameter (8.08cm) was recorded under 75%.

I-73. Effect of graded levels of NPK and spacing on growth quality and flower production in China aster (*Callistephus chinensis* L.)

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Studies were carried out on the effect of graded levels of NPK kg/ha (00: 00: 100; 100: 75 : 50; 150 : 100: 75 and 200 : 125 : 100 kg NPK / ha) and different spacing (30 x 15, 30 x 30 and 30 x 45 cm) on growth, quality and flower production of china aster during Rabi season of 1994-95 at College of Agriculture, Pune, (MS). The graded levels of NPK with 150: 100: 75 kg/ha found to be beneficial for profuse growth quality in termas of plant height (61.98 cm), number of branches/plant (16.03), number of leaves/plant (53.45) and size of flower/plant (49.0). While in case, spacing of 30 x 30 cm was found superior over other spacing by recording profuse growth and flower production (44.40 flowers/plant). However, no significant interaction between graded levels of NPK and various spacing was observed so far.

I-74. Effect of growing media on growth and flowering of chrysanthemum (*Dendranthema grandiflorum* Tzveleve)

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Studies on the effect of growing media on growth and flowering of chrysanthemum were conducted in the Department of Floriculture and Landscaping Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni -Solan (H.P.) during 2000 -2001 to find out suitable growing medium. Experiment was conducted on two cultivars namely; 'Snowball' (standard) and 'Glance' (spray) using cheap and easily available growing media like; leaf mould, municipal solid waste (MSW), sawdust and soil + sand + FYM (1: 1: 1, v/v) (control), solely or in all possible combinations. The findings revealed that among different growing media, tallest plants with maximum number of longest side shoots and leaf number were obtained in leaf mould + MSW. Leaf mould + MSW + control was close to leaf mould + MSW; resulting earliest flowering in both cultivars. However, largest flowers of 'Snowball' (11.76 cm) and 'Glance' 6.63 cm) were recorded when MSW + leaf mould + control (1:1:1, v/v) and leaf mould, respectively, were used as growing media. Pot presentability of both the cultivars was maximum when grown in leaf mould + MSW.

I-75. Rooting of terminal cuttings in African marigold (*Tagetes erecta*) under mist

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Terminal cuttings from seven cultivars of marigold (*Tagetes erecta*) were studied for their rooting behaviour under mist. Cultivars showed significant variations for percentage of rooting of cuttings, number of roots per cutting, length of the longest primary root, number of shoots, length of the shoot and number of leaves per cutting. Among the cultivars studied MDU-1 proved to be the best for rooting performance (93.2%).

I-76. Effect of different dates of planting and sources of nitrogen on flower and seed yield in African marigold *(Tagetes erecta)* cv. Pusa Narangi Gainda

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Studies were conducted on planting dates (15th July, 2000 and 15th Feb, 2001), sources of nitrogen (CAN, Urea and Neem Coated urea) and doses of nitrogen (10, 20, 30, 40, 50 g/m^2) on African marigold *(Tagetes erecta)* cv. 'Pusa Narangi Gainda' in a split plot design. Planting done in February had maximum flower size (6.70 cm), number of flowers per plant (53.33) and flower yield per square meter (1480.39 g); whereas, July planting resulted in maximum plant height (108.30 cm), plant spread (41.85 cm), seed yield per square meter (114.42 g) and seed number per head (191.62). Application of 50.9g nitrogen/m^2 through CAN resulted maximum plant height, plant spread, number of days taken to bud formation and days taken to flowering. However, best flower and seed character were obtained with 30g nitrogen/m^2 when applied through CAN. A nitrogen dose of 30 g/m^2 applied through CAN during February, resulted optimal flower crop, whereas, July planting resulted in seed crop. Studies were also done to calculate economics both for flower and seed crop. July planting gave maximum profit of Rs. 17,571 per acre for flower crop and Rs. 1,50,684 per acre for seed crop moderated with 30 g nitrogen/m^2 in the form of CAN, while February planting yielded gain of Rs. 28152.0 per acre for flower crop and loss of Rs. 37524.50 per acre for seed crop with 30 g nitrogen/m^2 in the form of urea.

I-77. Rooting of carnation (*Dianthus caryophyllus* l.) cuttings by using different rooting media

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oting in carnation cuttings was studied on five rooting media containing soil, sand, 3 part sand: 1 part soil, 2 part sand: 2 part soil and 1 part sand: 3 part soil. Rooting medium containing sand had the highest survival percentage (92.75) and the medium containing soil showed the lowest survival rate (12.75%). Increase in the proportion of sand in the rooting media proved better efficiency of the medium to enhance and improve rooting of cuttings. Earliest rooting was obtained from cuttings raised on sand (23.00 days). Delayed rooting was noticed with soil (42.13 days). Root number was found highest with sand raised cuttings (22/cutting) and lowest with cuttings rose on soil (3.63 roots/cutting). Roots produced in the cuttings raised on sand were found longest (8.11 cm) and shortest with soil (1.10 cm). For successful rooting of carnation cuttings sand is found to be the most effective rooting medium.

I-78. Growth enhancement of ornamental foliage aroids in coir pith and coconut based media

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Growing media containing different proportions of coir pith manure and coconut husk were found to enhance growth in selected foliage aroids. In *Aglaonea, Dieffenbachia* and *Philodendron,* coir pith manure and coconut husk could substitute for cow dung in media mixtures with sand. Plant height, leaf production and leaf area were increased. The pH and electrical conductivity were also influenced by the media treatments.

I-79. Effect of chemicals and growth regulators on sprouting, growth, flowering and corm production of gladiolus

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A field experiment was conducted at Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidhyapeeth, Akola during 2000-2001 in Randomized Block Design with three replications and twelve treatments. The treatments given to gladioli corms before planting comprised of GA_3 (100 and 200 ppm), Ethrel (100 and 200 ppm), Thiourea (500 and 1000 ppm), KNO_3 (1000 and 2000 ppm), BA (25 and 50 ppm), water soaking and control (without any treatment). The treatment Thiourea 500 ppm was found to be more effective for early and uniform sprouting of corms; while, GA_3 200 ppm was best for better growth and flowering. Howerver, higher corms and cormel yield was obtained under BA 50 ppm treatment

I-80. Effect of growth regulators on rooting in stem cuttings of crepe myrtle (*Lagerstroemia indica* L.) cv. 'Seminole'

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An experiment was conducted at Department of Horticulture, B.A. College of Agriculture, Gujarat Agricultural University, Anand during the month of July-September, 1999 to study the effect of growth regulators on rooting in stem cuttings of crepe myrtle (*Lagerstroemia indica* L.) cv. 'Seminole'. An experiment was conducted in sand bed with 10 treatments assigning Complete Randomized Design having four replications. The treatments were comprised of three growth regulators (i.e. IAA, IBA, NAA) and their three levels of concentrations (i.e. 1000, 1500, 2000 mg/litre) and one control.

The results indicated that IBA @ 2000 mg/l gave highest shoot length (17.05 cm), number of primary roots (47.75) and secondary roots (151.00), rooting percentage (74.00) and survival percentage (72.50) as compared to control. IBA at 2000 mg/l also recorded maximum fresh as well as dry weight of sprouted cuttings. The growth regulators NAA and IAA at 2000 mg/l concentration also gave better results as compared to control.

I-81. Effect of maleic hydrazide on growth and flowering of balsam (*Impatiens balsamina*)

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Response of spraying of six concentrations of Maleic Hydrazide, viz., 0, 50, 100, 250, 500 and 700 ppm was studied on balsam *(Impatiens balsamina).* It was observed that spraying of 700 ppm Maleic Hydrazide was more effective in controlling the plant height. Number of flowers was increased due to spraying of 50 ppm Maleic Hydrazide. Spraying of 50 ppm Meleic Hydrazide proved effective in enhancing duration of flowering.

I-82. Effect of certain nitrogen, phosphorus and bio-fertilization on floral parameters in tuberose

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Investigations were conducted to study the effects of nitrogen, phosphorus and bio-fertilizers (*Azotobacter*, PSB and VAM) alone and in combination on flower production in tuberose (*Polianthes tuberosa* L.) cv. Double during 2000 and 2001 under Hisar conditions. Increased levels of nitrogen and phosphorus significantly delayed the flowering, whereas, application of bio-fertilizers caused early flowering. The application of VAM took minimum days for flowering followed by *Azotobacter* application. The spike length, number of florets per spike and fresh weight of 100 florets were increased with the solo and simultaneous application of nitrogen, phosphorus and bio-fertilizer. The longest spikes with maximum number of florets were obtained with 200 kg N, 100 kg P/ha and VAM application in both the years. The results obtained with 200 kg N and 100 kg P/ha were at par with bio-fertilizers application in combination with 100 kg N and 50 kg P/ha.

I-83. Effect of fertilizers and bio-fertilizers on nutrient uptake in tuberose (*Polianthes tuberosa* L.) cv. Double

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Different levels of nitrogen (50, 100 and 200 kg/ha) and phosphorus (25, 50 and 100 ha) as well as sources of bio-fertilizers (*Azotobacter*, PSB and VAM) were tried for various growth, flowering and bulb multiplication in tuberose (*Polianthes tuberosa* L.) cv. Double during 2000 and 2001 under Hisar conditions. Fully developed and recently matured leaves (5th leaf from the centre of plant) were collected at the time of flowering for the estimation of macronutrients (NPK) in leaf tissues. The nutrients in leaves were increased generally with the application of bio-fertilizers and at increased levels of nitrogen and phosphorus. The maximum N content in leaf tissue was found with the application of 200 kg N and 100 kg P/ha in combination with VAM application, however, phosphorus content was found to be maximum with 200 kg N, 50 kg P/ha and VAM application. Increased levels of N and P significantly decreased the K contents in the plant tissues. By using biofertilizers in combination with nitrogen and phosphorus, the results obtained with 200 kg N and 100 kg P/ha, respectively, can be met out from 100 kg N and 50 kg P/ha along with the bio-fertilizer application.

I-84. Effect of graded levels of nitrogen and pottasium on yield and quality of gerbera (*Gerbera jamesonii* H. Bolus)

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The experiment was carried out at the Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalainagar during September 2000 to April 2001. The plants were subjected to three levels, each, of nitrogen and potassium, viz., 100, 200, 300 mg per week and their factorial combinations.

The main effect of nitrogen was found to be significant for all characters, viz., number of leaves, leaf area, number of flowers, stalk length, stalk girth, flower diameter, single flower weight and vase life. The main effect of potassium was also found to be significant for all characters except stalk girth

Linear response was observed to added nitrogen up to 300 mg per week whereas in potassium the effect was negative beyond 200 mg per week. Among nine treatment combinations, N 300 K 200 mg per week recorded the superior performance in terms of quality parameters and this was followed by N 200 K 200 mg per week.

I-85. Effect of organic farming on growth and yield of gerbera cv. Ruby Red

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An experiment was conducted to study the effect of organic farming practices on growth and yield of gerbera cv. Ruby Red. The experiment consisted of four treatments *viz.*, i) organic; ii) conventional (chemical); iii) organic + conventional and iv) control. The organic treatments consisted of green manuring, applications of biodynamic compost, biodynamic preparations, agnihotra ash, biofertilizers, vermicompost and biocontrol agent *Pseudomonas fluorescens.*

The results showed that organic farming practices improved the growth of gerbera in terms of number of leaves (53.8/plant), leaf length (24.5 cm), leaf width (10.8 cm), shoot weight (183.28 g) and root weight (7.28 cm), which were statistically superior to the rest of the treatments. The organic practices also increased the stalk length of flowers (47.8 cm) and number of flowers (32.3/plant), which were highly significant than other treatments. Organic treatment recorded the maximum and significant number of flowers, which was 31.9 per cent higher than the conventional treatment and 121.9 per cent higher than the control. The shelf life of the flowers obtained from the organic treatment was 14 days which was 2,6,9 days more than organic + conventional, conventional and control treatments respectively. Treatment with organic practices recorded the highest benefic-cost ratio of 3.5. The organic treatments recorded the lowest disease index of leaf spot (2.5 per cent) and the root rot (1.2 per cent) disease incidence.

I-86. Studies on the flowering and productivity of gundumalli (*Jasminum sambac.* Ait) as influenced by nutrient management techniques

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Investigations were undertaken to study the effect of modified NPK fertilization, micronutrients and the method of application of micronutrients on growth, flowering and yield of jasmine (*Jasmimum sambac* Ait) cv. Gundumalii under Periyakulam conditions.

The experiment was laid out in a factorial randomized block design with three replications. Three levels of modified NPK fertilization viz., 120:240:240 g of NPK per plant in the months of November and June (N_1), in the months of October and April (N_2) and in four splits during the months of October, January, April and July (N_3) in the form of urea, super phosphate and muriate of potash; three levels of micronutrients, viz., 4g per plant and 0.5 per cent spray of Zn, 8 g per plant and 0.5 per cent spray of Fe and Zn + Fe combination in the months of December and June in the form of $ZnSo_4$ + $FeSo_4$; four methods of application viz., water spray (T_1) soil (T_2), foliar (T_3) and soil + foliar (T_4) were tried in all possible combinations.

Four split application of 120:240:240g of NPK per plant significantly increased the plant growth and flower yield. Four split application of NPK increased the chlorophyll content and the soil and plant nutrients like NPK, Fe, Mn, Cu and Zn. Advanced application of NPK nutrients in the months of October and April to that of the existing recommendation had similar effect as that of four split application of NPK nutrients.

Among different treatment combinations, application of NPK in four splits, $ZnSo_4$, $FeSo_4$ combined with soil + foliar method of application increased growth, flowering, yield attributing characters and yield/ha (4400 kg). The highest net return of Rs. 2,20,500 and the highest benefit-cost ratio of 2.56 were also obtained in the combination.

I-87. Effect of N, P and K on growth and flowering of chrysanthemum

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Studies were conducted to assess the response of chrysanthemum cv. Snow Ball to various levels of nitrogen, phosphorus and potash. Application of 30 g N/m^2 gave maximum plant height, stem length, number of leaves, plant spread and leaf area. Plants receiving 30 g K_2O and P_2O_5/m^2 each, also significantly increased the plant height, stem length, plant spread, leaf area and number of leaves per plant. Size of flowers and stem thickness were maximum with 30 g N/m^2. Cut flower weight was maximum with 45 g N/m^2 and vase-life was more under control. An application of 30 g P_2O_5 and K_2O/m^2 each, significantly influenced size of flowers, stem thickness, cut flower weight and vase-life of this cultivar. Days taken to flowering and duration of flowering were maximum with 30 g N, P_2O_5 and K_2O/m^2 ,each.

I-88. Effect of potting media and nutrients on flowering of *Dendrobium* hybrid 'White Fairy'

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Dendrobiums, the doyen among all orchids, constitute a biologically interesting and commercially significant group of cut flowers, which today occupy a prime position in the floriculture industry. So far, the potting media and nutritional requirement have not yet been standardized to suit different locations. Hence, the present investigation was carried out to study the effect of potting media and nutrients on the performance of *Dendrobium* hybrid 'White Fairy'. The experiment was carried out at the Department of Horticulture, Faculty of Agriculture, Annamalai University. The experiment was laid out in a completely randomized design with eight treatments replicated thrice. The effect of potting media viz., charcoal and gravel chips and nutritional spray of two concentrations of NPK based water soluble fertilizer at an interval of once in 4 and 8 days on the growth and yield was investigated. The vegetative parameters like plant height, number of leaves, leaf area and flowering characters like flower bud appearance, flower bud opening, number of flower stalks, length of flower stalk, number of flowers per stalk, flower diameter, longevity of flower stalk in the plant and vase life of flower were found to be favourably influenced by both potting media and spraying of nutrients.

I-89. Effect of nitrogen levels and planting dates on growth, flowering and yield of gaillardia (*Gaillardia pulchella* Fouger) cv. 'Yellow Double' under South Gujarat climatic conditions

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Investigations were undertaken to study the effect of nitrogen and planting dates on growth, flowering and yield of gaillardia (*Gaillardia pulchella* Fouger) cv. 'Yellow Double' at Agronomy Farm, GAU Campus, Navsari during 2000-01. Four levels of nitrogen, i.e. 0, 80, 130 and 180 kg/ha and four planting dates, i.e. 1st September, 1st October, 1st November and 1st December, along with all possible combinations were tried on gaillardia. The experiment was conducted in Split Plot Design with three replications.

Results showed that nitrogen @ 130 kg/ha significantly increased the plant height, number of leaves/ plant, earliness of flowering, number of flower/plant, and per unit area and yield/ha as compared to other treatments. As planting time is concerned, 1st October planting was found significantly superior in increasing all parameters under heavy black soil of South Gujarat. Interaction effect of nitrogen level and planting dates showed that the plant height, number of leaves/plant, number of flowers/plant and yield/ unit area were significantly higher with N_2D_2 (130 kg N/ha and 1st October planting date).

I-90. Propagation in hybrid lilies through scaling

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Investigations were conducted to study the effect of scale position, plant growth regulators and growing media for bulblet production and their growth on Asiatic lily cv. Sancerre and Oriental lily cv. Star Gazer. Outer scales of bulb gave best results with respect to survival rate, bulblets multiplication, diameter and fresh weight of bulblets in comparison to middle and inner scales in both the cultivars. Bulblets multiplication significantly increased when outer scales were initially treated with 100-200 ppm IBA for 1 hour and grown in vermiculite under sequential temperatures of 25°C for 11 weeks, 17°C for 4 weeks and 5°C for 8 weeks at 85 per cent relative humidity. Further, growth of bulblets was found to better in cocopeat as compared to common potting mixture (sand: soil: FYM; 1: 1: 1, V/V) under 50 per cent shade nets.

I-91. Effect of GA_3 and Succinic acid on growth and flowering in gladiolus cv. 'Show Princess'

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Investigations were undertaken during 2003 to study the effect of GA_3 (100 and 200 ppm) and Succinic acid (200 and 400 ppm) on the growth and flowering parameters in gladiolus cv. Show Princess. Plants were sprayed after 30 days of corm planting.

The result revealed that GA_3 was proved to be effective on majority of parameters of growth and flowering in comparison to Succinic acid. The various characteristics like plant height (71.4 cm.), number of leaves (15.0) width of leaves (4.2 cm), number of spike (20), days required to open first floret (93.6 days), number of florests per spike (16.6) and duration of flowering (13.3 days) were higher with the application of GA_3.

I-92. Evaluation of tropical foliage aroids for yield attributes

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Tropical foliage plants have been fascinating the florists for a pretty long period. The aesthetics that they offer, has positioned them almost equal to the status of cut flowers. The foliage plants belonging to the family Araceae, called aroids, have a major contribution to this popularity and they are highly in demand among florists.

A study was conducted on eleven tropical aroids belonging to five different genera with respect to their yield attributes. The plants were evaluated for yield per plant and also per hundred square meter of area (0.01ha). It was observed after a 10-month- long study that the area occupied by a plant was minimum in *Aglaonema costatum*, which recorded an average leaf production of 75 leaves per plant per year. This also recorded a maximum leaf production per unit area (8000 leaves/100m^2). The lowest leaf production per plant was recorded in *Monstera deliciosa*, (10 leaves/ plant/ year) which also contributed to the minimum leaf production (2000 leaves) per 100m^2.

I-93. Plant growth and seed yield as affected by PP333 and SADH in calendula

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An investigation was carried out at Floriculture Section, Department of Horticulture, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttaranchal to study the effect of paclobutrazol (PP333) and SADH on growth and seed yield in *Calendula officinalis*. Drench application of paclobutrazol at 5, 10 and 15 mg a.i./ plant was given at 30 days after transplanting of seedlings. Foliar spray of SADH was given at 500, 1000 and 1500 ppm to run-off stage at 30 and 60 days after transplanting and control plants were sprayed with distilled water in same manner. Treatments were replicated in a Randomized Block Design.

Drench application of paclobutrazol at 15 mg/plant significantly increased secondary branches/ plant and drastically reduced plant height which were at par with paclobutrazol at 10 mg/plant treatment. However, maximum leaf area index, fresh and dry leaf biomass were recorded with PP333 at 10 mg/ plant. Among seed attributes, all the treatments delayed ripening of seeds than control and did not show significant effect on number of seeds/flower. However, PP333 at 10 mg/plant significantly increased weight of seeds/flower, 100-seed weight, seed weight/plant and yield/m^2. In general, SADH at 1000 ppm ranked second on 100-seed weight, seed weight/plant and seed yield/m^2. On the basis of study it may be concluded that paclobutrazol can be used at 10 and 15 mg/plant to reduce the plant height which may be applicable in bedding and pot culture of calendula and also to increase leaf biomass for pharmaceutical preparation. Paclobutrazol at 10 mg/plant and SADH at 1000 ppm can be applied to enhance the flowering and increasing yield of bolder size seeds in *Calendula officinalis*.

I-94. Influence of plant growth regulators on growth, biomass and flowering in marigold

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An experiment was conducted during 2001 at Floriculture Section, Department of Horticulture, G.B. Pant University of Agriculture and Technology, Pantnagar to evaluate the response of plant growth regulators on growth and flowering in marigold (*Tagetus patula*). Plants of marigold were treated with GA_3 (100 and

200 ppm), IAA (50 and 100 ppm), kinetin (50 and 100 ppm) and control with distilled water. Treatments were given at 30 and 60 days after transplanting as foliar spray to run-off stage. Uniform cultural practices were adopted for all the treatments. Experiment was laid out in a randomized block design and replicated thrice. Maximum fresh and dry leaf biomass/plant were recorded with GA_3 100 ppm treatment.

Kinetin gave pronounced effect in increasing number of branches/plant and leaf area, which were statistically at par with GA_3 100 ppm. Earliness on flower bud initiation and flowering were noticed with IAA 50 ppm followed by GA_3 100 ppm. All the chemicals failed to exert striking effect on flower diameter. GA_3 100 ppm also resulted in maximum production of number and weight of flowers/plant followed by GA_3 200 ppm, kinetin 50 and 100 ppm. Lower values on leaf biomass and flower yield were encountered with control.

I-95. Effect of media on growth and yield of *Dendrobium aphyllum*

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A study was conducted on *Dendrobium aphyllum* at Central Agricultural Research Institute, Port Blair during 2001 and 2002 on media (charcoal, brick pieces, coir dust, coconut husk, leaf mould along with control). Number of flowers per spike (26.5), shelf life (24.8 days) flower size (3.85 cm) were recorded maximum under coconut husk, whereas maximum spike length was recorded maximum in charcoal and coir dust.

I-96. Studies on standardization of suitable root stock by stionic combination in rose (*Rosa spp.*)

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A field experiment was conducted at horticulture garden of Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (U.P.) during 2000-2001, to standardize suitable rootstocks of rose for rapid multiplication to meet the growing demand. The experiment was laid out in factorial randomized block design with three replications. *Rosa borboniana* (Edouord rose), *Rosa indica* var *odorata* and *Rosa wituraina* (Creeper rose) were taken as a rootstocks. Two varieties of rose, that is, Montezuma and Zorina were taken as scion. Various observations, viz. planting date of cutting, number of days required for bud take, length of sprout, diameter of sprout, length of root and diameter of root, were recorded. The result revealed that Montezuma produced relatively longer and thicker shoot as compared to Zoriana. Out of all the root stocks *Rosa indica* var *odorata* was found better in the term of improved shoot growth including number of leaflets. The maximum length and diameter of sprout was observed in the stionic combination of Montezuma with *Rosa indica* var *odorata*.

I-97. Effect of bulb size, planting depth and spacing on growth, flowering and bulb production of tuberose

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Response of three bulb sizes (1.0 cm, 2.0 cm and 3 cm in diameter), three depths of planting (3.0, 5.0 and 7.0 cm) and three plant spacings (20x10, 20x20 and 20x 30 cm) were studied in tuberose *(Polianthes tuberosa)* cuitivar 'Mexian Single' under Meerut condition. It was observed that bulb having a diameter of 3 cm, planted at 5 cm depth at the spacing of 20x20 cm gave better vegetative growth and flower yield over other treatments.

I-98. Standardization of optimum sample size for yield forecasting in major flower crops

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The forecasting of yield in any crop involves two different aspects of estimation namely, estimation at individual plant level and secondly at plantation level. Even for the estimation of yield in any aspect, and/ or by any procedure, it is a pre-requisite to have the optimum sample size. Hence, decision making about the optimum sample size, plays an important role for realistic forecasting of yield. The present paper deals with the standardization of optimum sample sizes for the estimation of yield in some of the major flower crops, which are having very good domestic and export markets. Using data on yield of some of the major flower crops viz., rose (*Rosa sp.)*, China aster (*Callistephus chinensis)*, chrysanthemum (*Dendranthema grandiflora)*, gladiolus (*Gladiolus grandiflorus)* marigold (*Tagetes erecta)*, tuberose (*Polianthes tuberosa)*, gerbera (*Gerbera jamesonii)* and carnation (*Dianthus caryophyllus*), optimum sample sizes were worked out for 95 and 99 percent of confidence for an interval not exceeding 5 per cent and 10 per cent of the mean. It was observed that there existed a wide range of variation of the sample size arrived at. For the normally acceptable level of 95 per cent and the sample mean falling within 10 per cent of the actual mean, a maximum of 20 per cent plants in rose, 54 per cent in China aster, 21 per cent in chrysanthemum, 17 per cent in gladiolus, 11 per cent in marigold, 40 per cent in tuberose, 7 per cent in gerbera and 11 per cent in carnation, are to be sampled to get better estimation. Hence, due to the existence of high variation in plant to plant yield, quite a good number of plants are to be sampled to get better estimates while forecasting yield in flower crops.

I-99. Yield forecasting in tuberose (*Poliathes tuberosa)* cultivar 'Mexican Single' as associated with growth and floral parameters.

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Tuberose (*Polianthes tuberosa)* is one of the major commercial bulbous flower crops in India, being grown for use in various forms of loose flower, cut flower and extraction of essential oils. A forecasting methodology for yield of individual plant of tuberose cv. 'Mexican Single' using vegetative growth and floral parameters like height of plant, number of leaves per plant, floret diameter, length of rachis and spike, duration of flowering, number of florets per spike and number of spikes produced per plant had been developed at the Indian Institute of Horticultural Research, Bangalore. A reliable relationship of important parameters viz., height of plant, diameter of floret, length of spike etc., individually or in combination of two or three had shown excellent and positive association with yield. Certainly, these parameters could help to predict the yield (number of spikes per plant or number of florets per spike) in tuberose to an extent of more than 80 per cent.

I-100. Effect of various forms of urea and GA_3 on growth and yield of chrysanthemum *(Dendranthema grandiflora* Ramat)

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Four forms of urea, viz., liquid feeding, tarcoated urea, neemcake coated urea and prilled urea and three levels of GA_3 viz., 50, 75 and 100 ppm, along with water spray in all possible combinations were tried on

chrysanthemum. Neemcake coated urea significantly increased the number of flowers per plant with maximum spray length and flower diameter as compared to other forms of urea. Among GA_3 levels, 100 ppm was found superior in increasing the above mentioned characters. Interaction effect of forms of urea and GA_3 showed that number of flowers, spray length and flower diameter were significantly higher with neem cake coated urea and 100 ppm GA_3.

I-101. Studies on the effect of different sources and levels of nitrogen fertilizers on growth and development of gladiolus cv. White Prosperity

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The present study was conducted during 2002- 2003 at the experimental field of Department of Horticulture A.A.I.D.U Allahabad. The experiment consisted of nine treatments, each replicated thrice, in Randomized Block Design. Study revealed that vegetative growth attributes like height, number of leaves, floral behavior, corm and cormel production were affected with different levels of nitrogen. Most of the vegetative characters were found to be superior with CAN @ 100g/m² and most of the floral as well as corm characters were affected with CAN @100g/m². It is concluded that the gladiolus performs better when it is supplied with 100g CAN/m².

I-102. Hydroalcoholic extract from different organs of calendula *(Calendula officinalis* L.) cv. Lemon Queen under nutritional variability

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The two year field experiment was carried out during winter seasons of 2000-02, Kalyani Horticulture Farm, B. C. K. V., Nadia, W.B. under clay loam soil, taking 27 treatment combinations comprising of three levels (0, 10, 20 g/ml) each of N, P_2O_5 and K_2O under three replications. The objective was to work out the optimum nutrient management for obtaining the higher hydroalcoholic extract from the different organs of calandula under the subtropical climate of Indian plains, as a part of crop diversification programme, to be utilized the same both for aesthetic and industrial, especially pharmaceutical utility. The highest amount of hydroalcoholic extract was noticed in the flower followed by leaf, shoot and to a lesser extent in the root. The percentage of extract under the treatment combination receiving 20g/m² each of nitrogen, phosphorus and potassium was maximum (16.4%, 14.8%, 9.8% and 6.4%, in flower, leaf, shoot and root, respectively) but that was at par with the result of the treatment that received N, P and K at the ratio of 20: 10:20 g/m². The least quantity was obtained under the control treatment. The distant effect of the major nutrients on the productivity of the extract was observed in case of flower, leaf and shoot but lesser in root.

I-103. Correlation studies of different characters of pot marigold *(Calendula officinalis* Lo) cv Lemon Queen under nutritional variability

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The two years field experiment was conducted during two winter seasons (October to March) of 2000-01 and 2001—02 at Kalyani Horticulture Farm, B.C.K.V., WB, under clay loam soil to estimate the correlation between the characters and to emphasize the most important factor in the direction of crop improvement.

Observation on different phenotypic characters were taken and used for working out the correlation between them. The treatment combinations comprised of three levels (0, 10, 20 g/m1) each of N, P, K. The experiment was laid out in a Factorial Randomised Block Design with 27 treatments and 3 replications.

The results revealed that most of the characters under the study were highly and significantly correlated. Among the high correlation values the highest value was noted for the correlation between the number of flower per plant and flower weight (g) per unit area (0.988), and between the flower weight (g) per unit area and the seed yield (0.976), which indicated that the flower production as well as seed production could be highly improved by improving the growth condusive to the flower production ability of the individual plant.

I-104. Effect of different fertigation levels on gerbera under low cost greenhouse

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Studies were conducted to investigate the effect of fertigation with straight fertilizers and water soluble fertilizers each at three levels. Application of 80 per cent of recommended levels of either water soluble fertilizers or straight fertilizers through fertiligation was most effective for improved growth and flower production.

I-105. Effect of N and FYM levels on dry matter yield and N content of African marigold *(Tagetes erecta* L*)*

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A pot culture experiment was carried out in sandy loam soil to investigate the effect of N (0, 60, 120, 180, 240 and 300 ppm) and FYM (0, 0.5, 1.0 and 2.0%) on dry matter yield and N content of African marigold. Application of N increased the dry matter yield of flower and shoot consistently upto 180 ppm N level and adversely affected the yield thereafter. Nevertheless, the flower and shoot yield were significantly higher even at 300 ppm N level as compared to control. Application of FYM also enhanced the dry matter yield of flower and shoot but the influence of FYM was more in the absence and at lower levels of N. The highest dry matter yield {flower and shoot) was obtained in the treatment where 180 ppm **N** along with 2.0 per cent FYM was applied. Futher, at this treatment flower yield increased 2.8 times higher than shoot yield in comparison to control. N content in flower and shoot increased consistently with increasing levels of N and FYM but increase was more prominent with N application than FYM. N content of 1.83 per cent in flower and 0.42 per cent in shoot contributed maximum dry matter yield.

I-106. Effect of indole acetic acid on vegetative growth and flowering of zinnia (*Zinnia elegans* L.)

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The present study was conducted at the Horticultural Research Farm of Choudhary Charan Singh University, Meerut (U.P.) during 1998 to observe the response of different concentrations of Indole Acetic Acid (I.A.A.) as foliar spray on zinnia. One-month old seedlings were transplanted in the field. There were

7 treatments i.e. 10, 20, 30, 40, 50 and 100 ppm of IAA, and one control. The maximum plant height (89.1 cm) and length of branches (35.4 cm) and their internodal length (11.4 cm) were observed in the plants which were sprayed with 30 ppm of IAA. The plants sprayed with 100 ppm were more stunted (67.9 cm). The largest size of flowers (7.17 cm) with maximum blooming period (36.5 days) were recorded in plants treated with 20 ppm of IAA.

I-107. Effect of pinching on seed yield and quality traits in African marigold (*Tagetes erecta* L)

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An investigation was carried out on the effect of pinching (nos.) on seed yield and quality traits of marigold cvs. Pusa Narangi and Pusa Basanti Gainda during rabi-2003 at seed production unit, IARI, New Delhi. The treatments were T-1 (control, no pinching), T-2 (single pinching, 30 DAT), and T-3 (double pinching, 20 days after the single pinching). The experiment was laid out in randomized block design with seven replications. Twenty-five day old seedlings were transplanted on 15th November 2002 in previously irrigated beds and fifty seedlings per replication were transplanted. Observations on average number of flower/ plant and seed yield/plant were recorded on five randomly selected plants from each replication/treatment at complete drying stage. The samples for 1000-seed weight., germination percentage, root length, shoot length and vigour were drawn from the processed seed lot of the treatments.

The analysis of variance revealed highly significant difference among the treatments for no. of flowers/ plant, seed yield/plant and 1000-seed weight in both the varieties. Double pinching (T-3) was found superior for no. of flowers/plant (62.00 and 48.34 in PBG & PNG, respectively) than single pinching (T-2) which has given 47.43 nos. and 32.86 nos. in PBG & PNG and control (T-1). The seed yield/plant was maximum in double pinching (T-3) in both the varieties, which were 20.94 g/plant (PBG), and 17.71 g/ plant (PNG). The seed yield/plant was also higher in single pinching (T-2) than control (T-1). The 1000-seed weight was maximum (2.95 g and 2.88 g in PBG &PNG, respectively) in control (T-1), followed by the T-2 (2.81g in PNG and 2.69 g in PBG) and T-3 (2.45 g and 2.37 g in PNG & PBG, respectively).

I-108. *Ex-vitro* nutrition of *Dendrobium* Sonia-17 plantlets

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Tissue cultured plantlets of *Dendrobium* Sonia-17 were found to respond to applied nutrients 6 months after *ex-vitro* establishment onwards. Shoot growth, leaf production and leaf area were enhanced with 2.0 to 10.0 mg of N and 2.0 to 6.0 mg each of P and K per week, up to the age of one year. Greater dry matter accumulation and a higher content of major nutrients were recorded in one year old plants in response to higher doses of nutrients.

I-109. Evaluation of coir pith as a growing medium for foliage plants

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The experiment with an objective to evaluate the suitability of coir pith as a growing medium for foliage plants was conducted using uniform plants of *Aglaonema, Diefferbachia and Philodendron.* The treatments included were T_1 - coarse sand + dry cowdung, T_2 - coarse sand + dry cowdung + coir pith, T_3 - coir pith

alone, T_4 - coir pith + coarse sand, T_5 - coarse sand + dry cowdung + coconut husk bits, T_6 - coarse sand + coconut husk bits + coir pith and T_7 - coarse sand + dry cowdung + coconut husk bits + coir pith.

Evaluation of the physical parameters of the growing media showed that the highest moisture percentage was in the medium containing sand, cowdung and coconut husk in equal proportions (16.05%). Water holding capacity was the highest in the growing medium of coir pith alone (267.76%), and the lowest in the medium with sand and cowdung in equal proportions (35.70%).

In *Aglaonema*, plant height, number of leaves and leaf size varied significantly. Plants were the tallest in T_1 (61.33cm) containing sand + cowdung. This treatment was on par with T_7 (sand + cowdung + coconut husk + coir pith), T_5 (sand + cowdung + coconut husk) and T_6 (sand + coconut husk + coir pith). Plant height was the lowest in T_4 (44.67cm) containing sand + coir pith.

Number of leaves was the highest in T_6 (48.83) containing sand + coconut husk + coir pith. This treatment was on per with T_1 (sand + cowdung). The lowest number of leaves was in T_4 (25.00) containing sand + coir pith. Leaf length was the highest in T_5 (sand + cowdung + coconut husk). This treatment was on per with T_2 (sand + cowdung + coir pith), T_6 (sand + coconut husk + coir pith). Similar results were obtained in *Dieffenbachia* and *Philodendorn.*

It was concluded that coir pith could be used along with sand and cowdung in equal proportions as a growing medium for foliage plants. Coir pith alone is not a good growing medium for foliage plants as observed in three commercially important genera viz., *Aglaonema, Dieffenbachia* and *Philodendron*

I-110. Effect of growth regulators on yield, vegetative and flowering characters of golden rod *(Solidago canadensis* L.)

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The effect of various plant growth regulators, viz., BA (Benzyl Adenine) with concentration 10,25 and 50 mg l^{-1}, GA_3 (Gibberellic acid) at 25, 75, 125 mg l^{-1}, CCC (cycocel) at 1500, 2000 and 2500 mg l^{-1} and PBZ (Paclobutrazol) at 10, 20 and 30 mg l^{-1} were studied with a view to enhance yield and quality of cut flowers of golden rod. It was observed that spraying of GA_3 125 mg l^{-1} 30 and 45 days after transplanting is significantly beneficial for most of the vegetative and flowering characters, viz., height of the plant, number of leaves per plant, fresh and dry weight of the plant, days taken for opening of first flower, length of flowering region, number and spread of primary branches per panicle, length of panicle, diameter of flower stalk, fresh and dry weight of panicle and number of panicles per plant. BA 50 mg l^{-1} was more beneficial for number or suckers per plant. The inhibitory effect on plant growth and development is found at high concentrations of CCC and PBZ.

I-111. Effect of foliar application of multiplex on growth and flowering in gladiolus cultivars

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Investigations were conducted on the effect of foliar application of multiplex (1000, 2000 and 3000 ppm) in three gladiolus cultivars viz, Regency, Show Princess and Lavender Puff during the year 2002-2003.

The maximum plant height was observed in cv. Regency (84.83 cm.) by the treatment with 100 ppm of multiplex. The maximum number of leaves was observed in cv. Show Princess (12.68) treated with 3000 ppm of multiplex.

The maximum number of spike per plant was reduced in Regency (1.39) with 3000 ppm multiplex. The earliest flowering was also recorded (96.94 days) by this treatment. The width of florets and length of spike were not affected by multiplex treatment.

The maximum period of flowering was recorded with application of multiplex 2000 ppm. The cv. Regency was found most out standing among the three cultivars and application of 3000 ppm of multiplex was found very effective for betterment of majority of parameters of growth and flowering.

I-112. Effect of graded levels of plant paclobutrazol, ethrel and GA_3 on growth and flowering of gerbera *(Gerbera jamesonii* H Bolus)

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The present investigation was made to study the effect of plant growth regulators, viz., paclobutrazol, ethrel and gibberellic acid on gerbera cv. Mammut.

The effect of graded levels of plant growth regulators, viz., paclobutrazol (0.05 mg a.i) Ethrel (10, 25, 50, 75 and 100 ppm) and GA_3 (100 and 200 ppm) was studied on *Gerbera jamesonii* var. Mammut under a naturally ventilated green house. Plant growth regulators significantly influenced the number of flowers per plant, flower diameter, stalk girth, flower weight and number of suckers per plant. Among the twelve treatments, the highest number of flowers per plant per year (24.50), the flower diameter (13.22), stalk girth (3.02), flower weight (34.03) and the highest sucker per plant (3.20) were recorded from the plantss treated with paclobutrazol 0.20 mg a.i. The increased yield was attributed to production of more number of suckers under paclobutrazol treatment than ethrel and GA_3.

Session II

Protected cultivation

II-1. Genotypic variation in leaf macronutrient concentrations of exotic chrysanthemum varieties under protected cultivation

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India has been well recognized for growing exotic varieties of chrysanthemums under protected conditions for export purpose. However, increasingly high cost of fertilizers may become major constraint on the increased productivity and therefore it is imperative to isolate or identify the genotypes, which can better use presently available resources. There is sufficient evidence to suggest that gene differences, which distinguish plants within species/varieties, play an important role in mineral accumulation. A study was conducted with an objective of identifying the nutrient accumulation in exotic (sprays) chrysanthemum genotypes of commercial importance under protected cultivation.

Twenty-four exotic genotypes growing under protected conditions in soil have been selected to determine the amount of genetic variation that exists for macronutrient accumulation in leaves. During the vegetative phase of the crop, uppermost fully matured 4th or 5th leaf has been collected from 50 to 60 plants at random in different plots of particular variety. Thus 50 to 60 leaves were collected, processed and analysed for macronutrients. The varieties Darkbos, Lupo and Linikar Amber accumulated significantly more Nitrogen, Phosphorus and Potassium in their leaves compared to the rest of 21 varieties studied. The variety Cherry Reagan in respect of phosphorus and Silver Jublee in respect of potassium accumulation are comparable to them. The varieties Lupo and Harry accumulated more Calcium and Magnesium compared to other varieties whereas the varieties Gilsay and Belmont have shown the lowest accumulation. Thus, these findings of differences in accumulation of N, P, K, Ca, Mg and S among chrysanthemum exotic genotypes clearly demonstrates that genotypic differences within the species/ varieties play an important role in controlling either absorption or translocation or both of macro-nutrient.

II-2. Evaluation of carnation cultivars under naturally ventilated green house

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The study was carried *out* to evaluate the performance of six standard carnation cultivars (Cobra, Gaudina, Montezuma, Niva, Salsa, Super Green) under naturally ventilated green house at Satpuda Botanic Garden, Agriculture College, Nagpur during the year 2002 -2003.

The object of investigation was to assess growth, flowering and flower production under hot and dry climates of Nagpur. The results revealed that all the six cultivars performed well in respect of growth, cut flower yield and post-harvest life. However cultivar Cobra, Gaudina and Super Green produced maximum yield of flowers over rest of the cultivars.

II-3. Standardization of agro-techniques for production of chrysanthemum under low cost polyhouse

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Studies on different agrotechniques for production of cut flower chrysanthemum cv. Yellow Regan under low cost poly house were undertaken during September 2002- January 2003. Treatments included eight combinations of agro techniques, i.e. different media combinations (soil +compost + sand/cocopeat/ sawdust), soil moisture levels (20 kPa and 40 kPa) and nutrient sources (soluble /straight/biofertilizers) were tested in replications.

Among the treatments, T5 (soil + compost + cocopeat; 40 kPa; soluble fertilizers) recorded the maximum plant height (109.8 cm) and stem girth (3.05 cm) followed by TI (soil +compost+ sand 20 kPa; soluble fertilizers). Highest number of primary branches (6.83) and secondary branches (9.44) were recorded in T5 followed by T4 (soil +compost+ sand; 40 kPa; soluble fertilizers). Maximum total leaf area of 1301.8 cm^2 per plant and earliness to 50% flowering (92.2 days) were recorded in T4. Earliest flower initiation was observed in TI (82.1 days). However TI, T2 (soil + compost + cocopeat; 20 kPa; soluble fertilizers), T4 and T5 were on par for early harvest (105.4, 105.7,104.6 ad 105.9 days, respectively). Flower yield (stems) per square meter in this season was highest in T5 (238.9) followed by T4 (213.5). Similarly, T5 was found to produce best spike length (105.71 cm) and flower diameter (6.79 cm) followed by T4, which recorded 93.95 cm and 6.54 cm respectively

However T5 (12.61) preceeded TI (10.57) in number of flowers per spray. Overall comparison of growth parameters, yield and quality of flowers were found better in T5.

II-4. Assessment of gerbera cultivars under fan and pad cooling system

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The investigation was undertaken to assess the performance of ten exotic cultivars (Cabana, Charmander, Pink Elegance, Piton, Rodis, Rosaiin, Ruby Red, Sangria, Sunway and Tonneke) of gerbera (*Gerbera jamesonii*) at Satpuda Botanic Garden, College of Agriculture, Nagpur, during 2001-2002 under partially controlled green house. The results revealed that the cultivars Ruby Red, Cabana, Sangria, Tonneke, Pink Elegance, Sunway and Piton performed well in relation to growth and higher yield of flowers under hot and dry climate of Nagpur for commercial flower production.

II-5. Temperature and RH relations inside the greenhouses and ambient conditions

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The temperature and relative humidity (RH) inside the naturally ventilated and fan and pad greenhouses were recorded at 10 am, 1 pm and 4 pm for one year for gerbera crop. The linear regression model was fitted for monthly average of greenhouse temperature and RH for estimating these in relation to the ambient temperature, RH, wind speed and pan evaporation for naturally ventilated and fan and pad greenhouses separately. It was observed that the temperature inside the naturally ventilated greenhouse

(NVGH) was directly related to ambient temperature (R^2= 0.93). The RH inside the NVGH was also directly related to the ambient RH (R^2= 0.96). The effect of ambient RH was negligible on the temperature inside the NVGH. The effect of ambient temperature was also negligible on the RH inside the NVGH. The effect of ambient wind speed and pan evaporation was also negligible on temperature and RH inside the NVGH. The temperature inside the fan and pad greenhouse (FPGH) was dependent on ambient temperature and pan evaporation (R^2= 0.49). The ambient wind speed and ambient RH did not have any effect on the temperature inside the FPGH. The RH inside the FPGH was dependant on ambient temperature and RH (R^2= 0.72). The pan evaporation and wind speed had no effect on the RH inside the FPGH. The regression models are useful to estimate the temperature and RH inside the naturally ventilated and fan and pad greenhouses based on the ambient conditions.

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II-6. Influence of carbon dioxide enrichment on growth and quality parameters of rose *(Rosa hybrida)*

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An exotic rose cultivar 'First Red' and an indigenous cultivar 'Arjun' were raised in controlled conditions in a glasshouse. After bud break, the plants were transferred to growth chambers with different levels of CO_2 (1000, 1500 ppm and control (ambient)) to study its effect on growth and flower quality. CO_2 enrichment had significant effect on plant height, number of leaves, number of laterals and total leaf area at different growth stages. Plant height was maximum in Arjun when the plants were enriched with 1000 ppm CO_2, while First Red performed better under 1500 ppm in terms of total number of leaves, laterals and leaf area per plant. The root dry mass recorded at the end of the experiment was also higher in Arjun at 1000 ppm CO_2. The rate of photosynthesis, stomatal conductance, transpiration was low in Arjun at 1500 ppm CO_2. Chlorophylla *a, b* and total chlorophyll content in leaf were recorded higher in Arjun at 1500 ppm CO_2. The interaction between cultivars and CO_2 treatment for all the parameters were also significant. First Red required minimum number of days from flower bud initiation to harvest and recorded maximum vase life compared to Arjun, while the stalk length, flower diameter and number of petals were higher in Arjun when the plants were enriched with 1000 ppm. Arjun, an indigenous cultivar, responds to CO_2 enrichment up to 1000 ppm while First Red responded to upto 1500 ppm CO_2 concentration.

II-7. Studies on cost-effective correction of iron chlorosis in cut flower rose for export

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Cost competitiveness has become one of the important deciding factors in export oriented polyhouse rose industry in and around Bangalore, and fertilizers form one of the important components of cost of production. Iron chlorosis has become widespread resulting in reduced yield and poor quality and rejection at processing level. Correction of iron chlorosis using chelates like Fe EDTA and Fe EDDHA has become costly and unsustainable since it has to be continuously used. Hence an experiment was initiated to identify and standardize methods to correct sustainably and at economically affordable level so that the Indian exports continue to be competitive.

The treatments involved Fe EDTA at 1 g/plant, once in a week and neem cake 10% + $(NH_4)_2$ SO_4 0.25% and neem cake 10% + urea 0.25% at ½ l per plant at weekly interval for 2 months. The per cent chlorosis at monthly interval and analysis at the end of 2 months were taken. The results indicated that both Fe EDTA and neem cake + ammonium sulphate were effective in correcting iron chlorosis since 5% chlorosis

has been recorded in the above two treatments whereas in control it was 25-30% in 'First Red' variety that was tested. Neem cake + $(NH_4)_2 SO_4$ is cost effective since Fe EDTA involves an annual application of 30 kg/ha/yr @ Rs.12,000/- per year whereas neem cake and ammonium sulphate involves a cost of Rs.2,000/- per ha/yr resulting in saving of Rs.10,000/- per year. Neem cake + $(NH_4)_2 SO_4$ corrects iron chlorosis by acidifying the rhizosphere, and releasing soil iron which is in abundant supply.

II-8. Soil and ground water deterioration in polyhouse flower production units near Bangalore.

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Cultivation of flowers, and vegetables under protected cultivation in polyhouse is a high input, high output venture involving lot of agro-chemicals (water-soluble fertilizers and plant protection chemicals). Since the growth medium used near Bangalore is the soil, with a link with ground water, exercising caution on the health of the soil and quality of ground water is essential for sustainable productivity of the crops as well as the health of environment. Hence a study was initiated to understand the effect of nutrient management on soil and ground water in polyhouses near Bangalore and Hosur. Soil samples (0-15 and 15-30 cm) and ground water samples were collected from different polyhouses and analyzed for P, K, Ca, Mg and micronutrients, pH, EC and the NO_3 content in ground water. The results indicated that, there was a build up of K from 130-140 ppm to 800-1200 ppm, P from 8-15 ppm to 120-130 ppm, and Ca from 1100 ppm to 1600-3000 ppm and Mg from 500 ppm to 1400 ppm. The micronutrients like Fe, Mn, Zn and Cu also increased by 20-30% and pH increased from 5.8-6.2 to 6.7-7.2. The potash increase is due to the continuous use of KNO_3. P increase also is due to continuous use of P by phosphoric acid. This high P has the potential to increase micronutrient deficiencies like Fe and Zn antagonistically, which is also, of late, becoming a problem.

The analysis of ground water indicated NO_3-$_N$ at 3-5 ppm and has indicated significant pollution of nitrate from the polyhouse units. The excess use of nitrogen and porous nature of the soil have contributed to this ground water quality deterioration. Hence an integrated nutrient management strategy is needed to prevent physical and chemical deterioration in soil and water, by increasing use efficiency and need based supply based on leaf and soil analysis.

II-9. Response of limonium (*Limonium caspia*) cv. Blue Diamond to biofertilizers with different levels of inorganic fertilizers under greenhouse

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Studies were conducted to investigate the effect of biofertilizers with different levels of inorganic fertilizers on *Limonium* cv. Blue Diamond grown under greenhouse during 2001-02 at Hebbal, UAS, Bangalore. The experiment was laid out in randomized block design with 8 treatments and 3 replications. Tissue cultured plantlets were planted at a spacing of 30x45 cm.

The results revealed that the application of 75% N and P, 100% K (Recommended NPK 100:100:100 kg ha^{-1}), vermicompost with *Azotobacter (Azotobacter chroococcum)* and PSB (*Bacillus megaterium* var. *phosphaticum*) significantly increased the growth components like plant height (31.74 cm), plant spread (34.38 cm), number of leaves (21.93) and suckers (5.20). The earlest spike emergence (47.07 days), flower initiation (67.80 days) and harvesting (77.13 days) were recorded by the application of 50% N and P, 100% K, vermicompost with *Azotobacter* and PAB. The same combination showed higher value for

flowering components such as spike length (133.67 cm), spread (108.17 cm), number of branches (20.33) and fresh weight (83.67 g). The maximum flower yield per plant (4.80 spikes) and per m^2 (33.21 spikes) were recorded from the plots which received 50% N and P, 100% K, vermicompost with *Azotobacter* and PSB compared to FYM alone (2.40 and 16.61 spikes). Higher cost benefit ratio (1:2.11) was recorded from the same treatment. Hence, the use of *Azotobacter*, PSB and vermicompost along with 50% of recommended N, P and 100% K helped in realizing better plant growth and higher yield of quality spikes in the production of *Limonium* under greenhouse.]

II-10. Standardization of growing media under protected environment in gerbera *(Gerbera jamesonii* Bol. Ex. Adlam.) in mid hill of Himachal Pradesh

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Studies on standardization of growing media under protected environment in gerbera was conducted during 2001-2002 in the Department of Floriculture and Landscaping of Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni-Solan (H.P.) to find out suitable growing medium. The aim of the experiment was to test the possibility of using different substrates in the green house cultivation of gerbera. The experiment was carried out in naturally ventilated 1ow cost po1y house. During the period of investigation minimum and maximum temperature under poly house from September 2001 to July 2002 ranged from 3.90°C to 21.30°C and 20.82°C to 34.83°C., respectively and maximum light intensity was 14.83 kilo lux and minimum; 5.58 kilo lux.

This study was to evaluate different substrates such as cocopeat, sawdust, cocopeat + sawdust (1:1 v/v), cocopeat + sawdust + soil (1:1:1, v/v), cocopeat + sawdust + sand (1:1:1 v/v), sand + soil + FYM (1:1:1 v/v) in cut gerbera production. With this aim the materia1s were used either alone or mixed with each other and the effect of the growing media on flower yield and the quality of gerbera cv. Gerbera No.1 were investigated. Looking upon the effect of growing media in general, cocopeat + sawdust + sand (1: 1: 1 v/v) was found to be best with respect to days required for bud initiation (75.0 days), flower diameter (9.47 cm), flower stalk length (35.31 cm), flower weight (15.30 g/flower), number of flowers per plant (29.55), number of flowers per m^2 (210.0) and vase life (13.4 days). Cost of production of l00 m^2 in gerbera cv. Gerbera No.1 using best growing medium i.e. cocopeat + sawdust + sand (1:1:1 v/v) based upon the results obtained in the present investigations, was calculated for Solan -Nauni condition. Cost analysis in growing gerbera/100 m^2 showed that by investing Rs. 653206.00, growers can earn a net profit of Rs. 18794.00 by selling each flower @ Rs. 4.00.

II-11. Standardization of package of practices for rose under partially modified greenhouse environment

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An experiment was conducted at the MM- NATP on 'Protected Cultivation of Vegetables and Flowers in Hills and Plains' at NARP, Ganeshkhind, Pune-7 in RBD with thirteen treatments (modules) and three replications. The results of the study indicate that treatment 7 [media- soil:compost:sand (2:1:1), 20 k Pa irrigation regime, basal dose of 200:320:300 NPK kg/ha/yr + fertigation @ 200:0:300 NPK kg/ha/yr with straight fertilizers] gave the highest yield (187.4 flowers/m^2/year), which was at par to treatment 1 (same as treatment 7, except fertigation with water soluble fertilizers) i.e. 186.7 flowers/m^2/year. Treatment 1 was found to produce maximum number (31.3) of, 'A' grade (stem length 90 cm and above) flowers/m^2, followed by treatment 4 [same as treatment 1, except 40 k Pa irrigation regime] i.e. 30.2 flowers/m^2. Treatment 1 was also found to produce flowers with maximum (75.4 g) fresh weight with stem.

II-12. Effect of spacing on yield and quality of gerbera flowers under polyhouse conditions

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An experiment was conducted at AICFIP, NARP, Ganeshkhind, Pune-7 to study the effect of spacing on yield and quality of gerbera cv. Tonneke under polyhouse conditions in RBD with three treatments and seven replications. The results of the study indicate that the spacing of 30 X 30 cm significantly produced more number of flowers/plant /year (25.50). The spacing of 30 X 40 cm, however, significantly produced flowers with longer stalk length (52.50 cm) and larger diameter (11.60 cm).

II-13. Scheduling fertigation for roses inside hi-tech green house

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Fertigation scheduling refers to timely application of water as well as nutrient to the plant. Irrigation scheduling consisted of two important components namely crop water requirement and irrigation interval. Fertilizer scheduling consisted of stage wise application of nutrients to the plants in appropriate dose. Pan evaporation and tensiometer data were used to calculate daily crop water requirement. Three sets of tensiometer (20, 30 and 40 cm) were installed to facilitate irrigation scheduling. The tensiometer data helped in calculating the crop water requirement as well as irrigation interval. Suction probe was used to check the availability of nutrients particularly Nitrogen at the active root zone of the plant itself. Venturimeter was used for proportional application of water and nutrient to the plant. The completely automatic fertigation control system was used for timely and efficient supply of water and nutrients to the plants.

Tensiometer data helps in getting appropriate irrigation scheduling. The soil moisture should be around field capacity for most of the time of crop growing season. The soil moisture level for active flowering season was found to be 20, 23 and 25 centibar for the tensiometer depth of 20, 30 and 40 cm respectively. The average nutrient concentration for active flowering season was found to be N, 67 ppm, P, 14 ppm and K, 80 ppm.

II-14. Production of off-season lily inside net house with fertigation

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Off-season crop of lily consisting of three varieties namely, 'White Osnat' (European lily), 'Elite' and 'Star Gazer' (Asiatic types) were grown under 50 per cent shade net during hot summer as demand goes up in the local market. Most of the varieties of lily flower crops are susceptible to hot summer season as the crop may wilt and burn in spite of growing it inside naturally ventilated greenhouse with drip fertigation system. Irrigation scheduling was precisely done on the basis of latest FAO based Penman-Monteith method. The moisture level in crop root zone was kept at "field capacity" for most of the active growing time, especially after bud setting. It was found that potassium played a major role in getting good quality flowers in off-season.

The potassium concentration at the level of 80-100 ppm near and after bud setting was found to be ideal for getting healthy and good quality bud. Due to this specific fertigation treatment good quality off-season lily flower crops could be harvested even in the harsh summer month of May, when the maximum temperature level is more than 40°C. The variety 'White Osnat' out performed 'Elite' and 'Star Gazer' in producing A grade flowers with longer (85.62 cm) and thick (3.01 cm) cut stems, having 12 days longevity in vase at room temperature.

II-15. Standardisation of planting density in rose cv. Happiness under protected conditions

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An experiment was undertaken to study the effect of plant density on growth and flowering of rose cv. Happiness grown in low cost polyhouse from 2001 to 2002. The trial was carried out in RBD with four treatments of plant densities (2, 4, 6 and 9 plants/m^2) and six replications. Higher plant densities (6 and 9 plants/m^2) recorded greater plant height at the time of pruning while lower densities (2 and 4 plants/m^2) gave higher pruned wood weight. Flower diameter was maximum in lower plant density of 2 plants/m^2 followed by density treatment of 6 plants/m^2 during first flush of flowering. Vase life of cut flowers obtained from lower densities was longer in first flush and non-significantly affected by plant density during second flush. Plant density of 6 plants/m^2 took least number of days to flower and for bud opening in both the flushes of flowering and number of days to flower bud opening. Flower diameter in second flush of flowering, shelf life of flowers and number of flowers per plant were non-significantly affected by plant densities. However, plant densities of 6 and 9 plants/m^2 gave better flower yield per unit area.

II-16. Temperature and humidity regimes in naturally ventilated and fan - pad cooled greenhouses under mild climatic conditions

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Temperature and humidity variations have been observed for naturally ventilated and fan - pad cooled greenhouses in comparison to ambient conditions for a period of one year under Bangalore climatic conditions. Performance of gerbera crop has been monitored in the two greenhouses and linked to the greenhouse temperature and humidity conditions. Seasonal average temperatures in the naturally ventilated greenhouse were generally close to the ambient air temperatures and were higher by about 0.5 - 1.6 °C only. Relative humidity of naturally ventilated greenhouse was also close (within 5%) to the ambient relative humidity where as in case of fan - pad cooled greenhouse, the greenhouse temperatures were 3 °C - 4 °C lower than ambient during summer months. At other times of the year, the temperatures in fan - pad cooled greenhouse were close to the ambient. However, greenhouse humidities in fan - pad cooled greenhouse were 10 - 30% higher than ambient air values. The crop performance in naturally ventilated greenhouse was observed to be superior to that in the fan - pad cooled greenhouse. Higher relative humidities in fan - pad cooled greenhouse appear to be responsible for higher disease incidence and consequently, poor crop performance.

II-17. Performance of gerbera (*Gerbera jamesonii*) cultivars under fan and pad cooled greenhouse condition.

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The performance of nine exotic cultivars of gerbera viz., Diablo, Lyoneila, Orneila, Sunset, Tara, Thalassa, Tiramisu, Twiggy and Whitsun was evaluated under fan and pad cooled greenhouse environment, at the

Indian Institute of Horticultural Research, Bangalore, during July 1998 to June 1999. The maximum plant height (48.83 cm), number of suckers (5.16) and leaves (46.27) per plant were obtained with cultivars Tiramisu, Lyonella and Ornella, respectively, while the minimum values of above parameters were obtained in cultivars Whitsun (47.88 cm), Sunset (3.82) and Tiramisy (26.74), respectively. The earliest flowering in 100% plants was obtained in Whitsun (57.47 days) and latest in Tiramisu. (88.30 days). Higher diameter of flower (10.70 cm) and length of flower stalk (58.27 cm) were recorded in cultivars Tiramisu and Lyonella, respectively. The thickest (0.70 cm dia) and heaviest (22.20 g) flower stalks were produced in Twiggy and the thinnest (0.60 cm dia) and lightest (13.94 g) in Whitsun. The highest total number of flower produced per plot in a year and mean number of flowers per plant and per month in a year were obtained in Ornella (1058.00, 47.26 & 5.02, respectively) followed by Thalassa (988.00, 42.52 & 4.61) and the lowest in Tara (591.33, 29.48 & 2.82), followed by Sunset (600.00, 31.15 & 3.11). The higher percentages of 1st grade flowers were obtained in Lyonella (73.85), Sunset (70.41) and Tiramisu (70.54) and lower in Tara (47.16) and Thalassa (47.87). Higher percentages of discarded flowers were counted in Thalassa (37.30), followed by Whitsun (20.47). Higher percentage of plant survival was recorded in Thalassa (94.44%), followed by Ornella (88.88%) and lowerst in Twiggy (71.52%) followed by Diablo and Tiramisy (75% both). The incidence of fusarial wilt (*Fusarium oxysporum)* was heaviest in Sunset (82.33%) and Diablo (80.73%), whereas the lowest in Tara (26.48%) and Thalassa (36.73%). Considering the overall performance, cultivars Lyonella, Ornella, Tiramisu and Twiggy are recommended for commercial cultivation.

II-18. Evaluation of spray chrysanthemum cultivars under open and polyhouse cum rain-shelter conditions

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An experiment was conducted to evaluate twenty different spray chrysanthemum cultivars to assess growth, flowering and yield parameters under open and polyhouse conditions. The experiment was laid out in factorial Randomized Block Design with three replications. The planting was done with 30 x 30 cm spacing. Open planting exhibited significantly better growth, earliness to flowering (74.39 days), flower number (71.25), flower size (7.59 cm) and yield (2.24 kg/m^2) compared to the polyhouse planting. However, the blooming period (41.68 days) and vase life (15.08 days) of the flowers were found significantly better under polyhouse condition. The cv. Purple Decorative was found superior in terms of plant height (74.08 cm), plant spread (49.25 cm) and yield (3.35 kg/m^2) and it also produced second largest flowers (9.12 cm). Earliness to flowering was observed in cv. Yellow Bangla (62.00 days). Largest flowers were observed in cv. Ravi Kiran and Gulmohar (9.43 cm). Blooming period was found to be the highest in Charming (52.67 days) closely followed by Basanti (52.30 days). In terms of vase life cv. Aparajita was found to be the best (19.00 days) followed by Prof. Harris (18.17 days).

II-19. Assessment of comparative performance of some gerbera (*Gerbera jamesonii* Bolus) cultivars under open condition and plastic rain shelter in Assam condition.

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An experiment was carried out to study the growth, flowering and post harvest aspect of gerbera *(Gerbera jamesonii* Bolus) in the Department of Horticulture, Assam Agricultural University, Jorhat, during 1997-2000. The experiment was conducted for two years during 1997-1998 and 1998-1999 with 11 cultivars in two growing conditions to evaluate their comparative performance in factorial Randomized Block Design with three replications. The results revealed that almost all the cultivars exhibited significantly better

performace under plastic rain shelter as compared to the open condition in respect of growth, physiological and flower characters. Al1 the cultivars exhibited significantly early flowering in terms of visibility of flower buds, opening of flower bud to full bloom under plastic rain shelter as compared to the open condition. The size of flower (9.74 cm and 9.04 cm), length of stalk (36.13 cm and 33.72 cm), girth of stalk (1.56 cm &J1d 1.48 cm) number of flowers per plant (29.86 and 26.05), number of florets per flowers (171.77 and 166.60), shelf life (20.94 days and 19.06 days) and vase life (11.48 days and 10.15 days) were also significantly higher under plastic rain shelter. Irrespective of growing conditions the cultivar Popular exhibited significantly superior performance in respect to all the growth, physiological and flower characters except plant height under both the conditions followed by Eventing Bells, Red Monarch and Nebulusa.

II-20. Performance of carnation (*Dianthus caryophyllus L.*) varieties under *polyshades* in the plains of West Bengal.

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An investigation had been taken up by the Department of Floriculture and Landscaping of Bidhan Chandra Krishi Viswavidyalaya, West Bengal at Jaguli Instructional Farm during 2001-2003 to study the performance of different carnation varieties. Seven standard and two spray (Supermix, Red and White) varieties were selected for the experiment and the varietal assessment showed that Peacly Mambo was the tallest cultivar (72 cm) followed by Charmant (68.33 cm) and Supermix, Red (66 cm). Supermix, White was found to produce the maximum number of shoots per plant (12) followed by Supermix, Red (8) and Charmant (6.66). The number of flowers per plant was higher in Supermix, Red (77.66) followed by Supermix, White (70.33) among the spray types and Bodega (6.66) followed by Charmint (6.33) were promising among the standard types. The largest flowers (in diameter) were obtained in Solamanca (6.93 cm) followed by Design (6.80 cm) and Prado Mint (6.73 cm). The spray varieties flowered earlier. Supermix, White required 83 days after planting compared to standard varieties i.e. Bodega (116 days) and Design (119 days). The spray type flowers remained fresh for a longer time on plant (26.33 days) as compared to standard ones e.g. Design, Prado Mint, Tabor (all 15.66 days).

II-21. Effect of thinning of vegetative / blind shoots on cut flower production of alstroemeria under polyhouse conditions

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Investigation was conducted on one year old plants of *Alstroemeria* cv. Serena on quality and yield of cut flower under poly house conditions by 30%, 60%, and 90% thinning of vegetative shoots on monthly basis during flower production. The maximum number (per plant per year) of flowering stems and length of flowering stem were observed to be 75 and 91.37 cm respectively by 30% thinning of vegetative shoots followed by 60% thinning (61.5 and 87.5cm respectively). 30% thinning gave better response for number of 'A' grade (38) flowering stems followed by 60%, and 90% thinning and control without thinning of vegetative shoots (34, 32 and 24 respectively).

II-22. Varietal evaluation of gerbera *(Gerbera jamesonii bolus)* under low cost green house

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Studies were conducted at the Department of Pomology and Floriculture, College of Horticulture, Vellanikkara, to evaluate the performance of five gerbera varieties, viz., Essandre, Juvena, Lindessa, Tamara and Yanara and to compare ground planting with pot culture under low cost green house. The varieties differed significantly with respect to vegetative and floral characters. Variety Essandre was found to have maximum plant height, number of leaves, petiole length and leaf area. Plant spread was maximum in variety Yanara and variety Lindessa had the maximum number of lobes on leaves. Variety Essandre produced maximum number of flowers, per plant whereas variety Tamara was very poor in flower production. Flower diameter and stalk length were maximum in variety Yanara, while maximum stalk girth was recorded in variety Lindessa. Variety Juvena took minimum number of days for the emergence of first flower bud and from flower bud emergence to flower opening. Field life was maximum in variety Tamara. No significant variation was observed in the vase life of flowers of different gerbera varieties. When the method of planting was concerned, it was found that varieties exhibited better plant height, number of leaves, leaf area and more number of flowers when planted in ground, rather than in pots.

II-23. Evaluation of standard carnation cultivars for flowering, flower quality and yield under protected cultivation

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Investigations were carried out with nine cultivars of carnation to know the performance of cultivars with respect to flowering, flower quality and yield parameters. Cultivars Desio, Sorisso, Madame Collette were early to flower, whereas cultivars Pirandello and Aicardi were late to initiate flower bud. Cultivars Aicardi, Alma, Candy, West Pretty and Madame Collette had maximum flowering duration as compared to other cultivars. The flower stalk length was the highest in cultivar Pirandello followed by Candy, Madame Collette, Sugar Baby and Aicardi, whereas the girth of flower stalk was highest in cultivar Sugar Baby followed by Madame Collette, Alma and West Pretty. Cultivars Madame Collette, Pirandello, Candy and West Pretty recorded higher diameter for both buds and flowers. Number of petals per flower was the highest in cultivar Alma followed by West Pretty, Aicardi and Sorisso. Cultivars Alma, Desio, Aicardi, We .t Pretty and Madame Collette recorded higher vase life of flowers. Cultivars Madame Collette, Sugar Baby, Aicardi and Pirandello recorded higher flower weight. Only two cultivars Sorisso and Madame Collette had fragrance, Sorisso had intense fragrance, whereas Madame Collette had mild fragrance. In general, high quality flowers were obtained in Madame Collette, West Pretty, Desio, Aicardi and Alma. With respect to yield, cvs. Madame Collette, West Pretty, Desio and Aicardi were found superior in terms of number of flowers per plant and per square meter.

II-24. Stenting: A novel approach to propagate greenhouse roses

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Conventional propagation techniques to multiply greenhouse roses through budding/ grafting are labour intensive, time consuming and inconvenient to budder. Hence, investigations were conducted on simultaneous budding/ grafting of scions and rooting of rootstocks in a single stroke (stenting) during

2001-2002 on greenhouse rose cvs First Red and Soleido under mid hills of Himachal Pradesh. Maximum per cent of successful stentlings in a short span consisting optimal diameter and length of sprouts were obtained during spring than winter. Among propagation methods, tongue grafting was found to be satisfactory than chip budding, T-budding and split grafting. However, per cent field survival of stentlings upon transplanting was better from autumn propagated plants than spring in both the cultivars.

II-25. Evaluation of black centred gerbera cultivars under polyhouse

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Five black centred gerbera cultivars were evaluated to assess growth, flowering and yield parameters under natural ventilated polyhouse at Assam Agricultural University, Jorhat, Assam. The cultivars were Golden Gate, Sangriea, Aquilla, Ellymay and Sunway. The experiment was laid out in Randomized Block Design with three replications and planting was done with 30 x 30 cm spacing. The results revealed that the cuitivar Sunway recorded maximum plant height (55.70 cm), leaf number (10.55), leaf area (37.77 cm^2), plant spread (78.50 cm) and stalk length (54.77 cm). Maximum flower diameter (9.92 cm) was observed in cuitivar Aquilla. Cuitivar Ellymay recorded maximum stem thickness (2.41 cm) and flower number (51.00/m). Highest blooming period (19.55 days) and maximum vase life (12.22 days) were observed in cuitivar Golden Gate. Based on the performance, Ellymay and Golden Gate have been identified as the most suitable cultivars for cultivation under polyhouse in Assam condition.

II-26. Decision process under greenhouse

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Greenhouse environmental control and production management is not an easy task. Automation or atleast supporting the decision making process is becoming an increasingly important issue in order to master this complexity and make a more rational use of resources. In order to support the greenhouse user in decision making, the knowledge of scientists, advisors and growers must be implemented into practice in the form of a computer programme. The choice of set points for environmental parameters must be done by a reasoning process integrating the situation outside the greenhouse, inside situation that we want to manage in an advantageous manner, ensuring a profitable combination, through safe combination of growth and development factors while keeping the energy spending within acceptable bounds and as low as possible.

II-27. Stalk length variation in Indian roses grown under green house

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Ten Indian rose cultivars grown under green house condition were tested for the quality parameters such as flower stalk length, vase life and total flower yield. Dr. B.P. Pal and Angelique produced superior quality flowers than remaining varieties. Nehru Century and Golden Times were found to produce shorter stalk length and vase life. A positive relationship between flower stalk length and vase life was noticed among the cultivars. For instance, flower stalk length of 60 cm and 45-60 cm had 56% and 68% positive relationship with vase life. An inverse or negative relationship of shorter stalk length and below 30% correlation with yield is obtained in the present study, thus indicating that stalk length is associated with vase life and selection can be made based on stalk length.

II-28. Nutritional studies in gerbera grown in polyhouse

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A study was taken up during 1998-99 in cv Sangria to standardise the nutritional requirement of gerbera in poly house. The trial consisted of N at three levels (10,15 and 20 g/m^2), P_2O_5 and K_2O at 10 and 20 g/m^2. The data analysis showed that application of N at 20 g/m^2 had significant influence on yield. However, vase life was significantly higher (8.28 days) in plots where N was applied at lower doses (10g/m^2) as compared to higher dose of N (20g/m^2) where it was 7.86days. Application of P_2O_5 at 10 g/m^2 and K_2O at 10g/m^2 had significant influence on yield as compared to higher doses of 20 g/m^2 each. All the other parameters like plant height, number of leaves, flower stalk length and diameter were not significantly influenced by the different treatments.

II-29. Hydroponics in floriculture

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In combination with greenhouses, hydroponics is becoming increasingly popular, especially in the USA, Canada, Western Europe and Japan. Hydroponics is a technology of growing plant in a nutrient solution with or without the use of an artificial medium. It is highly productive, water and land conservative and environment protective. The first account of the successful work was undertaken at Glasshouse Crop Research Institute, Littlehampton (GCRI) and method was referred to as Nutrient Film Technique (NFT). A modified Nutrient Film Technique was developed for the production of cut chrysanthemum and resulted in an increased production of mum stems per unit area of green house by 50 per cent. Different methods of hydroponic systems are NFT, deep flow hydroponic (floating hydroponics), aeroponic, rockwool culture, gravel culture and plant plance hydroponics. Commonly used methods in hydroponic flower production are NFT in chrysanthemum, deep flow hydroponics in tulips, rockwool culture of carnations and gerberas. The hydroponic technology is being increasingly used for flower production in recent years due to the reason related to the decreasing fertility of natural soil, disease limitations, increase in salinity as well as the need of the growers for improving efficiency in the nursery and quality of the products, by means of better control of production through technological innovations.

II-30. Effect of growing media and fertilization on growth and flowering of carnation under protected conditions in mid hills of H.P.

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Carnation *(Dianthus caryophyllus* L.) cv. 'Sunrise' was planted in different growing media viz. soil + FYM + sand (2: 1: 1), soil + FYM + cocopeat (2: 1: 1) and soil + FYM + sawdust (2:1:1) and fertigated with 100 ppm N and 140 ppm K (twice a week) with water soluble and straight fertilizers. The results revealed that soil + FYM+ cocopeat (2: 1: 1) to be the best medium for important parameters such as plant height (77.93 cm), bud size (1.91 cm), flower size (7.22 cm) and vase life (15.73 days). Among the fertigation treatments, water soluble fertilizers (100 ppm N and 140 ppm K) were found best for getting maximum number of quality flowers per plant. No disease incidence was observed during the course of investigation.

II-31. Impact of weather parameter and media composition on plant establishment and branching characters in carnation under protected condition

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Carnation is grown under protected cultivation. Changes in weather parameters as well as interaction among these parameters with each other and their impact on plant growth is still being experimented for better performance of the crop under Indian conditions. It is important to understand the control of temperature, humidity and availability of light that can be regulated under the protected structure compared to ambient. Usage of locally available media like saw dust and coco peat are experimented to analyse their suitability of crop growth. Growth response was analysed in three different media compositions viz., sand:soil:compost (1:2:1), coco peat:soil:compost (1:2:1), saw dust:soil:compost (1:2:1)

Plant establishment after a month of planting was maximum in media consisting of sand (99.65%) followed by that in cocopeat (95%) and sawdust (88.48%). Apical buds were pinched at the position of 6th node after a month of planting. Observation of number of branches was taken one month after pinching. Number of side branches were more in cocopeat (5.43) compared to that in sand (5.24) and in sawdust (4.60). Minimum temperature during the period of plant establishment and emergence of branches ranged from 10^{0} C to 18^{0}C; whereas the maximum temperature during the period ranged from 32^{0} C to 42^{0} C. Average relative humidity available during the period of establishment was 60%. Average light availability inside the polyhouse was 19k.lux during the period establishment. This is 70 per cent lesser than outside, whereas by removal of shade net, 65 per cent of the light can be made available for growing plants. Relationship between temperature and light in presence and removal of shade net was worked out for providing optimal cultural condition. Similarly, relationship between temperature, light and humidity was worked out when sides were covered with insect net in composition with polysheet. Accordingly structure of poly house for optimal growth of plants is arrived at.

II-32. Standardization of production technology for cut rose cv. 'First Red' under naturally ventilated polyhouses

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Studies were conducted to investigate the effect of growing media and fertilizers on growth and flowering of cut roses cv. 'First Red' under naturally ventilated polyhouses. Three soil based substrates (soil + FYM + sand, soil + FYM + cocopeat, and soil + FYM + sawdust) mixed in 2: 1: 1 (v/v) were used. Three weeks after planting N and K (150 & 200 ppm) were applied through fertigation (fertilizer sources: straight fertilizer and water-soluble fertilizer). In treatment combinations where biofertilizer wass used, fertigation was started 45 days after the planting. During first flush, it was observed that growing media containing soil: FYM: saw dust (2: 1: 1) was found to be the best in respect of getting maximum flower yield (5.58) per 2.5m^{2} per month when fertilized with water soluble fertilizer. Maximum number of flower of grade 60-89 cm and 30-45 cm stem length was recorded with straight fertilizer in growing media soil: FYM: sand.

During second flush, in treatment where RAP and GA_3 @50ppm at monthly interval from October to January were applied, with growing media soil: FYM: sand and fertilized, the plants with water soluble fertilizer excelled in all parameters except flower yield. Flowers of grade 30-45 cm were found to be maximum where growing media of soil: FYM: sawdust was used.

Session III

Biotechnology

III-1. Cryopreservation of clonally propagated plants

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Practically cryopreservation is storage of plant materials in liquid nitrogen at –196°C. Methodology of germplasm cryopreservation was created in 1970s, expanded in the 1980s and implemented at the end of the 20th Century. Cryopreservation technique is based on two mechanisms – first, classical technique based on freeze induced dehydration and second, a new technique based on vitrification i.e. vitrification, encapsulation-vitrification, encapsulation-dehydration, dormant bud preservation etc. A basic cryopreservation process involves different successive steps like choice of material, pretreatment, freezing, storage, thawing and recovery.

Cryopreservation is successfully applied on various types of seeds and cultures in ornamental crops for long-term conservation like cell suspension. Cryopreservation is considered as the best option for long-term storage of ornamental crops. Thus, physical and genetical stability is maintained for long period without any subculturing. Besides, it requires less space, reduced cost of conservation and facilitates international germplasm exchange.

III-2. Callus mediated organogenesis in tuberose cv. Single from inflorescence segments

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Inflorescence segments containing stalk and immature flower buds collected from field grown plants of tuberose cv. Single were surface sterilized with 0.1 per cent mercuric chloride for 10 minutes and inoculated in MS medium containing NAA alone and in combination with adenine sulphate. Maximum callusing was observed in treatment with NAA 15mg l^{-1} + adenine sulphate 10.0 mg l^{-1} for inflorescence segments with immature flower buds and NAA 20 mg l^{-1} + adenine sulphate 10.0 mg l^{-1}, for inflorescence stalk segments. The callus on subculturing in MS medium supplemented with BAP 4.0mg l^{-1} + KIN 6.0 mg l^{-1} differentiated into shoots. The differentiated shoots were elongated in half strength MS medium devoid of growth regulators and rooted in the medium containing IBA 4.0 mg l^{-1} + activated charcoal 0.2 per cent. The rooted plantlets were hardened and planted out.

III-3. In vitro propagation of *Heliconia psittacorum* L. through terminal bud.

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In vitro muitiplication of *Heliconia psittacorum* L. was tested using terminal buds in the Tissue Culture Laboratory, Department of Horticulture, Assam Agricultural University, during the year 1997-1998. Terminal buds of *Heliconia psittacorum* were successfully established in the MS medium with 5.0 -6.0 mgl^{-1} BAP, 0.05 -0.1 mgl^{-1} IAA and 1.50 -2.00 mgl^{-1} GA_3. The supplementation of 2.5 mgl^{-1} IBA, 0.2 mgl^{-1} IAA and 2.5 mgl^{-1}

^{1} GA was ideal for initiation of multiple shoots and their multiplication rates. Medium supplemented with 0.75 mgl^{-1} IAA, and 0.05 mgl^{-1} NAA gave the maximum rooting response (85 %), earliest root initiation (within 21 days) and maximum number of primary (3.70) and secondary (3.90) roots.

III-4. *In vitro* shoot proliferation and callus induction in *Gerbera jamesonii*

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Gerbera is one of the leading crops in the cut flower industry because of its attractive flowers with numerous colours and shades. An investigation was carried out to standardize a micropropagation protocol for gerbera by studying the influence of MS media supplemented with various growth regulators on shoot proliferation and callus induction. BAP alone was found to be the best, recording a maximum in almost all parameters suggesting that BAP as a single treatment is more beneficial than a combination of cytokinins. BAP concentration of 3 mgl^{-1} produced the maximum number of shoots and leaves, while in the case of Kinetin, 4 mgl^{-1} was the best with regard to number of shoots and leaves. Callus initiation, in general, was found to be better in a media supplemented with a combination of 2,4-D and Kinetin than BAP and IBA. However, in media supplemented with BAP and IBA, the early signs of necrosis was noted comparatively later than with 2,4-D and Kinetin. Rooting of the *in vitro* derived plantlets was found to be the best with IAA with the maximum number of roots in MS media supplemented with 7 mgl^{-1} IAA.

III-5. Modulation of flower colour by metabolic engineering: providing new functions for an old pathway

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Interest in flower colour is presently focused not only in chemistry and biochemistry, but also in the genetics of flower colour in a number of amenable plants including *Petunia, Gerbera, Chrysanthemum* and rose etc. The rapid progress in recombinant DNA technology, cell culture and plant transformation methodologies has now set the stage for the targeted improvement of several plant secondary metabolic pathways. An enormous variety of flower colour is attributed to flavonoid compounds. Flavonoid biosynthesis provides an ideal plant specific secondary metabolic pathway to investigate the feasibility of this approach because the enzymology and the genes involved are relatively well understood. Two general approaches to modulating flower colour viz., changing the amount of pigments produced or changing the specific pigments and/or co-pigments produced, are being made currently. This may be by introduction of genes, which are not naturally present in the receptor plant, or by the inhibition of specific steps or of a part of the flavonoid pathway. The generation of transgenic *Petunia* plants with 'brick-red' flowers due to pelargonidin synthesis was the first case of the creation of a novel flower colour in a highly directed fashion using recombinant DNA and gene transfer techniques. Genes which control the synthesis of any molecules, which can impart flower colour, their isolation and engineering, and the impact of altered expression in transgenic plants are the subject of this review.

III-6. Influence of explant and media on somatic embryogenesis in gerbera

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Gerbera is an important cut flower, successfully grown throughout India under wide range of climatic conditions. The conventional rate of multiplication in gerbera is slow. Somatic embryogenesis constitutes

a powerful tool not only for rapid clonal propagation but also for crop improvement exploiting genetic engineering. The present investigation was carried out to study the response of explant and media to callus induction and somatic embryogenesis.

Somatic embryogenesis has been achieved from callus cultures derived from leaf disc explants of *Gerbera jamesonii* cv Alsmeera. Callus cultures were initiated from leaf disc pieces (1-2 cm) on MS medium supplemented with varied combinations and concentrations of auxins and cytokinins. High frequency (91%) for callus formation was achieved on MS medium supplemented with BAP (1 mgl^{-1}) and 2,4-D (2.5 mgl^{-1}). Calli, developed on various callus induction media, responded differently for somatic embryogenesis after transfer to somatic embryo induction media i.e. MS media supplemented with IAA (1 mgl^{-1}) and BAP (5 mgl^{-1}) and MS media supplemented with Kinetin (2 mgl^{-1}) and BAP (1 mgl^{-1}). Maximum percentage of response for somatic embryo induction from callus clumps was 60% on MS media supplemented with Kinetin (2 mgl^{-1}) and BAP (1 mgl^{-1}). Histological studies confirmed the globular and heart shaped developmental stages during maturation of somatic embryos.

III-7. Protocol for isolation of polysaccharide free DNA of *Rosa sps*

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The *Rosa sps* contains more proportions of carbohydrates. Preparation of plant DNA is often contaminated by polysaccharides, which co precipitate with DNA after alcohol addition during DNA isolation and finally leads to highly viscous solutions. The presence of such contaminants can be very inconvenient for the further use of the DNA involving electrophoretic steps. It has been shown that carbohydrates can inhibit enzyme activities and also causes mechanical blocking of flow.

In the present experiment, Drislease enzyme, which is used in tissue culture experiments for cell wall hydrolysis was added in the procedure for preparing pure plant DNA combining in one step. The present experiment results demonstrated that digested sample with Driselase enzyme at concentration at room temperature, leads, after phenol and chloroform extraction, to the isolation of pure DNA without any polysaccharide contamination. The highly purified DNA can be used for PCR amplification. The protocol developed will be discussed in detail in this paper.

III-8. Protocol for *in vitro* production of gerbera through young capitulum

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In the international trade, there is ever growing demand for the introduction of new hybrids. Propagation of gerbera through commercial method is too slow to meet the requirements of the commercial industry. Micro propagation ensures rapid multiplication of plantlets independent of the season. In majority of the tissue culture labs, micro propagation is carried out with shoot tips. This exhausts lot of mother plants for culturing. Hence, an experiment was conducted to standardize the protocol for *in vitro* production of gerbera through young capitulum at Horticultural Research Station, Yercaud during 1997-2000.

Young capitulum explants of gerbera cv. YCD.1 were surface sterilized and inoculated in three media viz., MS, G and ½ MSH supplemented with combinations of BA at 2.0, 3.0 and 4.0 mg l^{-1} and IAA at 0.1 and 0.5 mg l^{-1}. Ten explants were inoculated per treatment and replicated thrice. Observations on the percentage of adventitious shoot production were recorded 35 days after inoculation. The days taken for adventitious shoot formation was recorded as and when the shoots were initiated.

The mean highest percentage of production (80.0) and the earliest initiation of adventitious shoots (23.67 days) was recorded in ½ MSH medium supplemented with BA 2.0 mg l^{-1} and IAA 0.1 mg l^{-1}. This proves to be a very viable method for commercial tissue culture units and could be adopted for novel or expensive varieties with limited planting material.

III-9. Controlling phenolic blackening in *in vitro* cultures of Phalaenopsis

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In a trial conducted to develop a method to reduce phenolic blackening in *in vitro* culture of inflorescence stalk node of *Phalaenopsis* five different treatments were tried. They were, adding AC (0.1%) in the media, rinsing the explants with PVP (1000ppm) and ascorbic acid (1000ppm) before inoculation, keeping the cultures in the dark and use of liquid media. The culture medium used was 1/2 MS containing BA 10.0 ppm and NAA 1.0 ppm with sucrose 3.0 per cent. Out of the five methods, two methods, viz., keeping the cultures in the dark and use of liquid media were found better.

Another trial was conducted using shoot node of *in vitro* cultured plantlet of Phalaenopsis, to develop a method for reducing phenolic blackening of the media used in *in vitro* cultures, by adding different antioxidants in the culture medium in different concentrations. The culture medium used was ¼th MS containing BA 10.0 ppm and NAA 0.1 ppm with sucrose at 1.5 per cent level. The trial was conducted by adding different antioxidants into the media at different levels. The antioxidants used were citric acid, ascorbic acid, PVP and cysteine- HCl, each at five levels (100,200,300,400 and 500 ppm). It was observed that with the increase in the concentration of the antioxidants, there was a proportionate reduction in media discolouration and the media containing citric acid at 500ppm was found to be completely free of phenolic blackening .

III-10. Role of activated charcoal and triadimefon on *in vitro* rooting of *Phalaenopsis* var. Diana Pinky

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The influence of activated charcoal and triadimefon on *in vitro* rooting of the orchid, *Phalaenopsis* was assessed. Shoot node of *in vitro* grown plantlets of *Phalaenopsis* variety 'Diana Pinky' was used for the study. For the trial with activated charcoal, the media used was 1/4th MS + BA 5.0ppm with six concentrations of activated charcoal viz., 0.025, 0.05, 0.10, 0.20, 0.40 and 0.80 per cent. in another trial conducted with triadimefon, the media used was 1/4th MS + BA 5.0ppm +AC 0.4 per cent and triadimefon was tried at four levels viz., 5.0, 10.0, 15.0, and 20.0 ppm. Among the levels of activated charcoal tried, maximum number of roots (4.17) was produced at 0.80 per cent level. The addition of triadimefon to the media recorded maximum healthy (4.50) and lengthy roots (8.00cm) at 20ppm level.

III-11. *In vitro* mutagenesis in gladiolus using gamma rays

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Axiliary bud explants derived from inflorescence of two gladiolus cultivars i.e. 'Eurovision' and 'Bonair' were exposed to gamma rays (1,2,3 and 4 Kr doses) and cultured on standardized medium (MS + BAP

(10 mM + NAA (0.05 mM) along with un irradiated explants (control). Shoots in large numbers were proliferated on the medium comprising MS + BAP (12 mM). Proliferated shoots were transferred to cormel induction medium consisting of MS + paclobutrazol (1 ppm) + sucrose (60 g/l). *In vitro* induced cormels were grown *in vivo* to increase their size for producing flowers. Well developed corms were grown *in vivo* and observations were recorded for various vegetative and floral characteristics. Studies revealed that over all growth of the plants including plant height was reduced in all the treatments as compared to untreated population. In cultivar Eurovision, the population treated with gamma rays with 1,2 and 3 Kr.doses induced variations in plant height, spike length, floret number, floret colour, arrangement of florets on the spike etc. as compared to untreated material. It was observed that at 1 Kr dose, some plants produced the spikes on which florets were arranged in such a way that their mouths were far away from the rachis in opposite direction.A few plants irradiated with 2 Kr gamma rays produced the spikes having two florets at one place as compared to one in original cultivar. At 3 Kr dose, there was a mutation where only one floret (4^{th}) in whole spike got mutated and spike fascinated (flattened) and crooked. The colour of this particular floret was pink (49A, as per R.H.S. colour chart) having white midrib inside and creamish white throat as compared to red colour (44B) of floret in original cultivar. In cultivar Bonair, 1 Kr gamma rays induced few variations producing shorter spike with less number of florets. At 4 Kr dose, both the cultivars failed to flower.

III-12. Micropropagation of chrysanthemum for commercialisation

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Chrysanthemum is among major cut flowers of commercial significance. It is imperative to maintain the quality of the planting material using conventional and non-conventional approaches. Micro propagation ensures rapid, true to type and disease free planting material. Therefore, the present study was undertaken on chrysanthemum cv. Snowball to assess the effect of different hormonal concentrations and combinations on rate of multiplication.

The shoot tip portions of plants were selected as explants and were established on basal MS media. High shoot proliferation of established explants was obtained when the MS basal media was supplemented with GA_3 (0.5ppm), BAP (0.5ppm) and kinetin (0.5ppm). Rooting occurred upon transfer of proliferated shoots on basal MS media, which were subsequently transferred to pots containing sterilized soil and FYM mixture.

III-13. Embryo culture and artificial seed production of *Spathoglottis plicata* and *Rhynchostylis retusa*

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An experiment was conducted to standardize the media for mass multiplication of two orchid species, *viz., Spathoglottis plicata* and *Rhynchostylis retusa*. Results showed that highest seed germination and its subsequent growth and protocorm development of *Spathoglottis plicata* were on Knudson C media supplemented with CW 150 ml/l, ME 0.5 g/l, KN 0.5 mg/l, IAA 0.5 mg/l and Tj 50 ml/l. However, subculturing of protocorm on Knudson C media supplemented with KN I mg/l and NAA 0.1. mg/l resulted in healthier seedling growth. In *Rhynchostylis retusa,* highest frequency of germination and protocorm development were observed in Knudson C media supplemented with ME 0.5 g/l, NAA I mg/l and BAP I mg/l. Subculturing of protocorm to Knudson C media supplemented with peptone and NAA (1.5 mg/l) resulted in the best subsequent growth and development of protocorms. The hardened seedlings of *Spathoglottis plicata* showed a higher survival percentage (90%) than non-hardened seedlings (80%) on transplanting to

community pot. The full grown protocorm of (150 days) of *Spathoglottis plicata* and *Rhynchostylis retusa* were encapsulated for artificial seed production and kept at four different storage temperatures. The artificial seed stored at 4°C under liquid paraffin showed significant increase in storage life as well as regeneration potential and could be stored upto 90 and 120 days, respectively.

III-14. Regeneration of carnation (*Dianthus caryophyllus* L.) from shoot-tip explants: Effect of NAA and Kinetin

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Optimization of *in vitro* culture condition of carnation bears high commercial interest for which identification of suitable regenerating media is an essential component. An experiment was undertaken involving 14 different regeneration media to identify effective media composition to get carnation plantlets *in vitro* from shoot-tip explants. Results from two consecutive years (1998 and 1999) revealed that MS medium supplemented with NAA (1 mg/l) + Kinetin (2.5 mg/l) and NAA (1 mg/l) + Kinetin (3.5 mg/l) were equally effective for production of proliferating cultures (99.45%) whereas response to other media was not satisfactory. A composition of MS medium supplemented with NAA (0.5 mg/ l) + Kinetin (0.5 mg/l) and NAA (1 mg/l) + Kinetin (0.5 mg/l) showed inhibitory effect on proliferation. Earliest sign of proliferation (3.97 days) was noticed using a culture medium containing NAA (1 mg/l) and Kinetin (2.5 mg/l). Explants cultured on the same medium also produced longest shoots (6.60cm) and highest number of leaves per culture (33.07). Maximum number of shoots/culture (6.73) was obtained from the explants cultured on MS medium supplemented with NAA (1 mg/l) and Kinetin (3.5 mg/l). MS medium supplemented with NAA (1 mg/l) and Kinetin (3.5 mg/l) may therefore be used for production of greater number of shoots while MS medium supplemented with NAA (1 mg/l) and Kinetin (2.5 mg/l) would be more useful for earlier and greater vegetative growth.

III-15. Towards development of a suitable protocol for regeneration of carnation (*Dianthus caryophyllus* L.) through callus induction

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Development of young plantlets from undifferentiated calli is the penultimate expression of cells totipotency. The present experiment attempted to identify suitable regeneration protocol for establishment of carnation plantlets through callusing. 'Chabaud Super Mix', a commercial carnation cultivar was used for callus induction in twelve different callusing media followed by seven regeneration media in two consecutive years. The study indicated that auxins like 2,4-D and NAA and the cytokinins like kinetin and BA are responsible for the callus production of carnation from terminal young unfurled leaf explants. Although basal MS medium did not produce any callus, 2,4–D @ 10 mg/l along with NAA (1 mg/ l) and BA (3 mg/ l) + NAA (2 mg/l) produced nodular, greenish yellow to greenish profuse callus which started their production after 10 and 8 days of inoculation respectively. Though MS medium having BA (3 mg/l) and NAA (2 mg/l) initiated callus earlier but profuse amount of nodular greenish callus is found on the MS medium having NAA (1 mg/l) and 2,4-D (5 mg/l).

Supplementation with kinetin (3 mg/l.) + NAA (1 mg/l) in MS medium resulted in earliest initiation of shoots (8 days after transfer to this medium). But MS medium supplemented with kinetin (4 mg/l) + NAA (1 mg/l) helped in more rapid shoot development. Therefore to get early plantlet establishment, MS medium having NAA (1 mg/l) and 2,4-D (5 mg/l) followed by kinetin (4 mg/l) + NAA (1 mg/l) might be an effective choice in carnation *in vitro* culture.

III-16. Effect of benzyl aminopurine and triacontanol on mericloning of *Cymbidium* Soul Hunt I

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Protocorms obtained from *in vitro* cultures of *Cymbidium* Soul Hunt I excised from meristem were cultured on Murashige and Skoog's and Nitsch media supplemented with BAP and triacontanol. Less number of days was taken for formation of 2nd, 3rd, 4th and 5th PLB's in media containing BAP. Maximum number of PLB's was recorded on MS with BAP and triacontanol. The rate of proliferation was rapid on media containing both triacontanol and BAP. Early leaf initiation and maximum number of shoot differentiation occurred on media containing BAP, but presence of BAP alone in the media suppressed further leaf development. Among the media, the protocorm proliferation was better on Nitsch media, while differentiation and growth of the plantlets were superior on MS media. Well-developed plantlets were cultured on media supplemented with paclobutrazol before hardening. Plantlets with 3-4 leaves were transferred to community pots containing coco pith and perlite and successfully established with very high rate of success.

III-17. Effect of sucrose on proliferation and conservation of *Cymbidium* hybrids *in vitro*

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Micropropagation is the most widespread form of biotechnological application for *in vitro* multiplication and conservation of orchids. Sucrose is an important source of carbohydrate and is very essential during proliferation or rooting. Root initiation was decreased proportionately with decreasing levels of sucrose. Shoots which rooted without sucrose did not survive after transferring to the greenhouse. The exact requirement of sucrose in orchids varied with the species. Hence investigations were carried out to find out the optimum sucrose requirement for proliferation, differentiation, growth and conservation of *Cymbidium* hybrids *in vitro*.

The responses of protocorm like bodies of *Cymbidium* Lunavian Atlas, *Cymbidium* HXB and BXH cultured on Murashige and Skoog's (MS) media with sucrose was observed two weeks after culture. Proliferation of PLB's was recorded early on media supplemented with 4% sucrose. Maximum number of large sized protocorm as well as plantlets was recorded at 4% sucrose. Sucrose at 1% and 1.5 % in the media completely suppressed the growth followed by gradual discoloration and death of explants in about 7-8 month period. Sucrose at 4% in the media resulted in enhanced culture weight and bigger sized PLB's. Maximum dry weight per cent was recorded at 2.5% sucrose. Plantlets cultured on media supplemented with 2% to 6% sucrose were maintained *in vitro* for over 15 months.

III-18. Genetic analysis of *Aglaonema* species and varieties using RAPD markers

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The genus *Aglaonema* is under the subfamily Aroidae of Araceae comprising of about 50 species and a large number of varieties. They are native to South East Asia extending from North Eastern India, Southern China and Indonesia to Philippines. Species and cultivar identification of *Aglaonema* is primarily based on morphological characters such as leaf variegation, which is difficult because of the high similarities between cultivars and their clonal origin. Therefore an attempt was made to characterize 27 genotypes of *Aglaonema* using RAPD markers for the first time. The protocols were standardized for the DNA extraction, PCR amplification and genetic analysis. The clustering analysis according to Squared Euclidean distance showed a low to moderate level of genetic diversity. The 59 RAPD markers obtained in the study showed a dissimilarity of 7 to 39 per cent. The dissimilarity was 9 to 35 per cent for 11 species and 11 to 30 per cent for 7 cultivars. The genotypes of *Aglaonema* formed into two major clusters bifurcating two groups with 17 and 10 individuals. The method proved precise and more efficient than morphological markers to discriminate *Aglaonema* species and varieties studied.

III-19. *In vitro* propagation of marigold

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The present investigation on *in vitro* propagation of marigold was conducted on "Apetalous Male Sterile Line" and "Pusa Narangi Gainda". Mercuric chloride (0.1%) treatment of shoot tip and nodal segment explants for 2 minutes resulted in maximum uncontaminated growing cultures. However, the percentage of growing response was maximum with shoot tips. MS medium containing 10ppm BAP was found to be optimal for culture establishment. During shoot multiplication, maximum number of shoots per original shoot (3.17) were obtained on MS medium containing 10ppm BAP + 2ppm NAA. MS medium supplemented 2-6ppm NAA or IAA resulted maximum rooting in *in vitro* multiplied shoots. Cocopeat was to be a suitable medium for the hardening of *in vitro* grown plantlets.

III-20. Creating a novel plant type through callus culture in foliage ornamental furcraea (*Furcraea gigantea.* Vent.)

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Furcraea is very important foliage succulent plant, adding an aesthetic value in the garden. It is available in mainly two types viz. Green and Variegated. It is commonly propagated by bulbils. Hence, it produces purely true to type plantlets. Furcraea improvement programme is not undertaken seriously till date. With a view to obtain variability, a simple but innovative method namely callus culture is used.

Callus was successfully induced and established from immature bulbils of 'Green' furcraea plants on MS medium supplemented with BAP and NAA. Maximum callus was induced on 0.5 to 1 mg/l BAP in

combination with 0.1 mg/l NAA. Shoots were regenerated from callus by eliminating NAA from the callus inducing medium. Variabilities were noticed in regenerated shoots. Two types of shoots, one with green leaves having white lining on the margin and other totally *albino* (white) were isolated. These variants were rooted successfully on MS medium containing MS + 0.1 mg/1 IBA. The former type of plants were established in polybag with normal growth, however, *albino* could not survive under the normal environmental conditions. Rooted plantlets were hardened in soil, Tera (1 :I v/v) successfully. More than 1000 plants were produced by this protocol and established in polybag and also in the field where they are growing satisfactorily.

III-21. Micro propagation of dendrobium (*Dendrobium osterholt*)

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Dendrobium osterholt was subject to *in vitro* multiplication at Regional Research Station, Mudigere. Among the different media used, Murashige and Skoog medium was found to be the best for initial establishment (100 per cent establishment), 60 days after inoculation (DAI) with a higher rate of multiple shoot production (4.05) and higher average shoot length (8.75 mm). Addition of BAP and coconut water to MS media has resulted in maximum multiple shoots (6.55), average shoot length (15.80 mm) and more number of leaves (15.90) at 60 DAI, among the cytokinins and organic additives used. The maximum rooting (15.33) was recorded as a result of application of IBA 1 mg/l + NAA 1 mg/l with half strength MS media. Use of perlite as potting media resulted in 100 per cent survival with a plant height of 24.20 mm and 4.6 leaves after 30 days of planting under polyhouse conditions.

III-22. Bioreactors: A tool of mass propagation in ornamentals

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Bioreactors are the large volume vessels generally from 1 l over 1000 l used for the culture of plants. To reduce the cost of plant tissue culture either for micropropagation or for the production of bio-active compounds, automatic plants having bioreactors are being developed. The production rates can be enhanced by million times. In bioreactors liquid media is used which is replaced regularly. For the production of plants, stirred tank reactors and immobilized cell reactors are used. The plant developmental pathways used in bioreactors are somatic embryogenesis, organogenesis, bud or meristem clusters and anomalous plant morphogenesis. Method for production of somatic embryos in *Euphorbia pulcherrima* was developed. Bioreactor culture enhanced bud cluster formation in *Ornithogalum dubium.* Bulbous plants are best suited for bioreactor culture as there is no problem of vitrification e.g. *Amaryllis, Brodiaea, Lilium, Gladiolus,* etc. Measurement and control of various factors like temperature, pH, gaseous atmosphere, carbohydrates, mineral nutrients and growth regulators are responsible for cell growth. Half strength MS media is best for culture of ferns, *Gladiolus, Nerine* and *Lilium.* In *Lilium,* application of sucrose @ 30g l^{-1} increase number of bulblets while @ 90 g l^{-1} increase the size of microbulbs. Increasing the concentration of oxygen from 10 to 60 per cent decreased the cell doubling time from 57 to 40 hours in *Poinsettia.* Higher bulblet development was obtained in lily scales in the presence of BA than kinetin. In gladiolus, use of B-9, ancymidol, paclobutrazol and uniconazol treatment cause extensive bud proliferation and cormlet production.

III-23. *In vitro* shoot and corm production in gladiolus

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In vitro shoot and corm production studies were undertaken in gladiolus (*G. grandiflorus* L.) cv. American Beauty. Half terminal bud explants surface sterilized with 70% ethanol (30 sec) followed by 0.1% $HgCl_2$ (10 min) and 1.0% NaOCl (15 min) were cultured with various concentrations of kinetin (0, 1, 2, 3, 4 mg/l) and NAA (0.0, 0.5, 1.0, 2.0 mg/l), out of which kinetin (2, 3, 4 mg/l) and NAA (0.0, 0.5, 1.0 mg/l) combinations were most suitable for culture establishment. The single elongated bud derived from half terminal bud explant proliferated maximum shoots (346.4) in MS medium supplemented with kinetin 4 mg/l as compared to the bisected bud mass. About 8 cm length shoots were taken for corm production *in vitro*. The rate of corm production (100%) and corm size (1.7 cm) were maximum in MS medium supplemented with 10% sucrose and IBA 1 mg/l. The corms were enlarged further by 91.7%, producing larger sized corm (2.3 cm diameter) in MS medium supplemented with sucrose 10%, IBA 1 mg/l and paclobutrazol 15 mg/l.

III-24. Diversity of orchid mycorrhizae

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The importance of mycorrhizal infection for the germination of orchid seeds and for successful development is well established. The subject of mycorrhizal colonization in adult orchids is largely neglected. The associations are the most ancient and widespread symbiotic partners of both terrestrial and epiphytic form of orchids. We are only beginning to understand the morphological, biochemical and molecular events which form the basis for their symbiotic interaction with the roots of their host plants. The availability sources easily amenable to the former has given a strong impetus to orchid mycorrhizal research. Reliable identification of diversity amongst orchid mycorrhizal fungi is a significant problem for modern mycology. The contemporary classification of orchid fungi is mainly based on morphological features of the fungus, which may differ being affected by the other environmental and non-environmental sporulating forms of the fungus. The aim of the present paper is to give a brief up-to-date overview of the association with reference to different analysis that is important for the symbiotic interactions between them.

III-25. Micro propagation of ornamental plants

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Micropropagation techniques on commercial level have been well demonstrated in case of several ornamental plants. Out of about 1000 million plants produced annually, 90 per cent are ornamentals. Micropropagated propagules are most stable planting material and it is the best answer to our hunger for quality planting materials. Moreover, the Government of India has given a strong thrust to develop floriculture and related activities in the country to tap global market. This requires production of large quantity of quality, disease free, uniform planting materials. This can be achieved only by micropropagation industries with support of appropriate basic research by Universities and Central Institutes.
Indian technology for micropropagation of important ornamental plants is available. However, while attempting *in vitro* propagation using available techniques, it was observed that the protocol reported in

the literature need to be modified according to local conditions. It was modified and success has been achieved in a number of ornamental plants. Chrysanthemum and roses using axillary bud culture, *Philodendron* from shoot tips, *Gerbera* from capitulum as well as shoot tips and tuberose and *Furcraea* from immature bulbils were successfully multiplied on large scale. Physiological status of mother plant and explant, surface sterilization procedure, nutrient requirement, etc. for optimum response were worked out and plantlets obtained were tested for their performance.

III-26. Rapid multiplication of Gerbera jamesonii through tissue culture

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Studies were conducted to standardize the protocol for large scale *in vitro* multiplication of gerbera. The shoot explants from *in vitro* grown plantlets were cultured on Murashige and Skoog medium supplemented with 6-benzyl amino-purine (BAP) and 6-furfurylamino-purine (kinetin) in the range 2.0-3.0 mg l^{-1} along with 0.1 mg l^{-1} a-napthaleneacetic acid (NAA) for the shoot regeneration. The addition of BAP to the culture medium was more effective than the addition of kinetin. 2.5 mg l^{-1} BAP + 0.1 mg l^{-1} NAA produced highest number of multiple shoots with better size. The shoots of more than 1 cm long were cultured on medium supplemented with varying concentrations of IBA and NAA for rooting. NAA induced early rooting compared to IBA. Development of callus was observed in IBA, which suppressed the growth of roots. The shoot and root growth were improved in the rooting media supplemented with 1 mg l^{-1} NAA. The rooted plantlets were transferred to pots filled with different hardening media, viz., peat, perlite and flyash + sand mixture.

III-27. *In vitro* regeneration potentiality of explants in *Gerbera jamesonii*

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Regeneration potentiality of four different explants viz., shoot tip, bud, flower and leaf of gerbera was analysed. The explants were forced to develop shoots on Murashige and Skoog medium containing 2.5 mg l^{-1} BAP+ 0.1 mg l^{-1} NAA. Regeneration of plantlets occurred indirectly through callus phase in all the cultured explants except shoot tips. The intensity of callus was high in leaf segments and moderate in bud and flower. In all the explants whereever callus was obtained, it was organised. The callus was dark green coloured in leaf explant, light green in bud and yellowish green in flower. There was no difference in shoot formation between flower and bud. Both the explants gave quickest response for the regeneration of shoots and produced highest number of multiple shoots per unit of callus. Though the intensity of callus was maximum in leaf, the adventitious shoot formation was comparatively less and delayed. The difference in response was due to difference in physiological state of the explants. Regeneration was not obtained from shoot tips mainly due to high per cent contamination and death of cells in the medium.

III-28. *In vitro* propagation of gladiolus cv. Peach Blossom

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In vitro propagation of gladiolus cv. Peach Blossom was successfully achieved through enhanced release of axillary buds. Intact cormels were used as explants of the culture establishment in Murashige and Skoog medium (MS). The effect of different concentrations of cytokinins, BA and kinetin alone at 1.00, 2.00 and 4.00 mg/l were studied for culture establishment and further shoot proliferation. Earliest initiation (3.67 days) was achieved in MS medium supplemented with kinetin 2.00 mg/l and NAA 0.10 mg/l. But

combinations of BA with auxins resulted in better survival and further growth of shoots. Maximum shoot proliferation rate (33.67) was noticed in MS medium containing BA 4.00 mg/l + NAA 0.50 mg/l. Low concentration of BA 2.00 mg/l or 1.00 mg/l were found to be ideal for further shoot multiplication. In rooting studies conducted on MS medium containing different concentrations of auxins viz, IBA, NAA and IAA, earliest rooting (7.00 days) and longest root (5.00 cm) were obtained with IBA 2.00 mg/l. The treatment having NAA 1.00 mg/l produced maximum number of roots (24.00) after four weeks of culture period. The *in vitro* raised plantlets were successfully planted out in sterile media consisting of sand: soil (2:1) in plastic pots. A survival rate of 100 per cent was obtained 15 days after planting out.

III-29. Polymorphism studies in African marigold (*Tagetes erecta* L.)

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In an experiment involving 30 genotypes of marigold (*Tagetes erecta* L.), isozyme polymorphism was studied at 3-5 leaf stage and during flowering through leaf and bud tissue using SDS-PAGE (sodium dodecyle sulphate and starch gel electrophoresis). Among the five enzyme systems, namely, acid phosphatase (ACP), esterase (EST), peroxidase (PRX), superoxide-dismutase (SOD) and alcohol dehydrogenase resolved, the acid phosphatase witnessed two distinct zones (ACP1 and ACP2) of resolution and showed fast moving bands towards anode. The dark bands of acid phosphatase were produced in Selection-7, Selection-8, Selection-29, Selection-60-6, Selection-60-11, MS-7 x Selection-21, (30 x 43)-1 and 12-12-34 at Rf 0.65 and 0.84 with varying degrees of migration and band frequencies. Esterase activity differed with large number (11) of bands in three regions (EST1, EST2 and EST3) of their activity at Rf 0.45, 0.51 and 0.60 and showed double banded patterns in Pusa Narangi Gainda, Pusa Basanti Gainda, MS-7 x Selection-21, MS-7 x Selection-21 (F_3) and FM-560. A wide range of polymorphism (Pi 0.02 to 0.17) was calculated for esterase activity on gels, which varied in both leaf and bud tissues. However, the single and double banded esterases were produced at Rf 0.89 in majority of the genotypes. At least three bands of peroxidase activity were resolved in three zones (PRX1, PRX2 and PRX3) with highest polymorphic index of 0.083 in the genotype (30 x 43)-1. Superoxide-dismutase (SOD) activity was resolved in 5 bands with two distinct zones (SOD1 and SOD2) and differed among all the genotypes in staining intensity in the leaf tissue. However, poor band staining was found in the bud tissue. The polymorphic band of alcohol dehydrogenase at Rf 0.45 was resolved with dark staining in Pusa Narangi Gainda, Pusa Basanti Gainda, Selection-7, Selection-29, Selection-32, MS-8, (30 x 43)-1 and Wild marigold.

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III-30. Effect of sucrose and charcoal on seedling growth of New Pink x Emma White, a *Dendrobium* hybrid

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A trial was conducted to find out the influence of sucrose and charcoal on the germination and further growth of seedlings of the *Dendrobium* hybrid New Pink x Emma White. Maximum and early germination was obtained with 3.0 per cent sucrose. The time taken for greening and protocorm formation was also minimum at this level (26.67 and 45.33 days, respectively). But 0.5 and 1.0 per cent sucrose gave significantly higher values for the length of leaves, number of leaves, number of roots and length of roots of the seedlings. Maximum seedling height (3.00 cm) and number of leaves (5.67) were also obtained at 0.5 per cent sucrose level. Sucrose is an important carbon source which supports initial germination and subsequent growth. Eventhough high sucrose is needed during initial stages it can be reduced during subsequent growth periods.

Charcoal absorbs phytotoxic metabolites and it provides added aeration, which could improve the growth. When different charcoal concentrations were employed for seed culture, it was seen that the parameters like height, number of leaves, leaf length, number of roots and root length were more at the concentrations 0.5 and 1.0 g l^{-1}. But significant difference could not be obtained with regard to the germination percentage and time taken for greening in different charcoal concentrations.

III-31. *In vitro* seed germination studies in *Dendrobium* hybrids

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Dendrobium is one of the best grown genera of orchids in the tropics and is widely used in the commercial cut flower production in Kerala. All the hybrids grown in our state are exotic and production of our own hybrids has become highly essential. Hybridisation work was carried out in Kerala Agricultural University, Trichur using six popular varieties of *Dendrobium* viz., Candy Stripe (CS), Emma White (EW) Hieng Beauty (HB), New Pink (NP), Sakura Pink (SP) and Sonia-28. The set pods were harvested at green pod stage and cultured under *in vitro* conditions. Germination frequency and subsequent morphogenetic changes leading to seedling development varied with the hybrids.

Very high germination was noticed in the crosses EW x NP, EW x HB, HB x CS, HB x NP, NP x Sonia-28, NP x HB, NP x EW, NP x CS and Sonia-28 x NP. The time taken for attaining different stages in culture was assessed and differntial responses were observed with respect to different parents. CS x Sonia-28 and Sonia-28 x HB took the minimum time (20 days) for greening and the maximum time was taken by HB x Sonia-28 (34 days). Earliest protocorm formation occurred in HB x EW (31 days). Sonia-28 x CS as well as Sonia 28 x NP took the maximum time (56.67 days) for protocorm formation. NP x HB took the minimum time (57.67 days) for first leaf production whereas Sonia-28 x NP took the maximum time (98.33 days). Regarding shoot and root formation earliest was that for HB x EW (91.33 days) and maximum time was taken by Sonia 28 x NP (131.67 days). Earliest planted out seedlings were those of NP x HB (257 days). Time taken for planting out was maximum for SP x Sonia-28 (317 days). In general, crosses involving Sonia-28 showed delayed development of seedlings.

III-32. Rooting response of carnation mutant in the presence of different solidfying substances

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A selected mutant of carnation IIHRP-1 is being mass multiplied for future evaluation. In the process of working out a suitable protocol for micropropagation of the mutant, agar and gelrite were evaluated for their suitability as solidifying substances for efficient rooting. Media composition consisted of half strength of Murashige and Skoog (MS) media with 15% sucrose and without any growth regulator. Gelrite (2.5 gm.) and Agar (8 gm.) were tried out as solidifying substances. With the usage of gelrite, yellowing of leaves could be avoided. Rooting response in terms of both number and length was found to be better in gelrite compared to that in agar .On an average, root length noticed was 15.4 mm. in agar compared to 45 mm in gelrite. Percentage enhancement of rooting response in gelrite over agar was 142% for root number and 192% for root length. In the presence of gelrite, root number varied from one to 12, where as in agar it was one to 8. Root length ranged from 15 mm to 70 mm in case of gelrite compared to 5 mm to 40 mm in case of agar. On an average, the shoot length in agar was 89.9 mm while in gelrite it was 123.7 mm. The internodal length ranged from 10.8 mm. to 18.5 mm in agar and from 12.5 mm to 27.5 mm in gelrite with an average of 26.1 mm and 34 mm in agar and gelrite respectively.

III-33. Characterization of genetic diversity in rose by randomly amplified polymorphic DNA

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Rose cultivars are normally identified by horticultural and morphological parameters, measurement of which varies considerably due to environmental fluctuations. In this era of plant variety protection, a fool proof method of characterizing the indigenous plant wealth is of paramount importance. Patent infringement and Intellectual property rights (IPR) are serious problem for breeders and companies that offer improved cultivars.

The present study of DNA finger printing of roses provides a permanent record of the genotypic make up of different cultivars. Polymerase chain reaction (PCR) based Random Amplified Polymorphic DNA (RAPD) technique allows rapid and relatively inexpensive finger printing of rose varieties and is useful for identification and patent protection purpose.

The purpose of this study is to prepare DNA profile of notified varieties of roses and to develop genetic relatedness of the germplasm by phylogenetic analysis. Protocols for efficient isolation of genomic DNA have been perfected and RAPD analysis of 10 indigenous rose cultivars have been documented in this preliminary experiment. Random primers of 10 oligo were utilized for the analysis and the polymorphic blue print thus generated, is discussed in this paper.

III-34. Estimation of genetic diversity among china aster (*Callistephus chinensis* (L.) Nees) varieties/accessions through RAPD markers

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China aster [*Callistephus chinensis* (L.) Nees] belongs to one of the largest families of flowering plants 'Asteraceae'. This crop is extensively grown for bedding and cut flower purposes in tropical and subtropical countries. There is a vast scope for increasing the area and production through crop improvement, which can be made by adopting several breeding methods that mainly depends on the use of existing genetic variability. Randomly Amplified Polymorphic DNA (RAPD) has been most widely used for DNA finger printing, diversity studies, map construction and linkage analysis. These markers were used as a means to estimate the genetic diversity of twenty eight varieties/accessions of China aster. Eight random primers were used which generated ninety one polymorphic bands. Cluster analysis based on Wards SED (Squared Euclidean Distance) method lead to the formation of two major groups mainly based on geographical origin and morphological characters with a maximum dissimilarity of forty one per cent.

III-35. *In vitro* propagation of rose cv. Super Star as influenced by anti-auxin

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Rapid multiplication of rose cv. 'Super Star' through tissue culture technique is described. Shoot tips and nodal segments of the cultivar were inoculated in Murashige and Skoog medium supplemented with various growth regulators. Nodal segments were proficient in response and proliferated higher number

of shoots per explant. The combination of growth regulators for shoot proliferation were cytokinin (BAP), auxin (NAA) and gibberellic acid (GA). Addition of anti-auxins like 2, 3, 5 -T and 2, 4, 6 -T into proliferation medium increased number of shoots per explant and length of shoot. It also increased the number of leaves per shoot. The proliferated shootlets, when transferred to half strength MS medium supplemented with IBA and NAA, efficient rooting was recorded. Rooted plantlets were acclimatized for three weeks and planted under field condition with survival over 75 per cent.

III-36. Interaction of dark period and calli type on regeneration in carnation

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Selected carnation mutants IIHRP-I and IIHRP-2 are being propagated in Murashige and Skoog (MS) media supplemented with BAP (0.25mg 1^{-1}), NAA (0.1mgl-l) and GA (0.25 mg 1^{-1}). Soft watery calli and green compact calli were observed at the base of the micropropagated shootlets and regeneration was attempted from both the types of calli. MS media supplemented with growth regulators 2,4-D (0.5 mg 1^{-1}) and NAA (0.5mg 1^{-1}) was used as regeneration media and incubated under two different durations of dark period (8hrs and 24hrs). Irrespective of duration of darkness, proliferation was noticed only in case of compact green calli. The soft watery calli did not respond and turned brown. The compact green calli under 24hrs of darkness showed maximum proliferation percentage and was transferred to next regeneration medium consisting of MS salts supplemented with kinetin (mgl^{-1}) and BAP (0.5 mg 1^{-1}). Regeneration response was evaluated when incubated in dark period of 8 and 24 hrs. Regeneration was noticed in calli incubated under 8hrs of darkness. Well formed shoots were observed after 10 weeks of incubation in this treatment. The callus incubated under 24 hrs of dark period, showed slight green pigmentation but no regeneration.

Session IV

Crop improvement

IV-1. Induced mutation in tuberose (*Polianthes tuberosa* Linn.) by gamma rays

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Bulbs of four tuberose cultivars, viz., Single, Double, Shringar and Suvasini, were treated with gamma rays (5.0 to 25.0 Gy) and planted in the field and observations were recorded. Morphological variants like chlorophyll mutants, non-flowering mutants and compact spike mutants were observed, in different cultivars at different levels of mutagen. Based on growth parameters and floral characters, four mutants were isolated, viz., dwarf mutants, high tiller mutants, non-flowering mutants and compact inflorescence mutants. They retained the characters in VM_2 generation also and were evaluated for genetic parameters. High heritability and genetic gain were noticed for number of flowers per spike, spike length, flower diameter, leaf length and leaf width. The mutants isolated in this study may prove to be useful for tuberose improvement programme.

IV-2. Studies on stability parameters in gladiolus varieties

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Stability is one of the most desirable properties of a genotype to be released as a variety for wide cultivation. Fifty varieties of gladiolus were tested at four different locations in randomized block design with three replications in each case during 1997-98 and 1998-99. Some of the stable parameters were found desirable for commercial exploitation in a range of environmental and climatic conditions. Total yield of florets was found to depend upon its floret number, spike length and plant height. The expression of these characters was observed to be highly influenced by all the environmental factors. The environment was also found to be differing significantly for some characters which indicated that environment selected for testing of genotypes were quite variable in its effect on the performance of genotypes. However, high magnitude of environment (linear) effect in comparison to genotypes x environment (linear) effect for all the characters was recorded which may be responsible for the adaptation in relation to yield. Out of 50 genotypes no single genotypes possessed ideal characteristics of a stable variety for all the traits over four stable environments tested. In first year 39 genotypes and in second year 17 genotypes for length of spike revealed regression coefficient less than unity. Number of forest revealed less regression coefficient for 35 and 22 geotypes during 1997-98 and 1998-99, respectively.

IV-3. Vegetative growth and flower yield as influenced by different cultivars of china aster (*Callistephus chinensis* Nees.)

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Studies were carried out at Kittur Rani Channamma College of Horticulture, Arabhavi (University of Agricultural Sciences, Dharwad, Karnataka) in 1999-2000, 2000-01, 2001-02 and 2002-03 to know the

performance of different china aster cultivars. Among the ten cultivars evaluated for four years, cultivars Phule Ganesh White, Phule Ganesh Purple and Phule Ganesh Pink performed better with respect to growth, yield and quality parameters.

IV-4. Studies on induced mutation in chrysanthemum (*Dendrathema grandiflora* Tzueleu)

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An investigation on the induction of mutation in chrysanthemum was conducted with the objective of creating variability through mutagenesis. The rooted cuttings of Co.1 and Co.2 cultivars were subjected to treatments with gamma rays, EMS and their combinations at different levels. The mutagen treated and the control population were evaluated for 11 economic traits in vM_1 and vM_2 generations.

The sensitivity studies on the basis of survival percentage of plants on 45th day indicated the LD_{50} value for Co.1 and Co.2 remained between 1.0 and 1.5 kR of gamma rays, from 10 to 20 mM of EMS. There was a trend of reduction in survival of plants as the dose of gamma rays and EMS increased. Among combination treatments, 1.0 kR gamma rays and 10mM EMS caused 50 per cent reduction in survival in both Co.1 and Co.2 cultivars.

High heritability coupled with high genetic advance were recorded for number of flowers per plant and yield of flowers per plant indicating the predominance of additive gene effects in controlling them. Hence, selection for these traits might be effective for crop improvement. Path co-efficient analysis revealed that number of flowers per plant and mean weight of flower exhibited profound positive direct effect on yield of flowers per plant in both Co.1 and Co.2 mutants.

The present study resulted in the isolation of useful mutants in vM_2 generation. A total of 19 dwarf mutants, 23 early mutants and 26 high yielding mutants were isolated among the Co.1 and Co.2 mutants.

IV-5. Induction of flower colour mutation in chrysanthemum

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Rooted cuttings of chrysanthemum cultivar 'Mother Teresa', 'Shanti' and 'Maghi Creamish White' were irradiated with 0, 10, 15 and 20 Gy of gamma rays for induction of somatic flower colour mutation. Reduction in survival, growth rate, plant height, branch and leaf number and size were recorded after irradiation. Various types of morphological abnormalities in foliage and flower head were observed which increased with increase in exposure to gamma rays. Morphological aberrations in leaves included fission and fusion of leaf lamina, leathery texture, obtuse apex, asymmetrical development of leaf lamina, narrow leaf, sickle shaped leaf, notching of different grades, entire margin and chlorophyll variegation. Fasciation in capitulum was observed only in cultivar 'Maghi Creamish White'. Somatic mutation appeared on cultivar 'Mother Teresa' and 'Shanti'. In both the cases mutant tissue colour was yellow. The range of mutation varied from few ray florets, small sector in head, complete head and a small branch. Isolation of the mutant is in progress to release it as new cultivar.

IV-6. Assessment of gladious cultivars under Marathwada region of Maharashtra

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Gladious (*Gladious grundi* florus) is the seventh most important cut flower of the world originated in South Africa, belongs to family Iridaceae. The flower crop is commercially viable and being adopted to

wide range of climatic conditions. Marathwada region of Maharashtra is semi arid region and flower crops are grown on small scale. To assess the suitable cultivar for growing in this region, a trial was conducted with eight gladiolus cultivars in Randomised Block Design with three replications at the College of Horticulture, Marathwada Agricultural University, Parbhani during the year 2001-2002. The performance of eight cultivars viz. American Beauty, Cadiman Red, Her Majesty, Jessica, J.V.Gold, Novellous, Rose Supreme and Sancerre was studied. The results obtained revealed that gladiolus cultivar Sancerre is the best cultivar suited to Parbhani condition in regards to flower quality and yield. Next best cuitivar is American Beauty followed by cv. J.V. Gold, Her Majesty, Rose Superme, Novellous, Jessica and Cadiman Red. Corm productions studies indicated that cv. Sancerre produced maximum number of corms followed by cv. American Beauty, Jessica, Novellous, etc. with regards to cormel production cv. American Beauty was found superior to all. It was followed by cv. Sancerre, Cadiman Red and Jessica.

IV-7. Genetic variability studies in gladiolus (*Gladiolus hybridus* L.)

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An experiment was carried out to study the genetic variability, heritability and expected genetic advance in gladiolus during 1996-97 at UAS, Dharwad on red soils. Six varieties of gladiolus *viz.*, Snow White, Melody, Ethyl Cava Cole, Sylvia, Han Can Green and American Beauty were studied for characters like plant height, leaf number, leaf width, days to first flowering, length of rachis, number of flowers per spike and inter-nodal length. The study revealed that, selection of individual plants would be done based on days to first flower and plant height which showed moderate to high genotypic coefficient of variation, heritability and genetic advance over mean. These characters may be considered for crop improvement in gladiolus.

IV-8. Green Rose: Modification of leaves as petals

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Plants have evolved with each one of its parts, whether it is a leaf or flower, having a specific function to perform. In our pursuit of building up a base germplasm collection of rose, a green rose has been added from western ghat region of Karnataka. Unlike other rose varieties with attractive colors, this rose plant has green colored petals looking similar to leaves. This study was undertaken to understand the function of flower in green rose. Morphology of flower structure revealed it to be similar to any other normal flower with the presence of sepals, petals, androecium and gynoecium. Photosynthetic pigments were estimated in petals and leaves of green rose and for comparison, the same estimation was made in petals of four different rose varieties of various colors. Chlorophyll-a was estimated to be ranging from 0.02 to 0.05 mg/g fresh weight of petals in case of all other varieties of rose, where as in green rose the same was found to be comparatively higher (1.07 mg/g fresh weight of petals). Similarly, estimated chlorophyll-b in other varieties ranged from 0.03 to 0.10 mg/g fresh weight of petals and was found to be comparatively higher in green rose (0.65 mg/g fresh weight of petals). Considering estimation of both pigments (chlorophyll a + chlorophyll b), green rose was found to be rich in these pigments (2.02 mg/g fresh weight of petals) when compared to the range observed in other varieties (0.08 mg/g to 0.22mg/g fresh weight of petals). Both chlorophyll a and b estimated in green rose petals as well as leaves were found to be on par with each other.

IV-9. Estimation of genetic variability, heritability and genetic advance in marigold (*Tagetes sp.*)

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The experiment was carried out with ten African Marigold varieties, viz, Double Cupid Mix, Double F1 Hybrid, Marigold Orange, Marigold Golden, Marigold Yellow, NDMS-2, NDMS-4, First Lady, Saffron Spice, Snow White and Ten French Marigold varieties, viz., Boneta, Bolero, NDMS-9, NDMS-1, NDMS-8, Super Petite, NDMS-3, NDMS-6, NDMS-7 and Harvest Moon. The twenty varieties of African and French Marigold depicted significant differences in all the characters studied. The cofficient of variation was minimum for flowering span (PCV=15.34, GCV=15.02) and maximum for area of leaf (PCV=83.26, GCV=82.59) in African Marigold but in French Marigold it was minimum for last picking of flower-days after transplanting (PCV=12.92, GCV=12.80). Heritability estimates for all the characters were generally very high.

The high heritability along with high genetic advance were observed for days from transplanting to first picking of the flower (h^2=99.60, GA=59.37), days from transplanting to last picking of the flower (h^2=99.50, GA=37.68) and number of lateral branches per plant (h^2=99.30, GA=130.40) in African Marigold, whereas in French Marigold high values were observed for days to visibility of bud and first picking of the flowers (h2=99.60, GA=68.67) (h2=99.60, GA=46.53), respectively. The results pertaining to phenotypic coefficient of variation were higher than those of genotypic coefficient of variation for the all characters studied. Hence, it is reveled that phenotypic selection could be effectively exercised in these traits for improvement in flower production of the marigold.

V-10. Evaluation of commercial cultivars of gladiolus in the Tarai region of Uttaranchal

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A total of forty-nine commercial cultivars of gladiolus were analysed for quality characteristics. The cultivars showed significant difference in recorded characters. Variety Sringarika showed maximum vase life (15.66 days) which was at par with the varieties Punjab Down (14.66 days) and Ratna Butterfly (14.66 days). The lowest was counted in Royal Jubilee (9.33 days). The duration of flowering ranged between 12.93 days (Charm Glow) and 42 days (Novalux). Among the varieties studied, seven were found early flowering (70-85 days), eighteen varieties were mid (85-100 days) and a total of 24 varieties were found late (more than 100 days). Oscar produced the longest spike (more than 124.60 cm). The maximum number of florets produced were found to be around 15. Flower diameter was more that 10cm in some varieties. The varieties Pink Friendship, Subhangini and Hybrid -10 were found most ideal for almost all the desired characters.

IV-11. Screening of certain cultivars of African marigold (*Tagetes erecta* L.) for flower yield and carotenoid pigments

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A field experiment on evaluation of African marigold cultivars was conducted on an acidic, red sandy loam of ANGRAU Farm, Hyderabad, during 2001 -2002 crop seasons to find out the marigold cultivar having

higher content of carotenoid pigments (xanthophylls) coupled with higher fresh flower yield. Ten open pollinated varieties were tested in RBD with four replications using the cultivars, Pusa Narangi Gainda, Orange Double, Hyd local -1, Pusa Basanti Gainda, Hyd local -2, Hyd local - 3, Hyd local -4, Yellow Double and Lemon Yellow. Better plant growth was found in Orange Double cultivar with the highest plant height, leaf area, fresh biomass and dry matter yield. The cultivar Orange Double gave the highest fresh flower yield of 21.91 than with a total carotenoid yield of 51.07 kg/ha. The cultivar Pusa Narangi Gainda produced the highest total carotenoids per gram of fresh weight of flower petals followed by Orange Double. Early flowering was observed in Orange Double cultivar followed by Pusa Narangi Gainda. Duration of flowering was also observed to be higher in Orange Double cultivar followed by Pusa Basanti Gainda. Maximum seed yield and the highest per cent seed germination were obtained in Orange Double cultivar followed by Pusa Narangi Gainda.

IV-12. Performance of chrysanthemum cultivars under semi-arid conditions of Haryana

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Ten chrysanthemum cultivars, viz., Jaya, Puja, Flirt, Jayanti, Vasantika, Gauri, Suneel, Birbal Sahni, Basanti and Lal Pari planted at a spacing of 30 x 30 cm were assessed for their vegetative, floral and yield characters for two consecutive years. Plant height, spread and number of branches were observed maximum in Puja and minimum in cultivar Jayanti. Lal Pari exhibited minimum days to flower, whereas, Suneel and Vasantika took maximum days. Longest duration of flowering was observed in Gauri followed by Vasantika, Puja, Flirt, Jayanti and Jaya, whereas, minimum duration was found in Basanti. Weight of flowers was recorded maximum in Basanti and minimum in Gauri, whereas, maximum number of flowers and yield per plant was registered by cultivar Puja and minimum by Jayanti.

IV-13. Correlation and path analysis in seed production of celosia (*Celosia pyramidalis* L.) cv. Crusade:

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Simple correlation and path coefficients were worked out in assessing the relative contribution of different yield attributing characters on seed yield of *Celosia pyramidalis* cv. Crusader. The results of the present investigation revealed that the number of seeds per flower showed maximum association and highest positive direct effect on seed yield. On the contrary leaf area per cent of plant exhibited maximum negative direct effect.

IV-14. Correlation and path analysis in seed production of zinnia (*Zinnia elegans* Jacq.) cv. Gaint Flowered Mixed

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Simple correlation and path coefficients were worked out in assessing the relative contribution of different yield attributing characters on seed yield of *Zinnia elegans* cv. Gaint Flowered Mixed. The results of the present investigation showed that the number of flowers per plant had maximum association and highest positive direct effect on seed yield. On the contrary leaf area per plant exhibited maximum negative direct effect.

IV-15. Present status of available techniques for development of new flower colour / form in ornamentals

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Floriculture industry always demand for novel ornamental varieties. Flower colour and shape are the most important components of novelties. Classical mutation techniques by using ionizing radiations and other mutagens have successfully produced quite a large number of new promising varieties in different ornamental (bougainvillea, chrysanthemum, hibiscus, rose, tuberose etc.) plants by bringing about genetic changes at Floriculture Section, National Botanical Research Institute, Lucknow. For inducing novelties in flower colour of different plants the technique of selection of proper type/state of plant material for mutation experiment, suitable dose, detection of mutation at right stage of development, isolation and multiplication of chimeric tissues have been standardized.

The main bottleneck of mutation breeding is that the mutation appears as chimera. When the entire branch is mutated, mutants can be isolated through conventional propagation techniques while small sectorial mutation in the floret cannot be isolated using existing conventional techniques. Therefore, many new flower colour/shape mutants are lost due to the lack of a suitable propagation technique. A novel tissue culture technique has been standarlized to regenerate plants directly from such mutated sectors. A number of somatic flower colour/shape mutants have been developed in chrysanthemum by using this *in vitro* technique. *In vitro* mutagenesis is now being followed not only to increase mutation frequency but also to induce solid mutants. Combination of classical mutation technique and biotechnology will open a new vista to produce a wide range or new flower colour/type mutant varieties through retrieval or chimeric tissues to meet the increasing demand of floriculture. Molecular breeding is now being standardized in different crops to develop new varieties.

IV-16. Season, pre-treatment and stage of flower development for efficient crossing programme involving exotic rose cultivars

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Long keeping quality and good stalk length are major impediments that have to be addressed in rose breeding programme. Exotic cultivars with these characters are being incorporated in breeding programme to achieve the desired ideotype. For a fast progress to be made in this direction, it is desired to work out a strategic crossing methodology that can give rise to good number of progeny for further selection. With this objective, present experiment was conducted with a selected seed parent in combination with mixed pollen pool of 12 selected exotic varieties. Two factors, viz., stages of flower opening (bud stage, flowers with outer whorl of petals open and flowers with all the whorls open) and pre-treatment of stigmatic lobes with GA_3 (80,100 and 120 ppm) were worked out with 3 levels in each factor in all possible combinations. The experiment was repeated twice in the months of July and March.

Seed setting was found to be varying with season indicating the impact of temperature on fertilization phenomenon. Efficiency of pollination in rose is indicated by integrating multiple factors involving seed setting percentage, number of seeds, proportion of floaters and sinkers in a cross and seed weight. Seed setting and proportion of sinkers were high in the crosses attempted in July compared to that in March. Crossings attempted at the stage of flowers with outer whorl of petals open was found to result in maximum percentage of seed setting. However, for efficient seed setting in winter season pre-treatment with 120ppm of GA_3 was found to be essential. Maximum number of seeds per hip was 24 in July

crossing where as the same was low in March crossings (6.6). Similarly seed weight per hip was maximum in crosses of July (111.50mg.) compared to that in March (109.56mg.). Results of the experiment suggested the essentiality of pre-treatment with growth hormone and consideration of flower development along with seasonal impact for efficient crossing programme.

IV-17. Genetic improvement of *Dendranthema grandiflora* Tzueleu by gamma rays

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An investigation was carried out to induce somatic flower colour mutations in some charysanthemum cultivatrs through gamma irradiation. The rooted cuttings of ten chrysanthemum cultivars, viz.,, Ajay, Baggi, Bright Golden Anne, Ellen Van Langen, Glance, Gulmohar, Mountaineer, Nanako, Shyama and Snow Ball were treated with 2.0 k rads of gamma-rays at the Radiation Therapy Department, PGI, Chandigarh, These gamma irradiated rooted cuttings were planted in a RBD experiment with 3 replications. Ten rooted cuttings were used per replication along with the equal number of untreated (control) cuttings for every cultivar. A significant reduction in per cent survival, plant height, growth, number of branches, leaf number, leaf area, number of flowers per plant, flower size, plant spread, penducle length and increase in foliage and floral abnormalities, number of days taken to bud formation, days taken to bud showing colour, time taken to reach the harvesting stage and ratio of disc: ray florets per flower head was recorded in all the cultivars after irradiation. Somatic colour mutations were induced in Ellen Van Langen, Gulmohar, Shyama and Snow Ball. A maximum of four yellow colour mutants were obtained in Ellen Van Langen, followed by two in Snow Ball (one deep yellow and one light yellow) and one each, Gulmohar and Shyama, of brick-red colour.

IV-18. Conservation of seed germplasm in certain genotypes of marigold

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Marigold is a popular ornamental crop in tropics. It is widely used for flower beds in garden as well as for making garlands. Of late it is being used for dye extraction purposes. A wide genetic variation especially for plant habit and flower characters exists in this crop. Many of the primitive and old cultivars are at the verge of extinction, owing to replacement and large-scale cultivation of new high yielding cultivars and hybrids. It requires greater interest for the conservation of available genetic diversity and its use in near future. Seeds play major role in raising a crop and also in germplasm conservation. Seed germplasm is believed to be genetically stable even after long-term conservation. Further, it has greater advantages over other methods of conservation as they are easy to handle, practicable and economic to use. Seed germplasm of certain marigold cultivars viz., Sunshine, Queen Sophia and Butter Scotch were conserved in moisture semi and impervious containers at low (5°C), sub-zero (-20°C) and ambient temperature for 5 years. Seed quality in terms of viability and vigour was lost rapidly under ambient conditions and none of the seeds germinated after one year of storage. Seed quality was preserved well both at 5 and -20°C. The preservation of high seed quality was comparatively greater at -20°C than 5°C. High seed quality was preserved in laminated aluminium foil pouches especially when stored at -20°C after 5 years of

storage. Seedlings raised from stored seeds were vigourous and healthy. Seeds of cv. Queen Sophia and Butter Scotch could be stored well. Seed germplasm conservation at 5°C and/or at -20°C is effective and advantageous in conservation of genetic diversity in marigold.

IV-19. Performance of chrysanthemum (*Dendranthema grandiflora*) varieties for cut flowers

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A field experiment was conducted with nine varieties of chrysanthemum to identify the suitable variety for the production of cut flowers in Randomized Block Design with three replication at Modibag Garden, Department of Horticulture, College of Agriculture, Pune-5 during the year 1994-95. The results revealed that the varieties Shymal and Indira were tall, (84.40 and 82.43 cm plant height), erect (42.97 and 42.50 cm plant spread) and profuse branching (14.43 and 14.80 branches per plant). The varieties Solu Local, Indira, Pink Cascade and IIHR Sel.-5 were early in buttoning (105.56, 117.33, 125.86 and 120.33 days respectively) as well as early in flowering (161.93, 163.80, 165,93 and 166.73 days respectively) while Shymal and Jaya were found late in flowering (184.20 and 183.93 days). The best spray quality in respect of length of spray (52.76 cm), number of flowers per spray (6.50), diameter of flower (5.22 cm), diameter of spray stalk (0.36 cm) and vase life (13.03 days) was recorded in the variety Indira. The varieties Indira, Shymal and IIHR Sel.-5 were found high yielders (15.77, 14.20 and 12.47 sprays/plant respectively). Considering overall performance the varieties Indira, Shymal and IIHR Sel.-5 were found best in respect of growth, flowering, flower quality and yield.

IV-20. Combining ability in African marigold (*Tagetes erecta* L.)

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A line x tester crossing programme was done using three male sterile lines and set of 11 genetically diverse pollinators as testers. F1 Salong with parents were evaluated during winter of 1995 and summer of 1996. During the seasons, for plant height and flower size, additive gene action was higher compared to non-additive gene action, while for flowering days and stalk length, non-additive gene actions played important role during both the seasons, indicating the usefulness of hybrids in marigold cultivation. Similarly, for flower number during winter and for plant spread during summer, both additive and non-additive gene action played significant role. For other traits gene action was inconsistent during different season.

IV-21. Performance of exotic chrysanthemum varieties under greenhouse

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Chrysanthemum *(Dendranthema grandiflora* Tzvelev) has earned tremendous popularity as a cut flower for interior decorations. It has been recognized as one among the top five important commercially potential flower crops. In recent past, its commercial cultivation under protected conditions in our country, especially around Bangalore and Pune is gaining popularity.

Seventeen exotic spray verities were evaluated under polyhouse conditions in a randomized block design with three replications. Data were recorded on 13 quantitative characters and were statistically analyzed. Linekar Solomon recorded maximum plant height at harvest (114 cm) and the least was recorded in

Kermit (61 cm). Linekar Solomon also recorded maximum number of leaves per plant (41). Fareo was the earliest to flower (73 days) whereas Stallion Boy was late in flowering (98days). Flower diameter (6.68 cm) and stem thickness (0.69 cm) were recorded maximum in White Reagan. Edge and Silver Jubilee recorded less stem thickness (0.47 cm). Vase life ranged from 8 to 19 days. Linekar White and Solomon recorded maximum vase life (19 days) Chrysanthemum varieties grown in greenhouse performed better with respect to all the vegetative and flower traits. The study indicated the choice of varieties for growing under Indian polyhouse conditions

IV-22. Varietal evaluation of chrysanthemum for better growth and yield in open conditions

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Twenty varieties of chrysanthemum were evaluated in the field for various vegetative and flowering characters by adopting RCBD design with 3 replications. Significant differences were found among the varieties for all the characters studied. Among varieties, Chandrika recorded maximum height, followed by Cassa (78.20 cm and 75.36 cm, respectively). Arun Shingar was the most dwarf variety (16.53 cm). Red Gold (11.73) recorded highest number of branches followed by Chandini (11.40) and least was recorded in Raja White (3.30). All the varieties were categorized under low, medium and high with respect to rating of spray by taking into consideration the characters like number of flowers per plant, number of sprays per plant and length of the spray. All the varieties were classified under three categories (early, mid and late) depending upon the time taken for flowering. Variety Neelima recorded the highest yield of flowers (34.83 t/ha) followed by Red Gold with 32.40 tons/ha. Variety Arun Shringar recorded lowest yield or 5.40 tons/ha. Largest sized flowers were produced in Royal Mundial (7.96 cm) followed by Ravi Kiran (7.89 cm), while smallest sized flowers were produced by Kasturi Shevanthige (1.86).

IV-23. Evaluation of tuberose (*Polianthes tuberosa)* cultivars for concrete recoery

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A study was carried out to evaluate single petalled commercial cultivars of tuberose (*Polianthes tuberosa)* for yield of concrete from their florets. Three tuberose cultivars namely, 'Mexican Single', 'Shringar' and 'Prajwal' were grown at IARI, Research Farm, New Delhi. The florets were plucked between 5.00 am and 8.00 am, at fully mature floret stage, during June-July, 2003. The concrete extracted by petroleum ether and later on solvent was completely removed under vacuum. The residue was dried to a constant weight from the concrete. It was observed that the higher recovery of concrete was obtained from cv. 'Shringar' (0.1602%), followed by 'Prajwal' (0.0578%). The least recovery of concrete was reported in cv. 'Mexican Single' (0.5430%). The detailed gas chromatograph study of different concrete samples for various physico-chemical properties were made.

IV-24. Performance of China aster varieties under Delhi condition

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The varietal evaluation of four China aster varieties viz., Poornima, Kamini, Shashank and Delhi local was conducted at IARI, New Delhi to assess growth, flowering and yield parameters. The experiment was conducted in randomized block design with five replications. The seeds of China aster varieties were sown in nursery during September and one month old seedlings were planted during October on 1 m ridge beds at a distance of 45 x 30 cm. Crop was irrigated through drip system and data were recorded for various vegetative and floral characters. The results revealed that all the growth and flower characters studied were found significant except number of flower/plant and flower yield/plant. Among the varieties tested, Delhi Local showed better plant growth (43.20 cm), plant spread (42.80 cm), length of flower stalk (24.40 cm) followed by Shashank. The diameter (7.44 cm) and single flower weight (7.50 g) were found maximum in variety Poornima followed by Delhi Local (7.34 cm and 5.90 g respectively). Yield of flower per plant did not show significant difference statistically, but maximum flower weight per plant (126.70 g) was found in variety Poornima followed by Delhi local (125.61 g) and minimum in variety Kamini (89.31 g). Maximum duration of flowering (21.00 days) was recorded in variety Kamini and minimum in Delhi Local (15.40 days). The vase life was recorded maximum in variety Shashank (7.70 days) and minimum in Poornima (5.87 days) in normal water.

IV-25. Performance of gladiolus cultivars in the plains of West Bengal

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Usually gladiolus flowers are grown in hilly areas of West Bengal, mainly Kalimpong area in Darjeeling district during February to June. Similar climatic conditions prevail in plains during September to February. The present area under gladiolus in plains of West Bengal is more than 300 ha. Under this recent trend identification of suitable cultivars for commercial production was an imminent issue. In this context sixty genotypes collected from different parts of India were screened in field during 2002. The results of this experiment are presented in this paper.

Major characters evaluated were plant height, days required to reach seven-leaves stage, spike length, flowers/spike and number of flowers blooming at a time, number of shoots developed from one corm and cormel production per plant. Out of sixty genotypes only two reached seven-leaves stage by 45 days. In case of spike length 22 genotypes recorded more than 80 cm out of which six had more than 90 cm spike length. Similarly 10 genotypes produced 17 to 22 flowers per spike with a diameter of more than 10-11 cm. Shoots developed from single corm varied from 2 to 7 though most of the genotypes produced 1-2. Ten genotypes were observed to produce cormels numbering more than 55-60. On the basis of these selection criteria 15 genotypes have been identified for large-scale production.

IV-26. China aster varieties for lab to land - an analysis

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China aster [*Callistephus chinensis* (L.) Nees.] is an important annual flower crop. In tropical conditions it can be grown throughout the year. Unlike rose, carnation and gerbera, China aster can be grown in open field conditions and good quality cut flowers can be obtained. At present, majority of the farmers are growing local varieties viz., 'Local Pink', 'Local White' and 'Local Violet' and loose flowers are used for worshipping and floral decoration. To popularize the new improved varieties viz., 'Kamini', 'Poornima',

'Shashank' and 'Violet Cushion' developed and released from Indian Institute of Horticultural Research, Bangalore, seeds were multiplied and given to progressive farmers, State Department of Horticulture and private companies. Further it was multiplied and distributed to large number of farmers in Karnataka, Andhra Pradesh and Maharashtra State. It has been estimated that the area and production under IIHR China aster varieties has been increased five folds during the last three years. About 50% of the area has been occupied by the variety 'Kamini' as in this variety seed multiplication rate is very good and there is a good demand for dark pink coloured varieties. Improved varieties are becoming very popular as cut flower. These are also used as loose flower and for garden use. After assessing the merits of released varieties based on different traits, it is observed that the variety 'Violet Cushion' and 'Shashank' were preferred as novelty varieties whereas 'Poornima' and ' Kamini' were popular for commercial cultivation.

IV-27. Development of gladiolus cultivars moderately resistant to *Fusarium* wilt through hybridization

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Gladiolus is one of the most popular flower crops grown in India and other countries for cut flower and garden display purposes. In order to develop superior cultivars suitable for Indian conditions, hybridization was done at the Indian Institute of Horticultural Research, Bangalore. Indian bred and exotic varieties were used in hybridization during the year 1986. Hybrids were raised and evaluated for a number of years. Vegetative and floral traits of a promising hybrid are discussed in comparison with a popular variety 'Pink Friendship'. The IIHR Hybrid No. 86-17-6 was found to be very promising. The corms of the hybrid were inoculated artificially with *Fusarium oxysporum* f. sp. *gladioli* race 1. The hybrid No. 86-17-6 was found to be moderately resistant to fusarial wilt disease. This hybrid was named and released as 'Arka Kesar' for commercial cultivation. On an average it produces flowers in 61 days. Its spike length is 110 cm and bears around 18 florets per spike. It has attractive saffron coloured florets and has a vase life of 9 days. Spikes are long and are suitable for cut flower purpose.

IV-28. Evaluation of chrysanthemum varieties for commercial cultivation under Andhra Pradesh conditions

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Seven varieties of chrysanthemum collected from different parts of the country were evaluated during 2001-02 at AICFIP, ARI, Rajendranagar, Hyderabad (A.P.) for their flowering behavior. Significant variation was noted for all the characters studied except average flower weight. Maximum number of flowers/plant was recorded in Basanthi followed by Ratlam selection . Weight of 1000 flowers was maximum in Ravikiran followed by Ratlam selection. Based on flower production and colour, cv. Basanthi was identified as high flower yielding variety and suitable for commercial cultivation under A.P. conditions.

IV-29. Correlation and path coefficient analysis in gladiolus over different environments

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Correlation and path coefficient analysis were carried out on 22 genotypes of gladiolus for 20 characters at two places viz. Research farm (P.G.) College Baraut (U.P.) and Research farm (Floriculture), Ponichak Jammu *(J&K)* for two years. In all the genotypes, correlation coefficient was higher than phenotypic correlation coefficients. Rachis length, plant height and durability of whole spike showed significant

positive correlation with number of florets/spike. It is obvious from the findings that for the improvement of gladiolus, these characters are of primary importance. Therefore selection of cultivars on the basis of these characters can be helpful in finding good recombinants through a suitable breeding programme.

Path coefficient showed a lot of differences from one environment to another due to presence of high genotype x environment interaction. Results of pooled analysis for both the years revealed that plant height, average weight of cormels/plant, durability of spike, days to first floret colour showing and days to last floret opening showed positive direct effects towards number of' florets/spike. Therefore, for improvement in number of florets/spike single plant selection for these traits will be useful.

IV-30. New tuberose hybrid 'Vaibhav'

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Tuberose (*Polianthes tuberosa* L.) belonging to family Amaryllidaceae is an important commercial crop among ornamentals because of its popularity as a cut flower, loose flower as well as a source of perfumer's raw material. The loose flowers of single type are used in garlands, floral decorations, and for extraction of tuberose concrete. The cut flowers of double types are used for bouquets and vase decoration. Although tuberose is a very popular crop in our country and commercially cultivated for many years, no hybrids having improved economic value had been reported in this crop until the release of hybrids 'Shrjngar' and 'Suvasini' by the Indian Institute of Horticultural Research (IIHR), Bangalore. A new tuberose hybrid 'Vaibhav' developed at IIHR, has been released for commercial cultivation. It bears double flowers on straight, stiff spikes. The flower buds are greenish in colour, while the flowers are white. The spike yield of this hybrid is nearly 50 per cent higher than that of the other double types. Hence it is recommended for cut flower purpose.

IV-31. Evaluation of gerbera genotype

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Gerbera is a cut flower of international importance occupying sixth position in the world market. The selection of cultivar is very important for success of growing of gerbera for commercial cut flower production or garden decoration. Investigations were carried out to evaluate the performance of ten gerbera genotypes under Northern transitional zone of Karnataka. The genotype ACC-9 performed better in terms of number of leaves, leaf area, maximum horizontal spread and number of suckers. The floral parameters were found to be towards the higher degree for ACC-9. The flower yield (number of flowers per plant) data for different months revealed the superiority of ACC-9 except for December in which it had not started flowering. ACC-9 was followed by ACC-8 in performance. Hence, ACC-9 was adjudged as the most promising genotype for Northern transitional zone of Karnataka for different economically important characters, followed by ACC-8.

IV-32. Correlation studies in African marigold

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Correlation analysis carried out on 13 diverse genotypes of African marigold for 13 characters related to growth and flowering revealed that yield of flowers per plant had a significant and positive correlation with plant height, plant spread in East-West and North-South direction and number of flowers per plant at

phenotypic level, while it showed a significant and positive correlation with plant height, number of primary branches, plant spread (E-W & N-S), leaf area, flower size, individual flower weight, depth of flower and number of flowers per plant at genotypic level. However, a significant and negative correlation of days to flower with duration of flowering was observed both at genotypic and phenotypic levels.

IV-33. Genetic variability and correlation studies in dahlia

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An experiment with 18 genotypes of dahlia taking 36 metric characters was undertaken to assess the variability among the germplasm and to detect the degree of association among important yield attributing traits. Wide differences were found in mean performance of the genotypes under study for most of the characters. Tuber weight per plant had maximum coefficients of variation (GCV and PCV) coupled with higher heritability and genetic advance followed by flower number and internodal length which could be relied upon for effective selection and crop improvement. Correlation studies revealed that bud diameter at colour break stage (0.69), petal length (0.98) and petal width (0.69) showed significant strong positive association with size of flower whereas leaf number per plant (0.65) and ornamental crop duration (0.50) exhibited significant positive association with number of flowers. Thus, the results could reflect light on identification of suitable types for commercial use directly and/or through hybridization, which could be maintained and multiplied asexually.

IV-34. Response of carnation varieties to calyx splitting, wilt and mite infestation

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Experiment was conducted with nine cultivars of carnation in the progressive farmer's field at Belgaum of Karnataka to know the reaction of cultivars with respect to calyx splitting, wilt (under natural infection) and mite infestation. Calyx splitting which is a major disorder of carnation was minimum in cultivars West Pretty followed by Desio, Sugar Baby and Madame Collette (to an extent of less than 1 %). However it was maximum in cultivar Pirandello. Incidence of *Fusarium* wilt *(Fusarium oxysporum* f.sp. *dianthi)* was minimum in cultivar Madame Collette, followed by Pirandello, Alma, and Aicardi. Cultivars Candy, Sugar Baby and West Pretty were moderately free from disease incidence. Mite infestation on bud was minimum in cultivars Madame Collette, Sugar Baby and Alma, whereas it was maximum in Cv. Desio. Mite population was minimum on leaves of cultivar Desio, West Pretty and Madame Collette, whereas it was maximum in Cv. Sorisso.

IV-35. Improvement in chrysanthemum

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The chrysanthemum cultivars Local White Red and Gold suckers were irradiated at 1.0, 1.5, 2.0 and 5.0 krads. Observations were recorded on survival percentage, vegetative characters viz., plant height, main branches, number of laterals per plant, number of leaves per plant, leaf length, width, plant spread, stem

girth, number of suckers per plant and flower character, stalk length, days to first flower initiation, days for 50 per cent flowering, duration of flowering, number of flowers per plant, flower weight and diameter.

The survival percentage, plant height, number of leaves, leaf length and breadth were the highest in nonirradicted plants of both cultivars and they decreased with increase in dosage of gamma radiation. More number of laterals were obtained from 2.0 krads treated plants of Local White. The untreated suckers flowered earlier with longer duration of flowering and also produced more flowers and more number of suckers. However, length and breadth of ray florets were decreased due to gamma irradiation.

The number of disc florets were the highest at 2.0 krads of gamma rays in Local White and 1.0 krads of gamma rays in Red Gold. There was a change in flower colour in mutants from white to yellow in local white at 2.0 krads and from deep mauve to yellow in Red Gold at 1.0 krad of gamma rays.

IV-36. Evaluation of china aster *(Callistephus chinensis* (Lo) Nees) genotypes under transitional zone of north Karnataka

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The present investigation was carried out in the Floriculture unit of Department of Horticulture, University of Agricultural Sciences, Dharwad during 2001-02 with an objective to evaluate china aster *(Callistephus chinensis* (L.) Nees) genotypes under Transitional zone of North Karnataka. The genotype 'Phule Ganesh White' produced bigger sized flowers (8.48 cm) having maximum flower weight (9.89 g) and hence recorded the highest flower yield among all the genotypes. The genotypes 'Violet Cushion' and 'Shashank' produced more number of double flowers but their yield was comparatively lesser compared to 'Phule Ganesh' series. However, stalk length, flower diameter and vase life were comparatively superior. Hence, these genotypes performed better in terms of quality and were found suitable for cut flower production.

The genotypes 'Phule Ganesh White' and 'Kamini' produced higher seed yield per plant and per hectare as compared to other genotypes. The gross and net returns were highest in genotypes 'Phule Ganesh White' followed by 'Giant Branching Comet' and 'Rainbow Mix'. Among different genotypes 'Phule Ganesh Pink', 'Phule Ganesh Violet' and 'Pule Ganesh White' had significantly higher vase life. Phenotypic and genotypic coefficients of variation were medium for characters like number of flowers per plant, stalk length and vase life. High heritability with medium genetic advance was observed for number of leaves per plant and number of flowers per plant. .

Thus, the promising genotypes for transitional zone are 'Violet cushion', 'Shashank', 'Kamini' and 'Poornima' for cut flower production. Whereas, all the 'Phule Ganesh Series' are suitable for garland making.

IV-37. Performance of carnation cultivars at Yercaud

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Carnation is a very popular flower and has multiple uses such as, cut flower, potted plants, bedding plants and border plants in gardens. Evaluation of different cultivars helps in isolating the superior genotypes for commercial cultivation. A total of fourteen genotypes were evaluated at Horticultural Research Station, Yercaud during 2001-2003 for their growth and flowering characters.

Among the cultivars the highest plant height of 81.26 cm was recorded by the Cv. Murica. Cultivar sunrise produced maximum number of flowers per plant (6.31). The longest flower stalk (60.62 cm) and largest flower diameter (7.10 cm) were measured in Cv. Star Light. The same cultivar recorded the maximum vase life of 10.33 days.

IV-38. Field evaluation of gladiolus germplasm for Upper Pulney Hills

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Gladiolus is one of the most fascinating and valuable cut flowers grown commercially in many parts of the world. In order to identify suitable gladiolus variety for Upper Pulney Hills, 45 gladiolus varieties obtained from various parts of the country were raised under field conditions and evaluated for their suitability by observing plant height, earliness, flower stalk length, flower stalk weight, total number of florets/ spike, floret size, duration of flowering, keeping quality, corm diameter, cormlets/plant and weight of single cormlet. The variety, Shan-e- Punjab has performed well by recording the highest plant height (141.7 cm), more length of flower stalk (120.6 cm), more weight of flower stalk (62.4 gms) and more number of florets/spike (15 nos.), followed by Princess Margaret Rose, Suchitra, Provision and Priscilla. The variety, Jester was the earliest to flower (74.2 days) followed by Melody (83.5 days). It is evident from the results that Shan-e- Punjab, Suchitra, Princess Margaret Rose, Provision and Priscilla are promising varieties which can be explored for further cultivation at Upper Pulney Hills.

IV-39. Estimates of genetic divergence in dahlia genotype

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Dhalia is a valuable tuber-flower and it has important role in Floriculture. It has its place in the International flower trade with the standardization of production technology for most of the flowers in the plains. There has been a sudden increase in demand for different types of flowers. Genetic divergence is estimated in 25 genotypes with 13 characters of dahlia through the calculation of D^2 statistic of Mahalanobis, which is an important tool for finding out closeness of different genotypes. Each cluster was found to be comprised of closely related lines/hybrids. The crosses between the lines which are from distantly placed clusters are likely to release great genetic variability and also their hybrids may exhibit heterosis. Cluster II had lower mean value in number of days for bud maturity and number of flowers per plant in 1997 -98. Cluster V revealed the low mean values in length of leaf and width of petal in 1997-98 whereas it was highest for number of days required for bud maturity during 1998-99.

IV-40. Variability studies in canna germplasm

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Canna is one of the most important bulbous crops which is valued for its flowers as well as foliage. As a result of continuous breeding programme large number of varieties have been evolved. Experiments were laid out at C.S.A. University of Agriculture and Technology, Kanpur during 1996-97 and 1997- 98. Five main parameters were studied on all the fifty genotypes. Plant height was found to be minimum, 55.53, 57.50 cm in V_{15} and it was maximum, 177.67, 177.57 cm. in V_{41} during 1996-97 and 1997-98, respectively. Number of days taken for spike emergence ranged from 58.13 to 86.20 days in V_1 and V_{49} varieties in 1996-97 and from 63.00 to 86.77 in V_{24} to V_{36} in the year 1997-98. In flowering behaviour variety V_{44} revealed longest flowering span which was closely followed by the variety V_5, V_{28}, V_4 and V_{29}. In flower size its length ranged from 6.80 to 35.57 cm. in the variety V_8 and V_{20} during previous year and in the successive year it ranged from 6.00 to 35.83 cm. in the varieties V_{10} and V_{18}, respectively. Diameter of flower also revealed a great range of variation. Variety V_{15} showed maximum diameter of 16.17 cm. On the other hand variety V_9, V_{10} gave minimum diameter of 6.17 cm during 1996-97.

IV-41. Assessment of tuberose varieties for commercial cultivation under Andhra Pradesh conditions

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Six varieties of tuberose collected from different parts of the country were evaluated during 2002-03 at AICFIP, ARI, Rajendranagar, Hyderabad (A.P.) for various characters. Significant variation was noted for all the characters studied. Based on spike length, weight and number of florets per spike, Hyderabad Single and Hyderabad Double were identified as promising varieties suitable for A.P. conditions.

IV-42. Genetic studies in tuberose (*Polianthes tuberosa* L.)

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Genetic variability, heritability and genetic advance studied in fourteen tuberose genotypes involving Single and Double types for ten quantitative characters at IIHR, Bangalore during 20001-2002 depicted significant differences for majority of the characters. Coefficient of variation was minimum for number of flowers per spike (PCV=9.02%, GCV=7.58%) and maximum for loose flower yield (PCV=43.24%, GCV=39.02%) in single types, whereas in double types it was minimum for flower diameter (PCV=8.99%, GCV=6.28%) and maximum (PCV=48.60%, GCV=46.43%) was recorded for number of leaves per plant. Heritability estimates for all characters were generally high. High heritability along with high genetic advance was observed for hundred-flower weight (h^2=87.20, GA=59.22), Number of leaves per plant (h^2=96.30, GA=53.34) and loose flower yield/m^2 (h^2=81.50, GA=53.20) in single types. In double types, high values were recorded for number of leaves per plant (h^2=91.30, GA=92. 71), spike length (h^2=98.80, GA=44.24) and hundred-flower weight (h^2=99.70, GA=41.36). These results indicate the presence of additive gene effect for most of the traits and their amicability for direct selection in both the types of tuberose.

IV-43. Performance of new promising genotypes of tuberose

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Tuberose *(Polianthes tuberosa L)* is one of the most important commercial flower crops grown in India. It is having good domestic market and immense export potential. In tuberose, Single and Double are two types which are grown commercially. The single type cultivars occupy prime position, but in recent years, the double type cultivars are gaining popularity for their attractive flower spikes. Six hybrids (double types) developed at the Indian Institute of Horticultural Reserch (IIHR), Bangalore viz., IIHR-2 (Mexican Single x Pearl Double), IIHR.-4 (Mexican Single x Pearl Double), IIHR-5 (Mexican Single x Pearl Double), Suvasini and Vaibhav were evaluated along with the local cultivar Pearl Double under field conditions in a Randomized Block Design with three replications at IIHR, Bangalore. Data were recorded for different quantitative traits and subjected to statistical analysis. Among the six double genotypes, earliest flowering was recorded by the genotype, IIHR-5. Vaibhav recorded more number of spikes per plant, longest rachis length, longer flowering periodicity and medium sized bulbs, which are ideal characters. Suvasini recorded more number of spikes per plant next to Vaibhav. Based on the performance Vaibhav, Suvasini and IIHR-5 can be recommended for commercial cultivation.

IV-44. Screening of rose germplasm for suitability under tarai conditions

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The performance of six cultivars each of hybrid tea and floribunda roses under tarai condition were evaluated. It was found that in hybrid tea group, cv. Happiness had maximum growth rate, number of shoot per plant and shelf life. The maximum size of the flower was recorded in Crimson Glory whereas the plant height, vase life and canopy size at mature stage were recorded in cv. Super Star. Number of days taken to flowering was least in Crimson Glory. In Floribunda group, maximum growth rate was observed in Suryakiran, size of flower in Sukumari; vase life and shelf life in Sharda and plant height and canopy size in Yellow Contempo. In case of abiotic and biotic stress, Super Star was found to be least susceptible to insect pest and Suryakiran was found less vulnerable to cold and pests.

IV-45. Performance of various Asiatic and Oriental hybrid cultivars of *Lilium* under mid-hill zone of Himachal Pradesh

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Ten cultivars of Asiatic hybrids and three cultivars of Oriental hybrids of lilies were evaluated to ascertain their suitability for cut flower production without any cold treatment, under natural day light conditions and without any shade. The Asiatic hybrid cultivars were Enchantment, Penguin, Navona, Harmony, Bell Air, Mona, Gran Paradiso, Mont Blanc, Jolanda and Avignon. The Oriental hybrid cultivars were Star Gazer, Cascade and Concerto. Significant differences were obtained among the cultivars for all characters studied. Asiatic hybrid cultivars Jolanda, Gran Paradiso and Harmony and Oriental hybrid cultivars Cascade and Star Gazer were found to be highly suitable for cut flower production under mid hill conditions.

IV-46. Evaluation of different varieties of gerbera for year round production in Punjab

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In an experiment conducted during 2002-2003 to evaluate the thirteen varieties of Gerbera under subtropical climate of Punjab. It has been observed that the variety Blue Bay resulted in maximum number of leaves (26.3). Maximum plant spread (24.82 cm) was observed in variety Rosalin during the period of November to March. Significant variations were noticed among different varieties for various floral characters. Variety Rosalin took minimum number of days (14.0) to anthesis. Longest flower stalk length (36.70 cm) and flower diameter (9.3 cm) was observed in variety Golden Gate. However, the variety Priyadarshi resulted in maximum vase life (17.4 days) of flowers as compared to other varieties.

IV-47. Evaluation of China aster *(Callistephus chinensis* (L.) Nees) genotype under transitional zone of North Karnataka

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An experiment was carried out the Floriculture Unit of New Orchard. Division of Horticulture, University of Agricultural Sciences, Dharwad during Kharif 2001, to study the performance of China aster (*Callistephus chinensis* (L.) Nees) genotype under transitional zone of North Karnataka. The genotype 'Phule Ganesh Series' and genotype 'Poornima' and 'Kamini' were vigorous in growth in terms of plant height. The genotype 'Shashank' has recorded minimum plant height. Number of primary branches produced per plant was maximum in genotype 'Phule Ganesh Pink', 'Phule Ganesh Violet', 'Violet Cushion', 'Poornima', while the genotype 'Kamini and 'Shashank' recorded minimum primary branches. As far as secondary branches are concerned, the genotype, Phule Ganesh Purple which recorded minimum primary branches recorded maximum secondary branches of 'Phule Ganesh Series ' and 'Ostrich Plume Mix' recorded maximum leaf area. Generally, 'Phule Ganesh Series' recorded maximum total dry matter accumulation. The genotype 'Phule Ganesh Purple' produced thicker and straight stem compared to other genotypes. The maximum number of flowers was observed in genotype 'Poornima'. The flower yield per plant and per hectare was maximum in genotype 'Phule Ganesh White', 'Phule Ganesh Purple' and 'Giant Branching Comet'. Increased flower yield was because of increased flower size and flower weight.

IV-48. Vegetative growth and flower yield in different cultivars of carnation

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An experiment was carried out in a low cost polyhouse during the period 2000-2001 to study the performance of ten carnation cultivars. Among the cultivars, Madamme Collette, West Pretty and Alma were superior in their flower production by producing 5.40, 4.58 and 4.45 stems per plant, respectively. Cultivars Leon, Desio and Danton recorded minimum flower yield (3.13, 3.43 and 3.43 flower per plant). With respect to quality, cultivars Sugar Baby, Madamme Collette, Alma and Desio were superior as compared to other cultivars.

IV-49. Evaluation of marigold cultivars (*Tagetes erecta* L.) for cut flower trade

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African Marigold (*Tagetes erecta*) is one of the very hardy, flowering annuals grown with popularity in different pockets of our country. Presently it is being widely cultivated for the production of loose flowers for fresh flower trade. There is very scandy experimental data on the cut flower varieties of marigold. Therefore present investigation was carried out to identify the cultivars suitable for cut flower trade based on their corolla stalk length and vaselife. Among the cultivars evaluated, the Lemon Yellow produced lengthy flower stalk (9.42 cm) and had a vase life of 5.5 days.

IV-50. Introduction and evaluation of carnation varieties in cold arid regions of India

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Commercial cultivation of carnation *(Dianthus caryophyllus* L.) has taken deep roots in hills of India. However, commercial floriculture in cold arid region of Ladakh is still in its infancy. After successful introduction of gladiolus and lilium, a need was felt to introduce and study the performance of carnation in cold arid region of India since it is a potential flower of the floriculture industry. Rooted cuttings of fifteen varieties of carnation namely Arthur Sim, Cabrat, Corpalmor, Candy, Dusty Pink, Etore, Espana Flair, Irma, Managio, New Espana, Pink Pirra, Red Carmo, Shocking Pink and White Candy were obtained from IHBT (CSIR), Palampur (HP). A study was undertaken at Field Research Laboratory (DRDO), Leh at an altitude of 11,500 ft above MSL, with a view to evaluate their establishment, growth and yield characters. Cuttings were planted under polyhouse conditions in mid April 2000 at 20 x 20 cm distance. Data were recorded on five randomly selected plants of each variety during the year 2000 and 2001 at flowering stage. Data of both the years were pooled to obtain mean value parameters relating to per cent plant establishment, plant height, days to first flower, flower stalk length, number of flowers per plant, size of flower and duration of flowering. The findings have shown encouraging results relating to performance of carnation under Ladakh conditions. A repetitive satisfactory performance of carnation year after year has reiterated the potential of the crop for commercial floriculture in the region.

IV-51. Evaluation of jasmine species and varieties for hill zone

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A field investigation was undertaken to study the growth and yield of eight jasmine varieties under hill zone during 1999-2000 and 2000-2001 at College of Horticulture, UAS, Bangalore. Among eight varieties tested the species like *J. sambac*, *J. grandiflorum* (Jati mallige), *J. multiflorum* (Kakada) were observed to be tallest and produced maximum number of primary and secondary branches and canopy spread. Among the various floral and yield traits recorded, maximum bud length was recorded in *J.sambac* var. Ambur mallige (4.36) and least in *J. sambac* var. Gundu mallige (1.87 cm). The average maximum flower diameter of opened flower was observed in *J.sambac* var. Ambur mallige (4.36) followed by *J. multiflorum* var. kakada (4.74 cm). The average flower yield over two years was maximum in *J. multiflorum* var. kakada (8987.74kg/ha) followed by *Jasminium sambac* var. Gundu mallige (3438.20kg /ha). Flower yield was lowest in *Jasminium sambac* var. Seven round (548.15kg/ ha).

IV-52. Evaluation of gladiolus varieties under low cost poly house for hill zone

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Six varieties of gladiolus were evaluated under low cost poly house for their growth and yield performance under hill zone during 1997-1998 and 1999-2000 at College of Horticulture, Mudigere. The study revealed that the variety American beauty recorded maximum mean plant height (144.70 cm) followed by Her Majesty (144.70 cm). The minimum mean plant height was observed in Moon Magic (104.00). The variety American Beauty recorded maximum number of florets (17.43) followed by Golden Puff (14.40) and the minimum number of florets was recorded in Moon Magic (8.93). The highest average rachies length was

recorded in Moon Magic (59.09 cm) followed by American Beauty (54.64 cm). The lowest average rachis length was recorded in Her Majesty (41.21 cm). It is concluded from two year mean data that, among six varieties of gladiolus tested under poly house during rainy season, American Beauty performed well with respect to desirable plant height (stalk length), number of florets per plant and uniform distribution of florets on the spike and corm and cormels production. Hence the variety American Beauty found promising for growing as a cut flower variety followed by Her Majesty and Cheaper White for hill zone.

IV-53. Community organization of epiphytic orchids in Bay islands

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The Andaman and Nicobar Archipelago have an interesting and remarkable floristic composition in Indian flora. Epiphytes and plants that grow on the forest floor, stream banks and rock crevices tend to be rare in these islands. Epiphytic population of endemics of Bay islands contributes to the tune of about 5 per cent. Among the epiphytic population of these islands, orchids contribute to the maximum, followed by ferns and other groups. The tropical warm & humid climate of these islands provides ideal ecological conditions for the orchids to flourish in diversity in almost all the vegetational types represented in the territory.

Botanical explorations conducted over a period of three years have lead to identification of fifteen orchid species of 10 genera along with their host, type of vegetation, associated ornamental plants, habit and distribution with status. All the orchid species are epiphytic herbs except *V. andamanica,* which is a climbing herb. The important host trees that harbour orchids are *Samania saman, Lagerstroemia hypholeuca, Tamarindus indica and Mangifera indica* with 7, 6, 5 and 5 species of orchids, respectively. However, preference of orchids for host trees differs from each other. Even though, most of the orchid species have wide range of host trees, *D. formosum, Oberonia* sp., have only mango as the host. Orchids are found to occur in all types of forests, however, are dominated in evergreen forest. They are associated with their own/ other genera, ferns, trees and climbers on the host trees.

IV-54. Anthuriums under shade net condition in the Andamans

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Fourteen varieties of *Anthurium andreanum* were evaluated for two consecutive years (2000 -2001 and 2001-2002). Four varieties, viz., Honey, Wrinkled Orange, Mauritius and Agnihothri were found to perform well for the observed characters in the shade net at Andaman condition. The varieties Honey and Wrinkled Orange recorded maximum number of flowers/plant/year (25.5 and 24.6, respectively). The largest flower stalk length, 2.4 cm was recorded in Honey. Among the fourteen varieties, Honey performed better for most of the important characters, followed by Wrinkled Orange and Agnihotri in the shade net to provide 75 per cent shade under Andaman conditions.

IV-55. Studies on leaf and flower morphology in African marigold

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In an experiment with 30 genotypes of marigold (*Tagetes erecta* L.), conducted on leaf and flower morphology, it was observed that leaf shape and size varied from narrow to wide and broad. Out of the 30 genotypes studied, three genotypes (Selection-51, Selection-63 and Wild Marigold) were observed with

narrow leaves, nine (Pusa Narangi Gainda, Pusa Basanti Gainda, Selection-8, Selection-22, Selection-60-11, MS-7 x Selection-21 F3, 30 x 43-1, 30 x 43-1-2, 7-3-2-2-5 and FM-560) with broad leaves and rest of the genotypes were observed with wide leaves. No relationship could be established between leaf angle and leaf shape. The leaves were found originated at slanting angle in the genotypes viz., Pusa Narangi Gainda, MS-7, MS-7 x Selection-21, FM-560 and Wild Marigold. The rest of the genotypes showed the perpendicular leaves. A large variation was noted for flower form and colour and all the genotypes varied to a great extent. Almost all the genotypes produced double flowers with multiple number of whorls except Selection -8, Selection-60-11 and Wild Marigold. The colour of the flower ranged from yellow to orange at different scales of the colour chart of Royal Horticulture Society of London.

IV-56. Genetic variability in dahlia

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Fifty two genotypes of dahlia were evaluated for phenotypic and genotypic variability for 28 quantitative characters. The characters viz., number of disc florets, internodal length and diameter of disc florets exhibited high phenotypic and genotypic co-efficients of variability. All the characters exhibited high values of heritability. The characters internodal length, number of disc florets, leaf area and number of ray florets showed high heritability along with high genetic advance showing additive gene effects. Selection based on above characters will be more effective for further breeding in dahlia.

IV-57. Exploration, characterization and conservation of ornamental orchids

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India is blessed with about 1300 species of orchids with tropical, subtropical and temperate Himalayas as their main habitat. Some of the orchid species are highly sought after by specialist collectors and this can pose a real threat to their continued survival. Indian orchids play a significant role in promoting the floriculture industry. Conservation of the orchids is very important especially when rapid development and cultivation have reduced natural habitats of wild orchids and endangered the survival of valuable germplasm of orchids. Rough estimates, indicated that over 200 species are endangered and threatened of which more than 100 species are from eastern Himalayas. Collectors have visited nearly all populations and strip flowering orchids for thriving international market where high prices are fetched for the rare species. This has depleted many species and some are now on the verge of extinction. During the last three years several explorations were undertaken by National Research Centre for Orchids in Eastern and North Eastern Himalayas and some of the important and rare orchids were collected. The collected species are being maintained in national active germplasm site for orchids at NRC for Orchids, Pakyong, Sikkim. Further continued efforts are on for their maintenance, multiplication, characterization, utilization and conservation.

Session V

Crop protection

V-1. Role of environmental factors on the progress of powdery mildew (Sphaerotheca pannosa var. rosae) of rose and its management under polyhouse conditions

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Powdery mildew *(Sphaerotheca pannosa* (Wallr. Ex Fr.) var. *rosae* Wor.) is an important disease of rose in polyhouses where they are grown for cut flowers and reduces the quantity as well as quality of the flowers. The disease starts appearing in the polyhouses in the month of July after the onset of monsoon rains and various environmental factors play an important role in the progress of this disease. Studies were, therefore, carried out to see the role of various environmental factors on the progress of this disease and its management through chemicals. Powdery mildew appeared in the second fortnight of July and attained the maximum level, in August and September. Simple correlation coefficient between powdery mildew severity and average relative humidity (0.873) was found to be highly significant and positive showing thereby consistent effect of relative humidity on disease development. However, correlation coefficients between powdery mildew severity and temperature (-0.737) and light (-0.623) were found to be significant and negative while partial correlation coefficient between disease severity and average relative humidity (0.743) was significant and positive. Regression equation between web blight severity and environmental factors explained 80.34 per cent change in the disease was due to environmental factors. Triadimefon reduced the disease severity to 6.25 per cent as compared to control (64.37%) and was significantly superior to all other treatments, followed by triadimefon alternated with K_2HPO_4 with 23.12 and 23.75 per cent disease severity, respectively.

V-2. Bio-efficacy of Bifenazate 50WP (Floramite) against the two spotted spider mite, Tetranychus urticae Koch on rose in polyhouse

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Two spotted spider mite, *Tetranychus uriticae* Koch (Acarina: Tetranychidae) is a serious pest on rose grown in polyhouses. The mite mainly damages mature leaves and spreads to buds and flowers resulting in discolouration and drying. In order to identify safe and effective alternative to the presently used acaricides, a new molecule Bifenazate 50 WP (Flormite), belonging to Carbazate group was evaluated against *T. urticae.*

The experiment was conducted at the Indian institute of Horticultural Research, Bangalore for two seasons during March-April and September-October, 2001. The rose variety "First Red" widely grown for export was selected for the experiment. Bifenazate was tested at three doses i.e., 0.12, 0.18, 0.24 g/l and Dicofol 2.5 ml/l as standard. The trail was laid out in a Randomized Block Design with five replications. Number of mites was recorded before and 3, 7, 14 and 21 days after spraying on 5 leaves selected at

random per replication. The per cent survival of the mite was calculated and the data were subjected to statistical analysis.

Result indicated that all the three doses of Bifenazate were highly effective against the mite as compared to control in both the seasons. Bifenazate at 0.18 g/l was highly effective against *T. urticae* and recorded 0.00 – 11.40 % survival as compared to 81.86 – 190.26 % in control. Bifenazate was safe to indigenous predatory mite, *Amblyseius* sp., non-phytotoxic and the efficacy lasted for 21 days.

V-3. Effect or hot water treatment and different storage materials on the corm rot of gladiolus

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Hot water treatment was given to corms of "Peach Blossom" variety of gladiolus to eradicate the deep scated fungus, *Fusarium oxysporum* f.sp. *gladioli.* The treatment was given for 30 minutes in a hot water bath at 50, 52, 54 and 56°C, respectively. The corms after treatment were sown in pot to record the disease incidence. The data revealed that out of all the temperature treatments given to the corm, 56°C was the best to check the corm rot of gladiolus with a disease incidence of 15.0 per cent. Similarly, five different storage containers, viz., cardboard box, paper bag, polythene bag, cloth bag and open metal trays were used to see their effect on corm rot phase in storage. It was evident from the results that best storage container was cloth bag with a minimum corm rot incidence of 0.5 per cent, while the worst storage container was polythene bag, which gave highest disease incidence of 63.33 per cent.

V-4. Root-knot nematode problem in polyhouse roses and its management

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The yields of commercial polyhouses cultivating roses in and around Bangalore were observed to be declining due to soil-borne problems in spite of good management practices and care. Survey, sampling and analysis of soil from these polyhouses recorded high incidence (148-226 J_2/100cc soil) of root-knot nematode, *Meloidogyne incognita.* The root-stock used, *Rosa multiflora,* in most of the rose polyhouses exhibited high number of root knots and severe yellowing and drying of scion foliage, indicating *M. incognita* infection to be one of the causes to rose decline. An experiment was carried out in root-knot nematode infested rose commercial polyhouse using Dazomet as pre-plant soil sterilant (25 g/m^2); antagonistic fungus, *Verticillium chlamydosporium* (2 x 10^{10} spores/m^2); neem cake (0.5 kg/m^2) and their combinations. Observations on initial and final nematode populations, root knot index, fungal propagules, per cent healthy root and flower yield/ m^2 were recorded.

A combination of Dazomet followed by soil amendment with *V. chlamydosporium* and neem cake recorded maximum per cent healthy root, flower yield and plant recovery compared to other combinations. The fungus established better in Dazomet treated and neem cake amended beds as the Dazomet reduced not only nematode populations but also other soil-borne pathogens thus reducing the competition from soil flora and fauna. The next best treatment was Dazomet with *V. chlamydosporium* in terms of reduced nematode populations, establishment of the fungus and flower yield/m^2. This approach of treating soil with Dazomet followed by introduction of antagonistic fungus aided in restoring the soil health and antagonistic potential for long term benefit.

V-5. Serological detection of a novel tospovirus in chrysanthemum

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Chrysanthemum *(Dendranthema grandiflora)* is occasionally attacked by an aberrant tospovirus that causes huge economic losses by deforming around 30-40 per cent flowers in most of the commercial cultivars. Major economic losses are due to an extremely wide host range and the virus evokes distinct symptoms of green vein banding of leaves in addition to those caused by tomato spotted wilt virus (TS WV) in the form of faint mottling and browning of some areas between leaf veins. It was followed by formation of chlorotic and/or necrotic spots on leaves. Mechanical sap inoculation of the test plants produced symptoms that resemble those caused by TSWV. The most obvious difference was observed in *Chenopodium amaranticolor,* in which numerous pinhead chlorotic spots were formed by tospovirus from chrysanthemum but not by the TSWV.

In ALP based DAS-ELISA, the tospovirus from chrysanthemum did not react with antisera against TSWV and impatiens necrotic spot virus (INSV). However, indirect DAC-ELISA resulted in strong positive reaction with TSWV antiserum. Negatively stained preparations of clarified virus concentrate (CVC) and the preparations from epidermal peels of the infected chrysanthemum leaves when examined under electron microscope showed the presence of isometric virus particles measuring 80 nm. Based on these results it is concluded that the tospovirus from chrysanthemum is a distinct virus that does not belong to any of the established serogroups.

V-6. Fusarium wilt in gladiolus -studies on biological control

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Wilt and corm rot caused by *Fusarium oxysporum* f.sp. *gladioli* are the major threats to commercial cultivation of gladiolus. The fungus spreads through corms and cormels and survives in soil for prolonged periods. The present method of control, namely corm treatment in hot water and fungicides, often fails to give satisfactory results. Hence studies were initiated to develop a bio-intensive IPM strategy using non-pathogenic strains of *Fusarium oxysporum* as biological agents. A total of 26 isolates were obtained from symptomless plants and corms/cormels of gladiolus. Among them two isolates were found to be non-pathogenic and these were further evaluated for their antagonistic properties against the wilt pathogen in gladiolus and the results obtained so far were quite promising. Most of these isolates were either resistant or moderately resistant to carbendazim.

V-7. Reaction of chrysanthemum germplasm to spider mite, *Tetranychus urticae* Koch. and bud borer, *Helicoverpa armigera* (Hb.)

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Twenty germplasm collections of chrysanthemum including IIHR released varieties grown under polyhouse were evaluated for their relative resistance/susceptibility to red spider mite, *Tetranychus urticae* Koch. and bud borer, *Helicoverpa armigera* (Hb.) at Indian Institute of Horticultural Research, Bangalore.

The mite infestation was recorded both on leaves and flowers. The incidence on leaves varied from 0.2/ leaf in 'Angel Bell' to the maximum 11.0 in 'Collection No.I0'. The population on flowers was as high as 5.2/floret in 'Arka Ravi' while flowers of varieties 'Heavenly Tech' and 'Frost Whisker' remained free from mites. The borer damage was the lowest (6.25%) in 'Angel Bell' and the highest (77.77%) in 'Collection No.10' while 'Snowball' had no borer damage. Other collections which had suffered less than 10% damage were 'Nilima' (6.66%) 'Chandrika' (6.97%) 'Collection No.9' (8.600/0) and 'Arka Swarna' (9.52%). The variable reaction of different germplasm collections and the probable factors influencing this variation were discussed.

V-8. Management of nematode induced wilt disease complex in tuberose (*Polianthus tuberosa* l.) using Pochonia chlamydosporia (*Verticillium chlamydosporium*) and *Trichoderma harzianum*

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Root- knot nematode induced wilt disease complex affected the cultivation of tuberose (*Polianthus tuberosa)* under the field conditions in various tuberose growing tracts in Southern India. The wilt disease complex (caused by both *Meloidogyne incognita* and *Fusarium oxysporum* f.sp. *dianthi*) also reduces the productivity of the crop by 35 – 44% under the field conditions.

After establishing the role of *M. incognita* in inducing the wilt disease in tuberose, attempts were made to standardize an integrated approach for the management of both pathogens involved in the wilt disease complex.

The results of the experiments indicated that the application of neem based formulation of *Pochonia chlamydosporia* (*Verticillium chlamydosporium*) (40g @ 10^6cfu/g) and *Trichoderma harzianum* (40g @ 10^6 cfu/g) per 2 m^2 plots before planting and subsequently once in 4 months decreased, the incidence of root-knot nematode by 72% and wilt disease intensity by 62%. These treatments also increased the number of flowers per spike and also spikes per plot, significantly, contributing 24% increase in the flower yield.

V-9. Incidence and seasonal pattern of some major pests of flower crops

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Two pests viz. *Heliothis* spp. and Green house whitefly are reported to be the important pests of some flower crops, posing a major production constraint in Himachal Pradesh. These pests, i.e., *Helicoverpa armigera* Hubner and *Trialeurodes vaporariorum* Westwood chiefly infest carnation, snap dragon and fuschia, gerbera, jasmine and poinsettia, respectively. Pests firstly start their initial multiplication and population build up on these host plants and subsequent spread to vegetables and other preferred hosts, thus acting as hot breeding house by serving as main and alternative host depending upon the seasonal availability of these flowers. The seasonal abundance and other life history parameters also have been studied on these crops.

V-10. Plant protection measurements of hybrid gerbera

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Production of hybrid gerbera faces many problems like chlorosis of leaves, attack by yellow mites, thrips, white flies and others, causing serious problems like deformed flowers, fading of colors, mottled leaves

etc. Unless these are immediately managed it may lead to heavy damage ultimately leading to failure of the crop. In a pilot scale production of hybrid gerbera in the plains of West Bengal, a number of such problems were faced and through different protection measures all plants were recovered. This successful management of gerbera plants is presented in this paper along with photographic evidences and management schedule developed particularly with repect to plant protection measures.

V-11. Integrated pest management - an effective plant protection technology in roses (*Rosa indica* Linn.)

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An experiment was conducted at Krishi Vigyan Kendra, Nanded farm under IPM project during October 2001 to March 2002 in rose crop cut flower variety Gladiator. Two modules had been tested for their effectiveness viz. IPM and non-IPM module. The studies complied through incidence of pest complex like aphids, thrips, rose beetle, San Jose scale and the disease like powdery mildew, Fusarium wilt, black spot and rust etc. It is concluded from the result that the IPM module is found to be eco-safe, promising, quality productive and effective than non-IPM.

V-12. Studies on the effectiveness of marigold -French bean intercropping system on *Meloidogyne incognita*

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An experiment was conducted at Assam Agricultural University, Jorhat, Assam to study the nematicidal effect of marigold on marigold based intercropping with French bean. It was observed that the number of nodules, egg mass, galls, final soil nematode population, yield of pod and flower differed significantly with respect to different treatments. Considering these characters and comparison made among them revealed that the intercropping of African marigold (45 x 45 cm) with French bean (25 cm plant to plant) single row at every inter row was found to be the most suitable intercrop treatment.

V-13. Role of root-knot nematode (*Meloidogyne incognita*) in predisposition of carnation to wilt by Fusarium oxysporum *f. sp. dianthi*

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Cultivation of carnation *(Dianthus caryophyllus* L.) in polyhouses has gained importance in India because of the huge demand for its flowers in domestic and international markets. However, the wilt disease caused by *Fusarium oxysporum* f. sp. *dianthi* is so rampant that its cultivation is threatened in many polyhouses.

Due to heavy incidences of root- knot nematode, *Meloidogyne incognita* in wilt affected carnations prompted us to investigate the role of *M. incognita* in predisposition of carnations to *F. oxysporum* f. sp. *dianthi.*

The results of the experiments revealed that *M. incognita* infestation on carnations increases the susceptibility of the crop to *F. oxysporum* f. sp. *dianthi.* Prior inoculation of this nematode increased the wilt disease intensity by 35% in this crop. The increase in the intensity of the wilt is dependent on the inoculum densities of both the causal organisms involved in the disease complex. Efforts are also being made to investigate the bio- chemical basis of this phenomenon.

V-14. Effect of pre and post inoculative sprays of fungicides on blight of gladiolus caused by *Botrytis gladiolorum*

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Blight caused by *Botrytis gladiolorum* is a major threat to gladiolus cultivation. Once the disease appears in the field, normally it becomes very difficult to contain it. Keeping such devastating nature of the disease in mind, some chemical fungicides were evaluated with a view to promptly arrest the disease. The fungicides used were copper oxychloride (Blitox, 0.3%), fosetyl-aluminium (Aliette, 0.25%), metalaxyl + mancozeb (Master, 0.2%), triadimefom (Bayleton, 0.1%), ziram (Cuman-L, 0.2%), difenconazole (Score, 0.1%), penconazole (Topas, 0.05%), hexaconazole (Contaf, 0.05%) and tridemorph (Calixin, 0.05%). Efficacy of these fungicides was determined employing their pre-inoculative and post-inoculative sprays on detached leaves (cv. Sancerre) and cut spikes (cv. Anglia) of gladiolus. Spore load of 40,000 conidia/ ml of water suspension was used for inoculating the plant parts. The study revealed that post-inoculative (eradicative) sprays of the fungicides were not effective in checking the disease in either of the plant parts. Only pre-inoculative (protective) sprays of the fungicide provided satisfactory control on the foliar tissue. It suggests that chemical control measures should be started before the appearance of the disease, preferably before the plants reach the flowering stage.

V-15. Chemical control of brown patch disease of *Zoysia japonica*

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Lawn grasses are a major component of a landscape design. Korean grass *(Zoysia japonica)* commonly gets infected with brown patch disease, caused by *Rhizoctonia solani,* in rainy and post-rainy season in the plains of northern India. Eight fungicides, namely Emisan-1 (0.1%), Thiram (0.2%), Captan (0.3%), Bavistin (0.1 %), Benlate (0.1%), Dithane M-45 (0.2%), Kavach (0.2%) and Rovral (0.1%) were used, as a drenching treatment, for control of this disease. Two of these fungicides, namely Captaf and Dithane M-45 were found to reduce the severity significantly over the control.

V-16. Bio-efficacy of Milbemectin 1% EC against the two spotted spider mite, *Tetranychus urticae* Koch on rose in ployhouse

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Two spotted spider mite, *Tetranychus uricae* Koch is a serious pest on rose grown under protected conditions for export. The mite mainly damages mature leaves and spreads to buds and flowers resulting in discolouraiton and drying. In order to identify safe and effective alternative to the presently used acaricades, a new generation acaricide Milbemectin 1% EC was tested against the mite, *T. urticae.*

The trial was conducted for two seasons during February-March and August-September 2002 at the Indian Institute of Horticultural Research, Bangalore on popular export rose variety "First Red". Milbemectin 1% EC was evaluated at three doses i.e., 3.5, 4.5 and 5.0 g a.i/ha and Vertimec 1.9% EC as standard. The trail was laid out in Randomized Block Design with five treatments each replicated five times. Number of mites was recorded before and 5, 7, 14 and 21 days after spraying on 5 leaves selected at random per replication and the per cent survival was calculated. The data obtained were statistically analysed.

Results indicated that Milbemectin at all the does gave significant control of the mite compared to control in both the seasons. Among the three doses tested, Milbemectin @ 4.5 a.i/ha was highly effective recording 99.69-100% mortality of the mite as against 0.00 – 3.52% in control. The effectiveness of Milbemectin lasted for three weeks and was at par with that of Vertimec with no phytotoxic effects.

V-17. Influence of physiological factors on growth and sporulation of *Fusarium oxysporum* f.sp. *dianthi* inciting wilt of carnation

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Three physiological factors such as medium, both solid and liquid, temperature and pH were studied on the growth and sporulation of carnation wilt causing fungus, *Fusarium oxysporum* f.sp. *dianthi*. It was evident from the results that potato dextrose agar followed by carnation leaf agar amongst solid media and Richard's solution amongst liquid media supported maximum growth as well as sporulation of the fungus in comparison to rest of the media tested. A temperature of 25°C was found optimum while no growth and sporulation was registered at 10°C. However, pH levels ranging between 5.0 and 6.5 favoured the growth in terms of average mycelial dry weight of the fungus but maximum being recorded at pH level 5.5 with highest spore formation.

V-18. Use of non-chemical methods in managing *Fusarium* wilt of carnation

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The effect of non-chemical methods such as organic amendments, plant spacing and germplasm evaluation were studied on the development of *Fusarium* wilt *(Fusarium oxysporum* f.sp. *dianthi)* in carnation. Out of six organic amendments, soil amended with pine needles gave maximum disease reduction (88.24%), which was followed by neem cake (70.58%) and mustard cake (58.83%) while the insignificant reduction was registered with poultry manure. The results of the four plant spacing viz., 15 x 15 cm, 20 x 20 cm, 25 x 25 cm and 30 x 30 cm indicated that the wide plant spacings prevent the wilt infection compared to closer spacings. The lowest incidence of 22.22 per cent was observed in spacing of 30 x 30 cm followed by 25 x 25 cm compared to 66.60 per cent incidence in 15 x 15 cm plant spacing. Of 25 cultivars screened under artificial inoculation conditions, only two cultivars "White Cändy" and "Dona Precas" showed resistant reaction, while three namely Fantasia, Bologna and Macarena developed moderate resistance against *Fusarium oxysporum* f.sp. *dianthi* and rest of the cultivars were either moderately susceptible; susceptible or highly susceptible.

V-19. Screening gerbera genotypes against *Alternaria* leaf spot

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An experiment was conducted at Kittur Rani Channamma College of Horticulture, Arabhavi, Belgaum district on varietal evaluation of gerbera under low cost polyhouse during the year 2000-01. Among the 19-gerbera genotypes, cuitivar Rosa Matia recorded the lowest leaf spot incidence (7.06%) followed by Diablo, Testarosa, Navade and Ornella (7.86, 9.10, 9.40 and 12.30%, respectively). The genotype Ruby Red recorded the highest incidence of 23.60%.

V-20. Biology and the seasonal abundance of whitefly, *Trialeurodes vaporariorum* (Westwood) on *Fuchsia*

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The greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood) is one of the major pests found on ornamentals which limits the successful cultivation of these plants. The present studies were conducted on *Fuchsia* as it is the highly preferred host for this pest.

The total developmental period on this host from egg to adult took 23.88 days. Egg stage lasted for 5.58 days. There are four nymphal instars. Total nymphal period took 18.26 days. Seasonal abundance of *T. vaporariorum* on *Fuchsia* was studied from July 2000 to July 2001. Two peaks of whitefly population were observed during October 2000 and during March 2001, when 109.6 eggs and 67.8 nymphs and 107.2 eggs and 53.0 nymphs were recorded respectively.

V-21. Flower bud rot of marigold and its management

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A dry rot disease of developing flower buds of marigold (*Tagetes erecta* L.) was observed in the severe form at the floriculture area of the Department of Horticulture, CCS Haryana Agricultural University, Hisar-during 2002-2003 crop season. The causal organism has been identified as *Alternaria dianthi* Stevens and Hall. Keeping in view the severity of the disease, a trial was conducted to manage the disease with fungi toxicants, i.e. Dithane M-45 (@ 0.2 per cent), Bavistin (@ 0.2 per cent), Blitox 50 (@ 0.2 per cent), Bayleton (@ 0.05 per cent) and Ridomil-MZ (@ 0.25 per cent). Three sprays of these fungicides were applied at an interval of 10 days starting just after first apperance of disease in the field. Observations on disease severity were recorded till maturity. Mancozeb was found to be most effective in checking the disease, followed by Ridomil-MZ. Bilitox-50 was the least effective.

Session VI

Crop/product diversification

VI-1. Hilly region offers charming beauty of dry-flowers

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Himachal Pradesh is endowed with a wide variety of flora and fauna. Its diverse and natural forests and valleys harbour several plant species which are ideal for making dried flower products. These flowers can be put to varied uses e.g. the beautiful reddish leaves of *Pistacia khinjuk,* leaves of various types of ferns, flowers of *Clematis gouriana, Reinwardtia indica* and different grasses can be used for making cards, calendars and wall pictures; whereas, the turgid leaves of *Quercus* sp, *Ilex dipyrina, Cycas sp.,* flowers of *Verbena erinoides* and fruits of *Dioscorea* sp, *Hedera canariensis,* cones of *Cunninghamia lanceolata* and hips *of Rosa moschata* can be used for making bouquets, dry-flower arrangements and pot-pouries etc. Thus there is an imperative need for preservation and cultivation of such native species not only for aesthetic importance but also to restore ecological balance. Apart from these, the region with its varied climatic conditions creates a congenial environment for cultivating many ornamental plants suitable for making dried- flowers such as *Molucella, Helichrysum, Limonium, Nigella etc.*

VI-2. Evaluation of North eastern Himalayan orchids for product diversification in Indian floriculture

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A number of plant species have always been important to mankind as the source of food, fibre, medicine, building material and in totality for supporting the life itself in ecological sense. However, no other plant probably has acquired the status as orchids. Orchids, owing to their breath taking beauty, an array of sizes and shapes beyond human imagination, share 8 per cent of world floricultural trade. Though the awareness about the beauty and utility of Indian orchids is increasing, commercial exploitation is still far from its potential. The North Eastern Himalayas that lies between 21.5°N to 29.5°N latitude and 85.5°E and 97°E longitude has a total geographical area of 18.4 million hectares. The region is bordered by China in the north, Bangladesh in the south, Bhutan and Nepal in the west and Burma in the east. The region is one of the richest centres of orchid bio-diversity. A moderate estimate would suggest about 750 orchid species, of which 157 are endemic to this part of the world. The region forms the junction point for migratory elements from the neighboring countries: Malaysia, Thailand, Burma and China. This fact also probably explains the concentration of such high number of orchid taxa in a small geographical area. In the present paper, morphological characterization, economic importance, suitability for commercial exploitation and ethno botany of important orchid species of this region, with a special reference to their suitability for product diversification in Indian floriculture are discussed.

VI-3. Standardizing dehydration technology for ornamental plant parts of shrubs from mid hills of Himachal Pradesh

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Mid hills of Himachal Pradesh are rich in plant wealth, comprising of a wide variety of ornamental shrubs occurring in wild or naturalized state. Most of these with their magnificent array of flower colours have fascinated the tourists, naturalists, amateur gardeners and flower lovers. As cut flowers or cut foliage, these cannot be retained for longer duration and those who are unable to visit this region remains deprived of their beauty. Unlike, fresh flowers or foliage, dehydrated flowers or foliage are retained from months to years with less cost and labour. Therefore, in the present study efforts have been made to standardize the dehydration technology for 15 important ornamental shrubs, viz., *Asclepias curassavica, Asparagus adscendens, Caesalpinia sepiaria, Clerodendrum phillippinum, Deutzia staminea, Duranta repens, Holmskioldia sanguinea, Hypericum oblongifolium, Inula cappa, Inula cuspidata, Jasminum humile, Reinwardia indica, Sambucus nigra, Spiraea corymbosa* and *Woodfordia fruticosa* from mid hills. The ornamental plant parts, viz., flowers, flowering shoots or shoots have been dried in solar dryer, hot air oven, microwave oven, and at room temperature, with or without desiccants, viz., silica gel, river sand, saw dust and boric acid under different temperatures for varied duration. The ornamental plant parts of these shrubs were subjected to 20 treatments. Based on colour, shape and texture, these dried plant parts were given scores and best drying methods (treatments) have been worked out for individual species. In the present paper all the methods for drying of ornamental plant parts of these shrubs have been discussed. Further, the dried ornamental plant parts have been used in preparing various floral crafts.

VI-4. Effect of edible dyes on flower colouring of tuberose (*Polyanthes tuberosa* Linn.) cv. 'Single Local' and 'Double Local'.

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An investigation was carried out to study the value addition in tuberose spikes by artificially colouring them using different water soluble edible dyes. It was possible to induce various shades of pink, yellow, and blue colours by using dyes, Carmosine Red, Tartrazine Yellow, and Phalsa Blue, respectively. The investigation was carried out in four sets of experiments, the first three consisting of individual dyes and the fourth one with individual dyes mixed with 8HQ. It was observed that the time taken for absorption is dependent on the time of immersion of spikes in the dye solution and the dye concentration. Higher the concentration and more the time of immersion, quicker and deeper shade of the dyes is obtained as compared to lower dye concentration and lesser time of immersion. In the first three sets of experiment in which only dye was used, no significant effect on the vase life and opening of florets was noticed and here the immersion time of 6 and 9 hours and dye concentration of 0.25 per cent and 0.30 per cent were found beneficial for commercial purpose. In the fourth set of experiment in which 8HQ was used, it was observed that the dye was absorbed quickly and the deepest tinge of shade in all the dyes was obtained within 3 to 5 hours of immersion. Also a significant effect of 8HQ was observed on the vase life and opening of number of florets per day. When 8HQ is mixed with the dyes, it can be commercially utilized as the time of immersion is reduced significantly with a beneficial effect on the vase life.

VI-5. Grasses and sedges – with a new look in flori business

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Kerala, being a humid tropical high rainfall area, the diversity in plant species is quite high, comprising of a wide variety of ornamental trees, shrubs, climbers and herbaceous plants. Awareness of the beauty and utility of these species is lacking. In the present study, twenty two grass weeds belonging to the family Poaceae and Cyperaceae were collected and evaluated for their suitability in dry flower arrangements. The plants, *Saccharum spontaneum, Themeda triandra, Cymbopogon caesius, Eragrostis uniloides and Pennisetum purpureum* have beautiful plumes where as plants like *Apluda aristata, Chioris barbata* and *Paspalidum flavidum* bear inflorescence with graceful spikelets. Plants like *Bulbostylis barbata* and *Cyperus articulatus* are readily recognizable as the whole plant itself, is very attractive. These plants/plant parts require a warm, clean, well-ventilated dark area with low humidity for proper drying. They can be used in dry floral crafts as fillers to increase the volume and size of the bunch and also to provide colour contrasts in diverse floriculture products.

VI-6. Studies on the technology for dry flower production of gerbera (*Gerbera jamesonii* Bolus ex Hook.F)

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Gerbera jamesonii Bolus ex Hook.F commonly known as Transvaal daisy or African daisy or Barberton daisy belongs to the family Asteraceae. It is grown throughout the world in a wide range of climatic conditions. It is most commonly used worldwide as a cut flower and occupies fourth position among the top ten cut flowers. But its potential to be used in dry decorations has not been exploited widely. Therefore, a study was undertaken to standardise the technology for dry flower production in *Gerbera.*

Four critical stages namely, tight bud stage, half bloom stage, full bloom stage and over bloom stage were studied under different methods of drying. The results revealed that full bloom stage is ideal for effective drying. This stage recorded exceptionally high cumulative score for aesthetic and visual qualities viz., brittleness, brightness and colour fading characters under microwave oven drying method compared to all other stages. Among the other drying methods, silica gel drying also retained aesthetic parameters.

Attempts were also made to standardise the microwave oven drying method using various desiccants for commercial exploitation. The flowers embedded in fine clean white sand, in an upright position in microwave safe open container (glassware) retained aesthetic parameters when dehydrated for 6 to 7 minutes. The container after taking out of oven was left at room temperature for 20 to 30 minutes for setting. This method was the fastest among all the methods and the quality of the product was also excellent. It has got tremendous potentiality as a suitable substitute for fresh flower for interior decoration as well as for a variety of other aesthetic and commercial purposes.

VI-7. Identification and standardization of plant species as dry flowers suitable for Kodaikanal

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Dry flower production is one of the important techniques, by which, various plant species can be preserved for long period without affecting their colour, form and texture. Experiments were conducted at Horticultural

Research Station, Kodaikanal during 2002 to standardize the technology for dry flower production using different locally available flowers and grasses with three drying methods viz., sun drying, shade drying and oven drying. Observations on moisture loss, change of colour and form, change of texture and retentivity of the dried materials were made to identify the suitable plant species as dry flowers for Kodaikanal. The ten flowers, *Achillea, Helichrysum, Buddleya, Salvia,* lupin, marigold, golden rod, *Alstroemeria, Hydrangea* and daisy were subjected to sun, shade and oven drying. *Helichrysum,* lupin, *Salvia* and golden rod have retained their colour and form in all methods of drying and were identified as suitable dry flowers for Kodaikanal. There was change in texture for all flowers except *Helichrysum.* The retentivity of the dried materials was good in all the flowers except daisy. Among various plant materials tried, *Podocarpus, Cyperus* (vegetative), *Cyperus* with pod, burnish, *Thuja* and *Euonymous* were found to be suitable for dry arrangement in terms of quality after drying.

VI-8. Standardization of drying techniques for chrysanthemum (*Dendranthema grandiflora* Tzvelev cv. Button Type Local) flowers

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Dry flowers constitute 70 per cent of the export of Indian floricultural products, since they can be used in many ways and they are biodegradable, eco-friendly, long lasting and can be made available through out the year. Chrysanthemum (*Dendranthema grandiflora* Tzvelev cv. Button type local) flowers are more popular among the florists as they are available in wide sprectum of colours, different shapes, size and forms. Studies were conducted to standardize the method of drying, to determine optimum drying periods with different levels of micro power in microwave oven and optimum concentration of citric acid for better quality of dry flowers in terms of colour, texture, shape and overall acceptability.

The results of the experiment on the effect of different drying methods on quality of dry flowers revealed that best quality dry flowers were obtained by microwave oven drying with powdered silica gel as an embedding medium and the best results were obtained when flowers were dried at 80 per cent micro power level for 120 seconds and over all acceptability of the flowers was better when the flowers were treated with 400 ppm citric acid.

VI-9. Performance of ornamental plants as interior decorators in water medium

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Experiment on the performance of different ornamental plants as interior decorators in water medium was taken up at the post graduate laboratory, Department of Horticulture, B.A. College of Agriculture, Gujarat Agricultural University, Anand during 1998-99. The experiment was taken up in a completely randomized block design with three replications. Fifteen different plant species were taken as treatments i.e. Aglaonema (*Aglaonema marantifolium tricolor*), Pothos (*Pothos jambe*), Monstera (*Monstera oblique expilata* [leichtlinii]), Eranthemum (*Eranthemum nervosum)*, Dracaena (*Dracaena hookeriana* 'Rothiana'), Syngonium (*Syngonium podophyllum* 'Emerald Gem' [juv.]), Pilea (*Pilea serpillaceae*), Tradescantia (*Tradescantia blossfeldiana*), Purple Heart (*Setcreasea pallida*), Verbena (*Verbena peruviana* 'Chiquita'), Peperomia (*Peperomia obtusifolia*), Coleus I (*Coleus biumei* 'Rainbow Red'), Coleus II (*Coleus blumei* 'Vicoria'), Philodendron (*Philodendron craentum*) and Zebrina (*Zebrina purpusii).*

Maximum increase in number of leaves was found in Pothos (61.6%) followed by Zebrina (25.02%) and Syngonium (17.78%), while maximum increase in plant height was with Tradescantia (98.29%) followed by Peperomia (63.49%) and Zebrina (39.16%). Increase in root length was found to be maximum in

Tradescantia (76.68%) followed by Zebrina (62.35%) and Purple Heart (25.52%). Maximum total water uptake during experiment was found in Pothos (332.16 ml) and Syngonium (272.54 ml), whereas minimum water uptake was in Peperomia (21.29 ml) and Tradescantia (38.61ml). During initial foliage grading (out of 10 marks) Coleus I (8.00) followed by Dracaena (7.33) and Peperomia (7.26) were found to be best, while in final foliage grading (out of 10 marks) Pothos (7.46), Zebrina (7.26) and Syngonium (7.13) were found to be best. It is recommended that the plant species like Coleus I, Coleus II and Verbena are not suitable as interior decorative plants, while all other plants can be well grown for interior decoration in water media.

VI-10. Post harvest treatments for value addition in celosia

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In the recent past, post harvest management of flowers has been receiving greater attention. Considering the emerging need and the existing gaps, value addition in a traditional flower, namely, celosia was taken up at College of Horticulture, Kerala Agricultural University, through post harvest treatments like bleaching and dyeing for product diversification in dry flower industry. Celosia flowers were subjected to bleaching agents like calcium hypochlorite, sodium hypochlorite and hydrogen peroxide at different concentrations. Among the bleaching agents tried, hydrogen peroxide 30 per cent took six hours and scored high in terms of brittleness of flower and bleaching qualities and recorded least damage. The ratings for all aesthetic parameters were low for flowers treated with calcium hypochlorite. Hypochlorite bleaching resulted in cellulose damage and yellowing.

There were detectable differences among the different colour groups of dyes tested, with regard to the colour intensity and the level of colour fading on storage. The Vat group performed the best and recorded high score for visual aesthetic qualities. Under the Vat group, Basic Rhodomine, Basic Auromine Yellow and Methylene Blue were the suitable dyes for Celosia.

VI-11. Standardisation of technology for the dry flower production in China aster *(Callistephus chinensis Nees)*

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China aster *(Callistephus chinensis Nees.)*, a native of China and Japan is well known as a cut flower with diverse and beautiful range of colour shades. But, its potentiality in dry decorations has not been exploited in Kerala. Hence, attempts were made at College of Horticulture, Kerala Agricultural University, Vellanikkara to standardize the technology for dry flower production. Four critical stages, namely tight bud, half bloom, full bloom and over bloom stages were studied under different methods of drying after embedding. The results revealed that full bloom stage is ideal for effective drying. This stage gave high cumulative score for visual and aesthetic qualities, namely brightness, brittleness and colour change under shade drying. Among the different drying methods, microwave oven drying also retained the quality. The time taken for drying varied from four minutes (microwave oven drying) to five days (shade drying).

Studies were also conducted to standardize shade drying using different desiccants (fine clean white sand, silica gel powder, silica gel crystals, borax and sand: borax at 1:1 ratio) for commercial exploitation. Flowers embedded in fine clean white sand for five days proved to be cost effective with exceptionally high cumulative score for visual and aesthetic qualities.

VI-12. Cut foliage – an evergreen tool for diversification in commercial floriculture

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Among all forms of agri-business activities, floriculture is the most dynamic. Floriculture industry the world over is changing shape to accommodate the widest variation in order to cope with the changing fashion. Of the tools tested to achieve this diversity, cut foliage sector is the recent one. Also known as cut greens, they are used as fillers in bouquets, flower arrangements, etc. in combination with cut flowers. The important producers are Latin American Countries, the USA, Spain, Kenya and Sri Lanka.

Unlike with cut flowers, there is year round demand for cut foliage in Europe, the USA and Japan. However, during the cooler months, which extend to over six months, production in these regions is very low whereas demand is high. Production in India will be practically year-round because of the varied agroclimatic conditions. The investment cost is also low, compared to cut flowers. The risk of damage during transport is also minimum.

Tropical cut foliage is an important part of florist industry. The potential of cut foliage as an alternative to flowers, particularly during the lean period; the opportunities in the country, especially in the homesteads of Kerala; important species tested and their features etc are discussed.

VI-13. Studies on dehydration of *Gomphrena globosa* flowers

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Dried flowers are gaining popularity for aesthetic beauty, easy handling. They are long lasting and eco-friendly. Dried flower quality is greatly influenced by crop, season, cultural practices, harvest stages and drying methods. Hence, dehydration study was taken up with flowers of Bachelor's button *(Gomphrena globosa)*. Globose flower heads of magenta colour were harvested at 25 per cent, 50 per cent and 75 per cent of true flower visible stage. Drying methods used were sun, shade and oven drying. Observation on drying rate, dry weight, flower size, colour, floret shedding, display quality, and shelf life revealed that quality of flowers harvested at 50 per cent of true flowers visible stage, dried under shade, were found better in arrangements and *pot pourri* over flowers of other treatments.

VI-14. *Musa coccinea* and other ornamental Musa sp. : New flower crops for Kerala

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Ornamental *Musa* sp. are shade loving monocots preferring a warm humid climate. They have showy inflorescence with adequate vase life for use as cut flowers. They are particularly suited for Kerala where land is scarce and the cropping pattern is dominated by perennial trees.

Musa velutina comes under the wild sp of banana, under the section Rhodoclamys. Male buds and fruits are showy. The bracts are pink-purple on the outside and red on inner side. The mature fruits are orange, red, pink or purple; Bunches point upwards, are erect and the fruits are slightly curved or straight.

Musa coccinea comes under the section Callimusa. It bears brilliant orange inflorescence, which remains on the plant for months together. The flower head is erect with fiery red bracts, yellow at tips and with yellow flowers. It has long vase life making it a valuable cut flower.

Musa laterita comes under the section Rhodoclamys. The male buds are showy. The flower head is erect with red bracts homogenous to the base and bears orange flowers.

VI-15. Dehydration of chrysanthemum flowers (*Chrysanthemum morifolium* Ramat)

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Investigations were carried out to standardise the media, temperature and duration for embedded dehydration of chrysanthemum cv. Vasantika, a yellow coloured Korean double variety. Flowers were embedded in glass trays and kept in oven for drying using six media (river sand, silica gel, a mixture of river sand: silica gel; 75:25, 25:75, 50:50 and sand) at four temperatures (30, 40, 50 and 60°C) and three different durations (24, 36 and 48 hrs.) of drying in hot air oven. Observations revealed that proper weight loss, moisture loss and carotenoid loss in dried flowers was found with silica gel and 25:75; river sand: silica gel at 50°C for 48 hrs. of drying. The shape of petals was found normal in silica gel as compared to other media, whereas, maximum number of curly petals was observed with sand and river sand. On the basis of overall general appearance, excellent dried flowers were obtained in silica gel at 50°C for 48 hrs followed by good quality dried flowers in 25:75; river sand: silica gel at 50°C and silica gel at 50°C for 36 hrs. Poor quality flowers were obtained in sand and river sand.

Session VII

Post harvest handling

VII-1. Enhancement of keeping quality in commercial cultivars of gladiolus

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Two commercial cultivars of gladiolus (American Beauty and Novalux) were treated with different formulations of holding solutions applied at different concentrations. Amongst the eight treatments applied, the treatment containing sucrose (4%) + $Al_2(SO_4)_3$ (300ppm) + NaOCl (25ppm) was found best to improve shelf life parameters *viz,* overall vase life, per cent floret opening and size of floret.

VII-2. Post harvest behaviour of chrysanthemum cv "Yellow Fiji" as influenced by growth regulators and packing methods

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The investigation on different packing methods on post harvest behavior of chrysanthemum cv "Yellow Fiji" was carried out at TNAU, Coimbatore during 2000-2001 with newspaper, newspaper with ethylene absorbent, cotton dip in sucrose 3 per cent, benzyl adenine 50 ppm, hydroxy quinoline 500 ppm, Bavistin 0.2 per cent and packed in poly sleeve, poly sleeve with holes, brown paper and control. In poly sleeve packing pulsing treatment with sucrose enhanced the vase life upto 10 days. Floret opening was recorded to be 8.10 per cent and flower diameter 6.62 cm. This treatment reduced physiological weight loss by 14.93 per cent. In flowers packed in poly sleeve after pulsing treatment with sucrose, carotenoid content was recorded to be as high as 1.60ug /100 g.

VII-3. Studies on pulsing in *Dendranthema grandiflora cv.* "Yellow Fiji"

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The investigation on different pulsing treatments on post harvest handling of chrysanthemum cv "Yellow Fiji" was carried out at TNAU, Coimbatore during 2000-2001 with pre cooling at 7°C for 6 hours, hot water treatment at 50°C for 10 seconds, sucrose (2, 3, 4 %), benzyl adenine (25,50,75 ppm), hydroxy quinoline (250, 500, 750ppm), bavistin (0.1, 02, 0.3 %), and distilled water as control. Treatment with sucrose 4 per cent was found to be promising as this recorded high rate of floret opening (7.94 per cent), flower diameter (9.57 cm) and maximum vase life (18 days). Parameters such as water uptake and carotenoid content were also found to be high, 7.94 g/stalk and 2.60 ug/l00g, respectively.

VII-4. Effect of harvesting stages and chemical preservatives on the post harvest life of golden rod (*Solidago canadensis* L.)

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The effect of different harvesting stages viz., unopened stage with fully mature buds (H_1), 25 per cent opened stage (H_2) and 50 per cent opened stage (H_3) and chemical preservatives with three levels of concentrations viz., sucrose (1%, 2% and 3%), sucrose 2 per cent + $Al_2(SO_4)_3$ (0.03%,0.06% and 0.09%), sucrose 2 per cent + $AgNO_3$ (0.015%,0.03% and 0.045%) and sucrose 2 per cent + 8-Hydroxy quinoline (0.01%,0.02% and 0.03%) were studied with a view to enhance the post harvest life and quality of golden rod panicles. It was observed that less advanced stages, both unopened stage and 25 per cent opened stage recorded higher panicle weight, delayed senescence and enhanced vase life along with good quality maintenance. Among chemical preservatives, sucrose 2 per cent + 8-HQ 0.03 per cent showed significantly enhanced floret opening as well as vase life. The treatment combination of unopened stage and 25 per cent opened stage with sucrose 2 per cent + 8-HQ 0.03 per cent exhibited excellent flower quality with excellent flower colour maintenance, turgidity and freshness. Both the treatments showed cent per cent flower opening in panicle, recorded highest useful vase life (10.66 and 8.77 days, respectively) and total vase life (13.33 days, in both). Both these treatments can be recommended for enhancing post-harvest life and quality of golden rod flowers *(Solidago canadensis* L.).

VII-5. Carotenoids in marigold flowers: their importance and biosynthetic pathway

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Marigold is extensively used in making garlands, social functions and religious offerings and dry flower making, apart from its use in landscape gardening as flowerbeds and borders or even as potted plants. Xanthophylls are the major carotenoid fractions in the petals of marigold flowers, of which lutein accounts for 80 to 90 per cent of the total xanthophyll content. Dry petals contain about 90 per cent (w/w) carotenoids. The natural marigold carotenoids are the major source of pigments for colouring poultry feeds and are commercially used for pigment deposition and for colouring food products in place of synthetic colours. Further, dietary carotenoids have been produced as agents for the prevention and treatment of several illnesses such as cancer and photosensitive diseases. It has also been reported that purified extract of marigold petals, containing lutein dipalmitate is marketed as an ophthalmologic agent under the trade name, 'Adaptinol' and thus, the carotenoid pigments have considerable economic value. Industrial uses of carotenoids include pharmaceuticals, food supplements, animal feed additives and colorants in cosmetics. Zeaxanthin has greater demand in international market and fetch higher price of US $ 200/ g of the pigment on an average, while lutein costs $18-20/g of the pigment. Biotechnological interventions may help us to produce more of zeaxanthin. In this paper, different carotenoids present in marigold flowers and biosynthetic pathways of these carotenoid pigments in plant are presented and discussed.

VII-6. Post harvest studies on tropical cut foliage species

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Tropical foliage plants have been exploited for their ornamental value as interior plant decorators and also in flower arrangements and bouquets. However, the suitability of foliage plants as cut foliage has

been less investigated under humid tropical conditions where they grow extensively. Hence, a work was undertaken to assess the effect of pulsing and holding treatments on the vase life of twenty-seven foliage species.

Results of the pulsing treatments of cut foliage with sucrose (5%), $AgNO_3$ (50 ppm, 100 ppm), HQC (200 ppm, 400 ppm), acidified water (pH 3.5) and filtered water (control) for a duration of 3 and 6 hrs, and hot water dip at 50°C and 60°C for 5 seconds, revealed that all the treatments were statistically on par. The highest value for vase life (50.33 days) was recorded in pulsing with filtered water for 3 hrs.

Among the holding treatments with sucrose (5%), HQC (100 ppm, 200 ppm), $AgNo_3$ (25 ppm, 50 ppm), acidified water (pH 3.5) and filtered water (control), holding in acidified water gave the maximum vase life (35.44 days), which was on par with that in filtered water (34.40 days). Both were significantly superior to all the other treatments.

Studies on the combination of pulsing and holding treatments revealed that all the pulsing treatments along with two holding treatments (tap water and filtered water) were superior. Keeping the foliage in tap water (pH 3.5) was found to be the most cost-effective besides being eco-friendly.

VII-7. Post harvest life of cut tuberose spikes as affected by GA_3, NAA and sucrose treatments.

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With a view to enhance the vase life and quality of tuberose cut flowers, the cut spikes were kept in vase solutions of GA_3 (50 and 100 ppm), NAA (50 and 100 ppm) Sucrose (2% and 4%) and distilled water (control). Four per cent concentration of sucrose was observed to be most effective in promoting water uptake, vase life (9.72 days), floret opening, rachis length, diameter and length of florets, while sucrose at 2% concentration showed superiority with regard to fresh weight of spikes. The quality of cut spikes was also significantly improved with GA_3 treatments as compared to NAA.

VII-8. Enhancement of vase life of *Dendrobium* varieties

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Dendrobium hybrids are the most popular among the orchids commercially grown in Kerala and occupy a prominent place in the cut flower export market. Though orchids have greater longevity than almost all other cut flowers, post harvest treatments improve the flower quality, vase life, flower value and ultimately consumer satisfaction. Hence, a detailed investigation was undertaken to study the effect of various port-harvest treatments on vase life of *Dendrobium* hybrids. Post-harvest treatments like conditioning, pulsing and use of holding solutions in freshly cut and pulsed inflorescences were conducted in *Dendrobium* cv. 'Sonia' as four different experiments. The best treatments of these experiments were tried out in three other *Dendrobium* varieties, viz., 'Walter Oumae', 'Mary Trowse' and 'Candy Stripe'. Sugar content of flowers and stalks, fresh and dry weight, water content and size of flowers, spike bending and petal colour variations were also recorded.

The treatments significantly improved vase life of all the varieties when compared to the control. In *D.* cv. 'Walter Oumae' and *D.* cv. 'Mary Trowse', conditioning with tap water altered to pH 3.0 + pulsing sucrose 4 per cent + 400 ppm 8 Hydroxy quinoline (HQ) + holding solution [sucrose 2% + 400 ppm of 8 HQ + 30 ppm AgNO3] resulted in the maximum vase life (11 days) of inflorescence. However, in *D.* Candy Stripe a similar conditioning + pulsing treatment with a different holding solution [sucrose 6 % + 300 ppm of 8 HQ + 20 ppm AgNO3] gave maximum vase life of 13 days.

VII-9. Vase life and quality of China aster cv. 'Shashank' flowers as influenced by holding solutions

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A study was undertaken to find out the effect of holding solutions viz. 8-HQC (200ppm) + sucrose (1%), 8-HQC (200ppm)+sucrose (2%), 8-HQC (200ppm)+sucrose (3%), $AgNO_3$ (20ppm)+ citric acid (75ppm)+sucrose (1%), $AgNO_3$ (20ppm)+ citric acid (75ppm)+sucrose (2%), $AgNO_3$ (20ppm)+ citric acid (75ppm)+sucrose (3%), $Al_2(SO_3)_4$ (400 ppm) + sucrose (1%), $Al_2(SO_3)_4$ (400 ppm) + sucrose (2%) and $Al_2(SO_3)_4$ (400 ppm) + sucrose (3%) on vase life and quality of China aster flowers. All the treatments were found beneficial in increasing vase life and quality of cut flowers over the control (tap water). The maximum vase life (15.88 days) and solution uptake (40.13ml at senescence) was recorded under 8-HQC (200ppm)+sucrose (1%) over the control (8.42 days and 25.22ml, respectively). The fresh weight of cut stems increased at 3rd and 6th day in vase but declined at senescence day and similar changes were recorded on dry weight also. The maximum increase in flower diameter (7.35 cm) was recorded under $AgNO_3$ (20ppm)+ citric acid (75ppm) + sucrose (3%) over the control (5.99cm). Hence, it can be concluded that holding solution containing 8-HQC (200ppm) + sucrose (1%) was the best in prolonging vase life of China aster cut flowers followed by 8-HQC (200ppm) +sucrose (2%).

VII-10. Effect of stem length and panicle weight on postharvest quality of golden rod (*Solidago canadensis* Linn.)

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Effect of stem length and panicle weight of golden rod on postharvest quality was studied in the laboratory (ambient condition) of Department of Horticulture, B.A.College of Agriculture, G.A.U., Anand during 2001. Stem length from L_1-10 cm to L_9-50 cm with 5 cm intervals (L_2-15, L_3-20, L_4-25, L_5-30, L_6-35, L_7-40, L_8-40 cm) and weight of panicle W_1 (15-20 g), W_2 (25-30 g) and W_3 (35-40 g) were taken to constitute 27 treatment combinations. Experiment was laid out in completely randomized design with 3 replications. Stem length of 50, 45 and 40 cm, panicle weight of 35-40 g and interaction of 45 cm or 50 cm stem length with 35-40 g panicle weight showed higher water uptake and more number of open inflorescence per panicle. Maximum vase life was observed in 50 cm stem length (8.78 days) and was at par with 45 cm stem length (8.56 days). Least degradation in quality was noticed in 45 cm stem length and 35-40 g weighed panicle.

VII-11. Effects of biocides, nutrient salts and silver thiosulphate on keeping quality of cut roses

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Freshly harvested cut stems of seven commercial cultivars of rose, i.e. Grand Gala, Sangria, First Red, Kiss, Confidence, Starlite and Pareo were procured form a commercial grower and trimmed to uniform length of 40 cm under water to remove air-embolism. The stems were put in vase solutions comprising of varying concentrations of aluminium sulphate, chlorine, citric acid, 8-hydroxtquiniline citrate, calcium nitrate, potassium dihydrogen orthophosphate, potassium metabisulphite and silver thiosulphate. In all the cultivars, aluminium sulphate (300 ppm) and chlorine (50 ppm) significantly improved vase life of cut stems. Chlorine beyond 50 ppm proved phytotoxic. These two chemicals also significantly controlled

growth of bacteria in the vase water. The salt 8-hydroxtquiniline citrate, though significantly inhibited growth of bacteria in vase water, did not improve vase life. Citric acid, calcium nitrate and potassium dihydrogen orthophosphate also proved ineffective as far as reduction in bacterial count and enhancement of vase life are concerned. Potassium metabisulphite, though inhibited bacterial growth, had rather inhibitory effect on vase life. The response of cultivars to silver thiosulphate was variable. It improved vase life in Grand Gala, Sangria and Kiss, but had non-significant effect in cultivars First Red, Confidence, Starlite and Pareo. The study revealed that ethylene-sensitive cultivars should be treated with suitable ethylene inhibitors for improving their vase life.

VII-12. Effects of harvesting stage, seasonal variation and endogenous carbohydrate level on keeping quality of gladiolus cultivars

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Spikes of three cultivars of gladiolus, viz. Suchitra, Sancerre and White Prosperity were harvested on October, 25, January 10 and April 23, respectively, at two stages of development, viz. S1, when 1-2 basal florets showed colour and S2, when 5-6 florets showed colour. In all the cultivars, stages of harvest significantly affected the keeping quality parameters. Spikes harvested at S1 took longer time for the opening of the basal floret, exhibiting less vase life, floret size and floret opening than the S2 stage. Spikes harvested in the months of October and April exhibited less vase life, smaller florets and low percentage of opening of florets. Among the three cultivars included in the experiments, Suchitra recorded the lowest vase life whereas White Prosperity, the maximum. It is thus, evident that the seasonal variations significantly affected keeping quality of the spikes in different cultivars of gladiolus. The florets from spikes harvested in October, January and April were also used for the estimation of starch, total soluble sugars and reducing sugars. Starch content was low in October and April but high in January. Moreover, it was also higher at S1 than at S2. On the contrary, content of total soluble sugars was low at S1 than at S2. The content was also low in October and April but high in January. Cultivar White Prosperity had the maximum total sugar content at S2. Reducing sugar content of florets showed trends similar to that of total sugars. It thus, indicates that spikes exhibited higher starch content at S1, and higher total soluble and reducing sugar contents at S2.

VII-13. Evaluation of various genotypes of rose for vase life

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Shelf life of thirty-five rose varieties has been evaluated which were grown under dry subtropical climate of Punjab. The varieties Jadis, The Lady, Golden Giant, Mrinalini, Raktagandha, Raktima, Angelique and Jawani performed well with respect to floral characters and vase life. However, the performance of varieties Mrs.K.B.Sharma, Nefertiti, Mary Antoinette, Portrait and Waikeke was poor under Punjab conditions.

VII-14. Influence of aluminium on post harvest physiology of gerbera

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The effect of aluminium with or without sucrose on the post harvest physiology of cut flowers of gerbera cv. Sath Baba was investigated. Flower stalks obtained from a crop under standard cultural practices were kept in solutions containing two concentrations of aluminium sulphate (0.5 and 1.0mM) with and without sucrose (3, 5 and 7%). It was observed that aluminium sulphate treated flower stalks maintained

higher fresh weight for longer time. By the end of the 12th day, only aluminium sulphate 1mM + sucrose 7 per cent maintained fresh weight higher than the initial value. Aluminium sulphate was found to reduce the pH of the vase solution. It also increased both water uptake and water loss, but helped to maintain a better water balance. The investigation revealed that aluminium sulphate in general, enhanced the vase-life of gerbera flowers. The highest vase-life of 12.66 days was seen in the combination treatment of aluminium sulphate 1mM + sucrose 7 per cent.

VII-15. Effect of harvesting time and panicle weight on post harvest quality of golden rod (*Solidago canadensis* Linn)

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An experiment was conducted in laboratory condition (ambient) to study the effect of harvesting time and panicle weight on post harvest quality of golden rod (*Solidago canadensis*) at Department of Horticulture, B.A.College of Agriculture, Gujarat Agricultural University, Anand during 2001. Golden rod flowers were harvested every two hours interval starting from 6 am (T_1 - 6 am to T_{12} - 4 am) corresponding to three levels of panicle weight, i.e., W_1 (15-20 g), W_2 (25-30 g) and W_3 (35-40 g) to make a total of 36 treatment combinations. Completely randomized design was used with 3 replications.

The results indicated significant differences for time, weight and their interactions for water uptake, number of open inflorescence/ panicle, vase life and grade of flowers, while non-significant differences were noticed for total number of inflorescence/ panicle. Maximum vase life of panicle was observed at 4 pm hrs harvested (10.44 days) and 35 to 40 g weighed inflorescence (9.19 days).

VII-16. Influence of major nutrients and post harvest treatments on the post harvest life of bush jasmine (*Jasminum sambac.* Ait)

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The influence of major nutrients in combination with post harvest treatments was studied in a field experiment conducted in factorial CRD Design. Phosphorous applied at 600 kg; ha^{-1} prolonged the shelf life of buds. In ethylene absorbant treated buds, longest shelf life was recorded with the treatment of 450 kg ha^{-1} nitrogen, 600 kg ha^{-1} P_2O_5 and 450 kg ha^{-1} of K_2O. The effect of nutrients on flower buds treated with ethylene absorbants and newspaper lining was found superior at 450kg ha^{-1} of nitrogen and P_2O_5 and K_2O applied at 600 kg ha^{-1} Buds treated with ethylene absorbant took significantly longer time for opening. The time taken to retain colour and turgidity of flowers was maximum in case of buds exposed to low temperature treatment, though the buds failed to open.

VII-17. Studies on post harvest physiology of gladiolus

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Investigations were carried out to extend the vase life of cut gladiolus cultivars 'American Beauty', 'White Prosperity', 'Rose Spire', 'Nazrana', 'Sylvia' and 'Kum Kum' using different chemicals, sucrose and packaging materials during the year 2000-01. The prime objectives were to evaluate and standardize optimum concentration of vase solution for gladiolus cultivars alone or in combination with sucrose. Studies included the use of aluminium sulphate, calcium nitrate, zinc sulphate, silver nitrate and citric acid each at 100 and 200 ppm.

Treatment with different concentrations of silver nitrate drastically increased vase life, the diameter and opening of the florets with aluminium sulphate, zinc sulphate and calcium nitrate over control. Though all the chemicals used seemed to have beneficial effects in terms of better water relations and extended vase life, aluminium, silver and citric acid were more effective than calcium and zinc. Chemicals on combining with sucrose at 4.0 per cent further enhanced the water uptake by cut spikes of gladiolus. Sucrose when combined with the chemicals improved water balance of treated spikes compared to sucrose alone (4%), as a result of which maintenance of fresh weight was better in treated spikes.

Packaging of gladiolus spikes maintained higher percentage of fresh spikes compared to non-packaged control spikes. Packaging was found beneficial to obtain optimum humidity, which in turn, slowed down the process of evapotranspiration and maintained proper balance of carbon dioxide and oxygen concentrations, which slowed down the process of respiration. Packaging of gladiolus spikes in cardboard boxes was found to be very effective and it recorded highest storage life.

VII-18. Post harvest quality of cut flowers of rose 'Happiness' as affected by pulsing treatments

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The cut stems of rose cv. "Happiness" were pulsed with distilled water (control) 60 ml, sucrose, sucrose + silver nitrate ($AgNO_3$), sucrose + aluminium sulphate, cobalt chloride, calcium chloride, dimethyl sulphoxide (DMSO) and citric acid at various concentrations for different durations. From the different experiments, it has been concluded that pulsing with 3 per cent sucrose for 12 hours, 3% sucrose + $AgNO_3$ (50 ppm) for 24 hours, 3% sucrose + aluminium sulphate (300 ppm) for 20 hours, 1 per cent calcium chloride for 20 hours, 2.5 per cent DMSO for 1 hour and citric acid, (250 ppm) for 24 hours were found to be beneficial for improving the post harvest life and quality of cut flowers of cut rose. Among all the experiments, it was observed that pulsing with 3 per cent sucrose + $AgNo_3$ (50 ppm) extended the vase life at all durations of treatment. However 3% sucrose + $AgNo_3$ (50 ppm) was the most effective treatment.

VII-19. Studies on refrigerated dry storage of cut spikes of gladiolus cv. White Prosperity

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The spikes of gladiolus cv. 'White Prosperity' were harvested when basal floret showed color, put in water and precooled at 4°C for 6 hours. These were then bunched with 3 spikes per bunch, tied loosely at the base with a rubber band and stored in sealed polypropylene sleeves. The bunches were then packed in fiberboard boxes with circular vents on each sidewall covering an area of 4 per cent. These boxes were then stored erect in the cool chamber at 4°C for different durations. The post harvest parameters were studied in distilled water and sucrose (4%)+Al_2 $(SO4)_3$ (300ppm) +NaOCl (25ppm) solution. Maximum vase life of 11.36 days was recorded when fresh flowers were kept in sucrose (4%)+$Al_2(SO_4)_3$ (300ppm) + NaOCl (25ppm) solution. Vase life decreased significantly with the increase in storage duration. Minimum vase life of 3.18 days was recorded when spikes were stored for 12 days.

VII-20. Influence of storage temperature of bulbs on growth and flowering in tuberose (*Polianthes tuberosa* L.)

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A pot experiment was conducted to study the influence of storage temperature on growth and flowering in tuberose cv. Tindugul Local. The experiment consisted of storing the bulbs (small, medium and large) in different temperatures, viz., 2.5, 5.0, 10.0, 20.0, 30.0°C and at ambient condition for three different duration (10, 20 and 30 days). The experiment was carried out in FRCD with eighteen treatments in three replications. The results revealed that large sized bulbs stored at 10.0°C for 30 days resulted in highest plant height, number of leaves per clump and recorded earliness in flowering.

VII-21. Effect of chemicals on extending vaselife and quality of rose cv. Gladiator

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A study regarding the effect of sixteen different treatments (including one control), consisting of five chemicals used individually or in combination on the cut flower buds (1-2 petals unfurled) of Rose cv. Gladiator, was carried out during winter months (Jan-Feb) under Udaipur conditions to standardize a floral preservative. The chemicals belonged to different groups of compounds like metallic salt ($NiCl_2$), carbohydrates (sucrose), organic acid (citric acid), bactericide (8-HQC) and growth regulator (GA_3). It was observed that combined effects of these chemicals were more conspicuous than using them singly. Out of the sixteen treatments, the holding solution containing $NiCl_2$ (250 ppm) + Sucrose (2%) + Citric acid (500ppm) + 8-HQC (200 ppm) + GA_3 (150 ppm) was found to be the best not only in extending vase life (8.30 days) over control (4.03 days) but also for improving flower appearance, days for first wilting, fresh weight, flower expansion, water uptake etc. The holding solution was also found fit as a bud opener for winter months.

VII-22. Seasonal and varietal influence on the vase life of gerbera cut flowers grown under polyhouse

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Gerbera is extensively grown under shade net in polyhouse and open to produce year round quality cut flowers. Pre harvest factors like variety, environmental (temperature, relative humidity and light) and agronomic practices are known to influence the vase life of cut flowers. Under the present study, vase life of nine exotic varieties of gerbera cut flowers produced under polyhouse was recorded during all the months of 1999. During the study, temperature and relative humidity of the polyhouse and laboratory were recorded. Data revealed that vase life of all the varieties varied significantly at all the months. Maximum vase life of 13.40 days in var. Tiramisu, 10.76 days in var. Diablo, 10.20 days in var. Ornella, 10.16 days in var. Tara and 9.83 days in var. Sunset was recorded during December, 12.23 days in var. White sun and 12.20 days during June, 11.26 days in var. Twiggy during January and 10.13 days in var. Thalassa during July. Minimum vase life of vars. Thalassa (4.66 days), Twiggy and Diablo (5.33 days), Tara (5.6 days), Sun set (5.70 days), White sun (6.2 days) and Lyonella (6.4 days) during April, Tiramisu (5.96 days) during February and Orneila (5.6 days) during March was recorded.

VII-23. Effect of holding solutions on post harvest life of cut chrysanthemum (*Dendranthema grandiflora* Tzvelev) cv. Yellow Bangla

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An investigation was carried out in the Department of Horticulture, Assam Agricultural University, Jorhat to study the effect of sucrose, biocides and organic acid on the post harvest life and quality of pulsed (3% sucrose + 25 ppm $AgNO_3$ for 1.5 minutes) cut chrysanthemum spray cv. Yellow Bangla. Among the different chemicals used as holding solutions, 3 per cent sucrose + 200 ppm citric acid and 3 per cent sucrose + 300 ppm citric acid were found beneficial for improving the fresh weight, longevity of individual flower, longevity of inflorescence, per cent increase in total sugar content and delaying senescence. Maximum per cent of bud opening was observed in the treatment 3 per cent sucrose + 200 ppm HQC and 3 per cent sucrose + 300 ppm HQC. Lower respiration rate and ethylene evolution were not observed in all the treatments, except in control, 3 per cent sucrose and 3 per cent sucrose + 20 ppm $AgNO_3$.

VII-24. Post harvest life of gladiolus as influenced by storage temperature and wrapping material

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Flower spikes of gladiolus cv. American Beauty were kept in various wrapping material packets such as polyethylene, cellophane, butter paper, newspaper and packed in CFB boxes. The boxes were stored at 4°C, 10°C and ambient condition for 2, 4 and 6 days. After storage, the postharvest life of flowers were studied by dipping the spikes in a solution of sucrose 4 per cent + $Al_2(SO_4)_3$ 100 ppm + 8 HQS 200 ppm. Largest first and fifth florets, maximum fully opened florets and maximum solution uptake were recorded in cellophane packed flowers stored at 4°C followed by cellophane packed flowers stored at 10°C and butter paper packed flowers stored at 4°C at 2, 4 and 6 days after storage. Maximum longevity and longer vase life were recorded in butter paper packed flowers stored at 4°C followed by cellophane packed flowers stored at 4°C, butter paper packed flowers stored at 10°C and cellophane packed flowers stored at 10°C for 2, 4 and 6 days. Considering all the postharvest characters, cellophane was the best as packing material for floret size, opening and solution uptake while butter paper was proved to be the best for longevity of the floret and vase life.

VII-25. Vascular blockage in cut rose during the course of senescence: A SEM study

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An investigation was carried out in cut rose cv.'Super Star' through Scanning Electron Microscope in order to find out the causes for vascular blockage during the course of senescence. Freshly cut surface of rose stem showed clear vascular system with no evidence of bacteria, fungi and any kind of occluding and blocking materials. However, on third day, the rose stems held in tap-water exhibited the presence of globular bodies in some of the vessels and breakdown of secondary tissues, which advanced towards senescence and severely damaged the vascular structure with thick mass of white granular layer covering over the vessel walls.

VII-26. Minimum quality standards for cut flowers

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According to an estimate such as Austrade (Australian Trade Commission), total world trade of flowers is estimated at US$ 40,000 million and is expanding @ 15 per cent per annum. India's domestic trade is estimated at Rs. 4500 crores including traditional crops. The major trading countries are N. America and EEC accounting tor 2/3rd of the world trade. The major exporters are Netherlands, Colombia, Israel, Italy, Kenya etc. Japan is a distinct market where higher value realization for quality flowers is necessary. Roses, carnation, chrysanthemum, gladiolus and orchids are the most popular flowers. India's share in global cut flower trade is negligible because of poor quality of cut flowers. Hence, an effort is made here to provide minimum quality standards for cut flowers for flori business community to adhere to and practice.

VII-27. Regulation of flower senescence in gladiolus: biochemical and physiological aspects

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Senescence represents the final stage in the development of a whole plant, organ, tissue or cell. Flower petals are often the plant organ with the shortest life span and as such provide a useful tissue to study the mechanism underlying control of senescence. The senescence of the flower petals is associated with a series of physiological and biochemical changes. This includes an increase in hydrolytic enzymes, degradation of macromolecules, increased respiratory activity and a loss of cellular compartmentalization. Many of these processes are highly regulated and are result of active metabolism. Even though gladiolus flower spikes offer an interesting model system for study of flower senescence, studies in this direction are scarce. Individual florets provide a graded series of stages of development and senescence in identical genetic and environmental background.

Studies were made in terms of free radical production and anti oxidant enzyme system. Effects of 5 - Sulphosalicylic acid and a- Lipoic acid on the regulation of flower senescence in gladiolus are discussed.

VII-28. Influence of pulsing, wrapping and storage on the vase life of gladiolus cv. Little Prince

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Spikes of Gladiolus cv. Little Prince were packed in corrugated fibre board boxes after pulsing in 20 per cent sucrose solution for 6 hours and wrapping with packaging materials like polyethylene and newspaper for 24 hours, to ascertain the effect of these treatments on the vase life at consumers' level. One lot was kept in zero energy cool chamber (Pusa Cool Chamber) where the average temperature and relative humidity were 16 to 18°C and 88 to 90 per cent respectively, and another lot was kept under ambient condition (20 to 26 °C and 53 to 60 % RH). Pulsed spikes, in general, performed better in vase, which was reflected by increased floret opening and lesser days taken for basal floret wilting. Between the wrapping materials, polyethylene was undoubtedly better than newspaper that caused more weight loss, even higher than control in some cases. Due to lower temperature and higher humidity, the

physiological loss in weight was comparatively lower in cool chamber. Storage in cool chamber also helped in opening of florets which is depicted by higher percentage of flower opened in all treatments kept in cool chamber. Besides, the time taken for first floret wilting was also less in flowers kept in cool storage after pulsing. Thus it was considered that pulsing with 20 per cent sucrose for 6 hours and wrapping with polyethylene followed by storage in Pusa cool chamber, could efficiently improve the vase life of gladiolus cv. Little Prince, even after dry packing for 24 hours.

VII-29. Effect of pulsing, wrapping and storage on the vase life of tuberose cv. Calcutta Double.

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Spikes of tuberose cv. Calcutta Double were packed in corrugated fibre board boxes after pulsing in 20 per cent sucrose solution for 6 hours and wrapping with packaging materials like polypropylene, cellophane and newspaper for 48 hours under ambient condition (20 to 26 °C temperature and 55 to 65 % RH) to ascertain the effect of these treatments on the vase life at consumers' level. Pulsed spikes, in general, performed better in vase and among the wrapping materials, polypropylene was most effective causing least weight loss in dry packing. Thus it was considered that pulsing with 20 per cent sucrose for 6 hours and wrapping with polypropylene could efficiently improve the vase life of tuberose cv. Calcutta Double, even after dry packing for 48 hours under ambient condition.

VII-30. Effect of silver salts, sucrose and germicide on post harvest life of cut chrysanthemum cvs. White Fizii and Peach Fizii flowers

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Cut chrysanthemum (*Dendranthema grandiflora*. cvs. White Fizii and Peach Fizii) flowers grown under greenhouse condition were treated with silver nitrate ($AgNO_3$ at 10, 20, 30 ppm) and Silver thiosulphate (STS at 0.2, 0.4, 0.6 μM) individually. Thereafter, the best concentration obtained from each chemical was treated with sucrose (2 and 4%). Finally, the best combination obtained from previous experiment was treated with 8-Hydroxy Quinoline Sulphate (8-HQS at 100 and 200 ppm). Among the different concentrations tried on cv. White Fizii 0.2 μM STS, 20 ppm $AgNO_3$ + 2 per cent sucrose, 20 ppm $AgNO_3$ + 2 per cent sucrose + 100 ppm 8-HQS recorded maximum vase life of 22.2, 29.0 and 23.6 days against 17.0, 17.4 and 14.8 days in control, respectively. In case of cv. Peach Fizii, 0.2 μM STS, 20 ppm $AgNO_3$ + 4 per cent sucrose and 20 ppm $AgNO_3$ + 2 per cent sucrose + 100 ppm 8-HQS were observed to be eximious by recording 21.8, 29.0 and 28.2 days of vase life, respectively.

VII-31. Improvement of post harvest longevity of *Dendrobium* 'Sonia 17'

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Orchid is projected as cut a flower crop with great export possibilities. Kerala has been identified as a suitable region for the cultivation of tropical orchids with special emphasis on *Dendrobium*. Being highly perishable, the pre and post harvest management practices, which determine the longevity of cut flower, assume great significance.

The influence of pre harvest nutrition, stage of harvest and post harvest treatments on the longevity of cut flowers of *Dendrobium* 'Sonia 17' was studied in the Department of Pomology and Floriculture, College of Horticulture, Kerala Agricultural University under the NATP project.

The post harvest longevity of flowers was extended by the application of nutrient solution (0.2%) containing low proportion of N and high proportion of P and K (2:3:3 and 1:3:3) compared to N: P: K in 1:1:1 and 3:1:1. With regard to the stage of harvest of flower, inflorescence harvested with one bud showed significantly better longevity than that with two buds and three buds.

With regard to post harvest treatment, pulsing treatment significantly influenced the post harvest longevity of flowers. Pulsing with sucrose solution for 6 hours was the most effective treatment. The vase life could be extended from 15 days (control) to 32 days by holding in a solution containing 8 HQC 300 ppm + sucrose 6 per cent.

VII-32. Effect of post harvest application of chemicals on the physiological and biochemical changes during flower petal senescence and on vase life of cut rose (*Rosa hybrida* L.) cv. First Red

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Based on the individual performance of cut roses from a series of experiments pulsed with different chemicals at different temperatures and pulsing durations, the best treatment sucrose 4 per cent pulsed at room temperature (RT) for 24 hours was combined together with other best treatments from their respective experiments i.e., 8-HQS 300ppm at RT for 24 hours, $Al_2(SO_4)_3$ 400 ppm at RT for 24 hours and STS 0.4 mM at 10°C for 8 hours, to study the combined effect on flower opening and vase life. Among all the pulsing combinations tried, flowers pulsed with $Al_2(SO_4)_3$ 400 ppm + sucrose 4 per cent at RT for 24 hours followed by 8-HQS 300 ppm + sucrose 4 per cent at RT for 24 hours, pulsing significantly increased the flower opening, flower diameter (89.33% and 46.40%, respectively, over control) and vase life (55.48% and 46.94%, respectively, over control). These chemical combinations had a significant effect in reducing ion leakage and drop in the water potential of the flower stem, thereby maintaining membrane integrity of the cell. Further, these chemical combinations had moderate effect on the activities of membrane bound respiratory enzymes *viz.*, catalase and peroxidase activities, which led to delayed flower opening. The data on anthocyanin content also suggest that the combined effect of chemicals had a significant effect in reducing the blueing phenomenon when compared without sucrose 4%. These results showed that application of soluble carbohydrate and anti-microbial compounds in the vase water markedly reduced the microbial growth and improved the water relations in the floral tissue. The improved water and metabolite status in the floral tissue had shown a positive effect on the physiology and biochemistry of the floral tissue, there by increasing the vase life of cut rose cv. First Red.

VII-33. Influence of pulsing with $CaCl_2$ and $ZnSO_4$ and duration of dry cool storage on cut spikes of tuberose cv. Double

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An experiment was conducted to study the effect of pulsing with two different chemicals and duration of dry cool storage on cut spikes of tuberose cv. Double. A pulse treatment of sucrose (8%) + $CaCl_2$ (500 ppm) for 24 hours and $ZnSO_4$ (7.5 mM) for 6 hours were given to cut spikes of tuberose and then dry cool stored at low temperature (4-5 °C) for different duration, i.e., 4 and 5 days. Among the two different

chemicals, pulsing with sucrose (8%) + $CaCl_2$ (500 ppm) for 24 hours was found the best with respect to increase in rachis length, delay in wilting of first, third and last opened floret pair, extension of useful life, retention of fragrance, water uptake, opening of florets, increase in diameter and length of first, third and last opened floret pair and vase life over the cut spikes which were not pulsed but dry cool stored as well as cut spikes neither pulsed nor stored. Maximum vase life of 8.20 days for 4 days storage was recorded in Sucrose (8%) + $CaCl_2$ (500 ppm) for 24 hours. Hence it may be concluded that extension of useful life as well as vase life was recorded with sucrose (8%) + $CaCl_2$ (500 ppm) for 24 hours pulse treatment.

VII-34. Influence of pulsing and duration of dry cool storage on cut spikes of tuberose cv. Double

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An investigation was undertaken to study the effect of pulsing with three different chemicals and duration of dry cool storage on cut spikes of tuberose cv. Double. A pulse treatment of sucrose (10 per cent) + $Al_2(SO_4)_3$ (250 ppm) for 12 hours, sucrose (10 per cent) + STS (0.5mM) for 12 hours and sucrose (8 per cent) + 8-HQC (200 ppm) for 12 hours were given to cut spikes of tuberose and then dry cool stored at low temperature (4-5 °C) for different duration i.e. 4 and 5 days. It has been observed in general that pulsing and cool dry storage improved the post harvest life and quality of tuberose cut flowers. Among the different chemicals, pulsing with sucrose (10 per cent) + $Al_2(SO_4)_3$ (250 ppm) for 12 hours and cut spikes stored for 4 days was found best in respect to rachis length increase, delay in wilting of first, third and last opened floret pair, extension of useful life, retention of fragrance, water uptake, opening of florets, increase in diameter and length of first, third and last opened floret pair and vase life over the cut spikes which were not pulsed but dry cool stored as well as cut spikes neither pulsed nor stored. Maximum vase life of 8.90 days for 4 days storage was recorded with treatment of sucrose (10 per cent) + aluminium sulphate (250 ppm) for 12 hours.

Session VIII

Flori business

VIII-1. Prospects of floriculture Industry in Kannauj district of Uttar Pradesh

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The Kannuaj is a new district of Uttar Pradesh but is famous since Mugal period for flori-products for export including perfumes, itra, rose water, gulkand, etc. In this city, floriculture industry is getting momentum due to better economic returns. The main crops on which floriculture industry in Kannauj can flourish are desi (Chaita Gulb) rose, tuberose, marigold, gladiolus, gaillardia, jasmine, etc. For this, there is a quickest need to explore possibilities to boost up the industry related to floriculture. It can be achieved by creating infrastructure facilities like electricity, power, cold storage, cool chain, etc. which are inadequate at present with respect to post-harvest handling and marketing because flowers are highly perishable and delicate in nature. It is very much inevitable now to establish a co-operative system and to encourage the local farmers through financial help or crop insurance by the state as well as Central Government. Thus future prospects of floriculture industry is Kannauj are so much bright.

VIII-2. Study of flower market status and commercial floriculture in North East India

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Floriculture, more particularly production of flowers, has in the recent years blossomed into burgeoning commercial enterprise. The climatic conditions prevailing in Eastern Himalayan range offers the possibility of growing many cut flower species such as orchids, anthurium, *Lilium*, gerbera, gladiolus, tuberose etc. throughout the year and there is enormous potential for exporting these products to other countries world wide for commercial exploitation. The global turnover in flori-business is close to Rs 2.688 lakh crores of which even a 2 per cent contribution by the Indian floriculture industry would bring in a foreign exchange of Rs. 5376 crores into the country as against Rs 150-200 crores worth present exports.

Market survey has revealed that the annual turnover in Guwahati market, which is the only established flower market in North East India is worth Rs. 5-8 crores. The turnover during 1994 was just Rs 1 crore there by registering a 5-8 fold increase in the last 8 years. The domestic flori-business is increasing at the rate of 25 per cent per annum and reached Rs 600 -700 crores. The flowers in great demand in Guwahati market are tuberose, marigold, gladiolus and desi rose. Soil and climate of this region are very much favourable for these flower crops. The study presents the various production methods, cost of cultivation, financial, institutional and marketing aspects of these cut flowers and planting materials. Flori-business is a turning point for the economy of the north east region and the prosperity of the farmers of this region.

VIII-3. Economic analysis of production and marketing of anthuriums in India

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Anthuriums are tropical plants of great beauty and are grown under shade either for their cut flowers or cut foliage used for pot arrangements, bouquet etc. In India, anthurium cultivation is popular, in the states of Kerala, Karnataka and Tamil Nadu. Keeping in view the importance of anthuriums both in domestic and international markets, the paper examines the costs and returns associated with growing and marketing of anthurium in Karnataka and Kerala and their prospects for export.

The analysis of the data collected from Coorg district in Karnataka and Ernakulam and Trivandrum districts in Kerala indicated that in Karnataka, anthuriums are cultivated in beds whereas pot cultivation is popular in Kerala. The cost of establishment of 1000 anthurium plants consisting of shade house, pots, seedlings, material and labour inputs worked out to Rs.l.27 lakh in Karnataka and Rs.l.39 lakh in Kerala. The cost of seedlings is the major component of establishment cost in both the states. Cost of cultivation including amortised establishment cost would be Rs.49,000 in Karnataka and Rs.55,000 in Kerala. The cost of producing one anthurium stem would be Rs.8-10 in Karnataka and Rs.9-12 in Kerala. The average price received by the producer ranged from Rs. 7.5 to Rs.11/stem in Karnataka and Rs.8 and Rs.13/stem in Kerala depending upon whether the flower was sold in the local market or distant market.

Though the cost of cultivation was less in Karnataka, the net returns were also lower at Rs.l.15 and Rs.l.36/stem in Karnataka as against Rs.l.35 and Rs.l.46/stem in Kerala mainly due to higher price realized by the Kerala farmers who sold their flowers in the distant markets like Mumbai and Kolkata.

VIII-4. Pilot scale assessment of gerbera production in plains of West Bengal

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To test the commercial possibility of hybrid gerbera grown in Karnataka and Maharastra, a pilot scale experiment was conducted at Kalyani, Nadia with ten genotypes brought from Florist Gerbera, NL via Kumar Florist, Pune. Planting of seedlings was done in September 2002 in 10 inch earthen pots filled with soil, FYM mixtures at a ratio of 1:1. Pots were kept in net house, all sides open and top covered with fiberglass sheet. Flowering started from November. With respect to marketable parameters like stalk length, flower-diameter etc, all the genotypes performed equally well.

The experiment at pilot scale clearly indicated the possibility of commercial cultivation of these genotypes in all sides open field, top covered with polythene sheets to meet the growing demand of this flower at Kolkata.

VIII-5. Ornamental horticulture for beautifying our environment: present status and future prospect

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Our deteriorating environment is a growing concern and global problem. There are many ways for amelioration of environment but phyto-remediation is the best cheapest way recognised throughout the

world. The role of ornamental horticulture for beautification of our surroundings and its consequential effect on improvement of environment is well accepted by all. Urban and industrial areas are the focal places where much attention has to be paid considering highly polluted environmental conditions. It is reported that annual need of oxygen of one person is met by 40-50 sq. m. of greenaries. Of late, the awareness has come both in social and Government level regarding beneficial effect of greenaries and the plantation programme has gained momentum. Therefore, provision should be made for allocation of space for the development of greenbelt with suitable plant species. Screening of ornamental trees and plants after examining pollution tolerance capacity and their inclusion in the urban and industrial landscape plans is a primary requirement. NBRI has developed expertise on the use of ornamental horticulture as a tool for the improvement of environment out of its regular R&D activities. Pollution tolerant ornamental trees and shrubs have been screened for combating different types of pollutants. Technical advice on landscaping has been provided to many industrial houses and institutions by providing landscape plans and planting schemes. It is proposed to make plantation of trees and other plants in the residential, urban and industrial areas mandatory, so that ornamental horticulture can play a dual role of beautification and amelioration of environment. At the same time, development of ornamental horticulture will widen the future prospect of horticultural nursery business and generation of employment particularly in the rural areas.

VIII-6. Selection, analysis and landscape planning of some sites of Jorhat Town, Assam

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Study on selection, analysis and landscape planning of some sites of Jorhat town, Assam, was carried out in order to identify and select some of the potential sites of the town for landscaping. Accordingly, five sites, with four in the congested localities and one in the outskirts were selected based on their relative importance in city life and the necessity to protect these sites from encroachment and further environmental degradation. Study was made on site characteristics, location, site problems, existing plant species, their flowering periodicity, morphological characteristics, seasonal color variations, other landscape elements; and were analysed based on the principles and guidelines of landscaping. Various modifications were made based on these analyses and final plans were prepared for each selective sites. In this paper the landscape plan for one of the sites of Jorhat town will be presented.

VIII-7. A survey on orchid genetic diversity and orchid business possibilities in Andaman and Nicobar Islands

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Andaman and Nicobar has great potential of becoming a large producer of orchids, anthurium and foliage plants at National level owing to its favourable tropical warm and humid climate. However, till date Andaman & Nicobar Islands has failed to make any impact in this sector. Keeping this in view, a constant study is being conducted to survey the present diversity of the orchid genera and species in these islands under the project, NATP on Plant Biodiversity at CARI, Port Blair. The objective of study was to survey the islands of Andaman and Nicobar with a major aim to collect, catalogue, evaluate, conserve and document the diversity of orchids. Maximum diversity is reported from larger genera like *Dendrobium, Bulbophyllum, Phalaenopsis, Cymbidium, Eria, Eulophia* etc. Out of this, 25 species from 19 genera are reported as rare and threatened category and 17 as extra-Indian species. However, no efforts were made to commercialise the cultivation and export potential of orchid hybrids in these Islands. Having so many species of orchids in natural condition encourages on farm cultivation of orchids with promising export potential successfully. At present no other agricultural commodity is exported by Air Cargo to mainland India and flights go empty to mainland. A co-operative sector movement of cultivation of orchids, centralized packing and forwarding facilities with state support will help the farmers of these Islands economically. This will be the best exploitation of this highly congenial agro climate for agri business, as it is being done in the neighbouring South East Asian countries, which are very close to these Islands. A plan of execution of this is discussed in detail.

Author Index