Studies on the Insect Pest Complex of Marigold (*Tagetes* sp.) with Special Reference to Thrips *Caliothrips indicus* Bagnall (Thysanoptera : Thripidae)

RAMESH S. SUMBAD 1999 MAJOR ADVISOR: A. NAGANAGOUD

Investigations on various aspects covering pest complex on marigold, survey and status of insect pests, seasonal incidence of insect pests, biology of thrips (*Caliothrips indicus* Bagnall), screening different varieties of marigold and evaluation of synthetic insecticides and neem products was under taken at the Department of Agricultural Entomology, Agriculture College and Regional Research Station, Raichur, Karnataka during 1997-98.

Studies on the surveillance of various insect pests on marigold revealed five insects belonging to lepidoptera, 12 insects from hemiptera, 12 insects from coleoptera and 10 insects belonging to orthoptera as major, minor or as negligible insect pest as Raichur. Roving survey results revealed that the thrips (*Caliothrips indicus* Bagnall) incidence on marigold was noticed in all the three districts (*viz.*, Bidar, Gulbarga and Raichur). The thrips incidence was maximum (7.73/leaf) during vegetative stage of marigold at Raichur. The jassids and defoliators (*viz.*,*Helicoverpa armigera* Hb., *Spodoptera litura* F., ash weevil and *H. armigera* was recorded in all the three districts surveyed. Maximum incidence of thrips and *H. armigera* was recorded at Raichur and Bidar districts, respectively during flowering stage of marigold.

The studies on seasonal incidence of pests of marigold revealed the peak appearance of the thrips between January and May, jassids between October and November and *H. armigera* during December To obtain higher flower yield in marigold August, September and October months planting were found to be suitable. The total life cycle of thrips, *C. indicus* occupied an average of 16.80 ± 3.24 days from oviposition to adult emergence on marigold and it was 17.90 ± 3.60 days on groundnut. Marigold genotypes screened against several pests, revealed that dwarf red Dharwad, Crimson red tall and red tall registered the lower pest population. However, French dwarf marigold was highly susceptible to thrips and *H. armigera.*

Among the twelve synthetic and botanical insecticides tested monocrotophos, dimethoate, acephate, fenvalerate and spinosad were found to be superior to the rest in reducing the sucking pests and *H. armigera* incidence. Higher yields were obtained from monocrotophos treated plot followed by dimethoate.

Evaluation of Fly Ash in the Management of Insect Pests

P. R. BADRI PRASAD 1999 MAJOR ADVISOR: A. NAGANAGOUD

In an attempt to evaluate the insecticidal property of fly ash, an experiment was conducted during 1998-99 at the College of Agriculture / Regional Research Station, Raichur, Karnataka. The results indicated that fly ash dusting at 100 kg/ha had considerable effect in reducing population of pests *viz.*, leafhopper, thrips and *Spodoptera litura* Fabricius in groundnut ecosystem. Similar trend was observed under cotton ecosystem at 100 kg/ha of fly ash dust and reduced insect pest population of leafhopper, thrips, aphids and whiteflies as well as reduced boll damage due to bollworms.

Studies on the influence of fly ash on store pest *viz.*, *Callosobruchus chinensis* (L.) and *Sitophilus oryzae* (L.) under laboratory condition revealed that, fly ash at eight per cent by weight of grain registered least insect multiplication and grain damage. Similarly when *S. litura* and *Helicoverpa armigera* Hubner larvae when reared on fly ash dusted leaves in their different larval instars, there was detrimental effect of fly ash causing maximum mortality specially during early stages. However, the late larval instars survived till adult emergence. The adults emerged were deformed indicating its effect on the developmental stages of *S. litura* and *H. armigera.*

Studies on the Pest Status of Leafhoppers in Groundnut and Their Management

B. V. SRINIVASLU 1999 MAJOR ADVISOR: SOMASEKHAR

The present study was undertaken on the pest status of leafhoppers in groundnut and their management and was carried out in Regional Research Station, Raichur, Karnataka during 1998-99. Studies made during the roving survey in Raichur, Gulbarga and Koppal districts indicated maximum activity of leafhoppers during kharif than rabi. Among the leafhoppers collected, *Empoasca motti* was found to be predominent species. Field plot survey in Raichur taluka revealed, the maximum leafhopper damage and nymphs per plant during September and October

months on RRS farm and Kanyadoddi village. Correlation studies on different weather parameters revealed that, there was a non-significant positive relationship with morning RH, afternoon RH, total rainfall and number of rainy days.

Studies on the pest status of leafhoppers indicated that the early stage crop (30 DAS) can sustain upto ten leafhoppers per plant and can give normal yields while, 45 days and more aged crop can not sustain even five leafhoppers per plant which can be attributed to the capacity of early aged plants to putforth luxurient vegetative growth and cope up the damage. Biological studies conducted on predominant species, *Empoasca motti* which laid about 26-30 eggs and had four nymphal instars with an adult stage in the development, the life span of female was 36.04 days and 24.00 days for male.

Among the 85 genotypes screened, 33 were resistant, 22 were moderately resistant, 27 were susceptible and remaining were highly susceptible. The leafthickness and number of hairs on mid rib showed non-significant negative relationship with per cent leaf yellowing. Two sprayings (30 and 45 DAE) at peak inestations of leafhoppers indicated that, the new molecules *viz.*, acetamprid 20 SP and imidacloprid 200 SL were effective in reducing the leafhopper population, with maximum pod yield while, monocrotophos 36 SL, oxydemeton methyl 25 EC were next best chemicals. Among botanicals neem oil three per cent was found to be superior.

AGRICULTURAL MICROBIOLOGY

Mechanisms of Mineral Phosphate Solubilization and Growth Promotion by Diverse Bacteria

V. SANTHI 1998 MAJOR ADVISOR : Dr. P. U. KRISHNARAJ

The present study was conducted to understand the mechanism of mineral phosphate solubilization by comparing the mineral phosphate solubilizing (MPS) activity and related biochemical activities amongst the MPS^- wild types, MPS^+ wild types and their MPS^- mutant derivatives. The potentail of the MPS bacteria to promote plant growth through other beneficial triats was also studied.

Among the 96 isolates from the rhizosphere of different crop plants, 25 strains including 21 MPS^+ strains and four MPS^- strains were selected to assess their growth promotional potential.

The P_i released by these isolates in Tri-calcium phosphate broth ranged from 59 to 504 ug/ml. P_i supplemented in the form of K_2HPO_4 repressed MPS function indicating physiologically regulated gene expression in these strains. The MPS^+ strains predominantly secreted gluconic acid indicating the presence of direct oxidation-pathway inovlving membrane-bound glucose dehydrogenase.

Mutants defective in MPS activity were obtained through random mutagenesis using nitrosoguanidine. The MPS^- derivatives revealed significant reduction in root length, root dry weight and nodulation of soybean plants.

There was diversity amongst the isolates for their ability to release phosphate, fixe nitrogen, produce gum and growth-promoting substances. Inoculation of strains with such multiple beneficial traits resulted in higher total dry matter production, nodulation and total N and P uptake in soybean.

In the event of phosphate stress, it was noticed that MPS^+ wild type strains released organic acids, provide H^+ ions and get co-transported with soluble phosphates. Presence of $(NH)_2SO_4$ contributes to increase in acidity in the environment. A model for the co-ordinated regulation of phosphate starvation inducible genes has been proposed.

Effect of Granulation on Survival of *Bradyrhizobium japonicum* and Their Role on Growth and Yield of Soybean (*Glycine max* (L.) Merrill)

MANJUNATH S. HUGAR 1998 MAJOR ADVISOR : Dr. J. H. KULKARNI

Various carrier materials (Biogas spent slurry, charcoal, lignite, fly-ash, rock phosphate, vermiculture, vermicompost, pressmud and clay soils) were tested for their stability to form granules. Based on physico-chemical properties like higher water holding capacity, organic matter content etc. Lignite, vermicompost and vermiculite were selected for survival study. Survival of *Bradyrhizobium japonicum*, strain SB 120 was studied for a period of 120 days under two storage temperatures (24-40°C and 4-10°C). The population increased for initial do days and then decreased gradually till the end of the study in all the carriers. The population in these carrier based granules were significantly higher than in lignite powder. The suitability of these three carrier materials tested for the

production of rhizobial inoculants can be placed in the order of vermicompost > lignite > vermiculite. Different cells protectants viz., glycerol, liquid paraffin, sodium alginate and skimmed milk were used. Glycerol at 2 per cent was found to prolong the surival of *B. japonicum* for a longer period which may be ascribed to the higher water retention capacity of granules, increased cell loading capacity, slow release of rhizobia over logner period and capacity reduce the lag phase. Further, field experiment on the effect of granular based inoculants on soybean resulted in higher nodulation and growth parameters over the uninoculated control and seed inoculation. Granules at higher rates (5.0 and 7.5 kg ha^{-1}), irrespective of coating the granules with cell protectants recorded higher nodulation, nodule biomass and nodule occupancy. An increase of 4.4 to 23.6 per cent in yield was observed due to inoculation of *B. japonicum* through granular inoculants over the uninoculation.

Effect of Granulation on Survival of *Bradyrhizobium* Sp. and Their Effect on Growth and Yield of Groundnut (*Arachis hypogaea* L.)

VANITHA C. MALEKAR 1998 MAJOR ADVISOR : V. P. SAVALGI

Survival ability of *Bradyrhizobium* Sp. in three carrier based granular inoculants with and without cell protectants, stored under refreigerated and room storage temperature, was studied over a period of 120 days. Lignite based granular inoculants (type I) and lignite based granular inoculants with two per cent glycerol (type II), stored under refrigerated condition proved to be superior in supporting maximum viability of *Bradyrhizobium* for a period of 120 days. Further, a field study was conducted at Main Research Station, University of Agricultural Scieces, Dharwad, during summer season, 1998 to study the efficacy of type I and type II lignite based granular inoculants on growth, N uptake and yield of groundnut There were eight treatments consisting of type I and type II granular inoculants at three levels, viz., 2.0, 5.0 and7.5 kg ha^{-1} along with an uniculated control and seed inoculation.

Nodulation, nodule occupancy, dry matter accumulation, nitrogen content plant parts and shoot N uptake increased significantly with the application of granular inoculants at higher levels i.e., @ 5.0 and 7.5 kg ha^{-1} of both the types. Further, pod yield and yield components increased significantly with granular inoculants at higher levels. Pod yield increased by 31.6 per cent with application of granular inoculants @ 7.5 kg ha^{-1} (type II). Benefit cost ratio was highest with granular inoculation @ 5 kg ha^{-1} type II. Thus, considering the results of this investigation granular inoculants at higher levels i.e., @ 5.0 and 7.5 kg ha^{-1} irrespective of the type have shown to increase growth and yield of groundnut.

Survival of *Azospirillum brasilense* in Granular Inoculants and Their Effect on Growth and Yield of Sunflower (*Helianthus annuus* L.)

S. A. RAJKUMAR 1998 MAJOR ADVISOR: V. P. SAVALGI

An experiment was carried out during 1997-98 to study the survival ability of *Azospirillum brasilense* strain ACD L_4 in granular inoculants and their effect on growth and yield of sunflower. The experiment consisted of the storage of bacterium, having intrinsic antibiotic resistance of 50 ppm for streptomycin, inoculated to carrier based granules (lignite, vermiculite and vermicompost) at room temperature and refrigerated condition for 120 days. The granules retaining higher viable bacterial cells were mass produced and used in the field experiment on sunflower laid out at split plot design consisting of two main treatments (100% RDN + P and K and 75% RDN + P and K) and eight sub-treatments (uninoculated control, seed treatment and three levels each of two type of granules).

In storage experiment, vermicompost based granules coated with glycerol 2 per cent and stored under refrigerated condition proved to be best in retaining viable bacterial cells (log 8.606) compared to lignite powder (standard check), vermiculite and lignite based granules without and with other cell protectants skimmed milk, liquid paraffin, sodium alginate at 1 and 2% concentration).

In the field experiment, inoculation of *Azospirillum* sp. enhanced shoot and root growth, shoot and root N uptake, head diameter, early flowering and grain yield. The yield increase in response to *Azospirillum* sp. inoculant ranges from 26.82 per cent (seed treatment) to 42.39 per cnet (7.5 kg ha^{-1} level of type II granular inoculant) over to uninoculated control. When compared to seed treatment, it varied from 13.15 pe rcent (2 kg ha^{-1} level of type I granular inoculant) to 27.25 per cent (7.5 kg ha^{-1} level of type II granular inoculation).

Economics of *Azospirillum* sp. inoculants with granules and subsequent response of sunflower to their inoculation was found to be positive. Highest profit of Rs. 1.07 per rupee invested was obtained in 7.5 kg ha^{-1} level of granular application.

Effect of *Bradyrhizobium* sp. (Vigna) Inoculation on the Growth and Yield of Blackgram Varieties (*Vigna mungo* (L.) Hepper)

SHIVAPPA L. PALLED 1999 MAJOR ADVISOR: Dr. V. S. EMMIMATH

Pulses are leguminous crops grown mostly in tropical and subtropical areas. Among the pulses blackgram is one of the most important proteinaceous crop grown extensively in North Karnataka. In the present investigation isolation and screening of efficient *Bradyrhizobium* sp. (Vigna) for blackgram (*Vigna mungo* L.) was carried out. Five root nodule bacterial isolates were collected from the ARS, Gulbarga and Badnapur which were isolated from the roots of blackgram. These were subjected to morphological, biochemical, physiological and nodulation tests. All the five were found to be *Bradyrhizobium* sp. Further study for efficiency test on blackgram, revealed all the five strains GUR-3, GUR-4, GUR-5, BUR-9528 and BUR-9533 were effective, based on observations of nodule numbers, shoot dry weight, N per cent and nitrogen uptake over the uninoculated control. Strain and host interaction using the above five effective strain with released blackgram cultivars, TAU-1, T-9 and K-3 indicated superiority of inoculation with *Bradyrhizobium* over uninoculated control. Strain GUR-4 recorded maximum nodule number and dry weight of nodules, N content and N uptake and rhizosphere microbial population in plants with the cultivar TAU-1 inoculated with strain GUR-4. The performance of strain GUR-4 was significantly superior over the other strains and all the inoculated treatments were significantly superior over the uninoculated control. Among the blackgram cultivars, TAU-1 performed better than cv. T-9 and K-3 in respect of nodulation, biomass production and nitrogen fixation and total grain yields (TAU-1, 1513.56 kgs, T-9, 1131.67 kgs. and K-3, 1418.61 kgs/ha). The nitrogen and protein content in seeds of plants inoculated with strain GUR-4 were 3.96 and 24.76 per cent as compared to 2.32 and 14.49 per cent in the uninoculated control. Thus considering the result of this investigation, inoculation with strain GUR-4 and GUR-5 of *Bradyrhizobium* sp. (Vigna) resulted in grain yields in all the three genotypes of blackgram.

Development of Inoculum Consortia for Enhanced Growth and Nutrient Uptake of Sorghum (*Sorghum bicolor* L. Moench)

S. C. VEENA 1999 MAJOR ADVISOR: Dr. A. R. ALAGAWADI

In an attempt to develop inoculum consortia for enhanced growth and nutrient uptake of sorghum, several beneficial and major groups of general flora of sorghum rhizosphere were isolated. A total of 53 bacteria, five fungi, four actinomycetes and five yeasts were obtained. Among the 53 bacterial isolates, 22 were nitrogen fixers, 21 were phosphate solubilizers and 10 were predominant bacterial isolates. The nitrogen fixers mainly belonged to the genera *Azotobacter, Azospirillum, Acetobacter* and *Beijerinckia* among which, the amount of nitrogen fixed was maximum in *Azospirillum* followed by *Acetobacter, Azotobacter* and *Beijerinckia*. The phosphate solubilizing microorganisms were found to release Pi upto 47 mg/100 ml broth from tri-calcium phosphate (TCP). Majority of the P-solubilizers produced gluconic acid and few showed characteristic pigment production in TCP broth. Besides P-solubilizers, *Acetobacter* and *Azospirillum* isolates also showed P-solubilizing activity in broth. Several rhizosphere bacteria were found to produce polysaccharides and plant growth promoting substances.

Compatibility tests before consortia development revealed that except for few isolates of actinomycetes, fungi and P-solubilizers, all were able to co-exist with one another. Based on the beneficial traits, per cent occurrence and compatability, four beneficial organisms and one each of general bacteria, actinomycete, fungi and yeast were selected for preparation of consortia. Different combinations of general consortia and / or beneficial organisms in comparison with single, dual and triple inoculations were evaluated for growth and nutrient uptake in sorghum under pot culture conditions. Among the inoculation treatments, consortia consisting of all the eight component organisms produced best results with maximum plant growth, biomass yield and nutrient uptake which was almost equivalent to application of 75 to100 per cent recommended dose of chemical fertilizers. Combined inoculation of four beneficial organisms was also found superior over single, dual or triple inoculation of beneficial organisms.

Characterization of Azide Resistant Mutants of Soybean Rhizobia

H.T BHARATHI 1999 MAJOR ADVISOR: Dr. P. U. KRISHNARAJ

An attempt was made to isolate soybean rhizobia from native soil and improve some of them through mutagenesis. A large percentage (88.8) of the isolates were found to be fast growers indicating that these co-evolved recently with soybean. All the native strains were subjected to brute force plating on different concentrations of sodium azide to isolate azi^R spontaneous mutants. Spontaneous azi^R resistant mutants at frequency of 0.15 x 10^7 were obtained only from two strains, RLB 101 and RDB 101. *Bradyrhizobium* sp. USDA 24 was subjected to chemical mutagenesis using nitrogeguanidine (NTG). On screening 419 NTG survivors, two azi^R mutants USDA 24 M1 and USDA 24 M2 were obtained. Most of the mutants were similar to their wild type in most of the characteristics. The rest differed from their wild type with respect to resistance to nalidixic acid and tolerance to NaCl. The mutations in *azi* locus seemed to be pleiotrophic in nature.

The Azide resistant mutants were analysed for their effectiveness and were classified into three categories.

1. azi^R, Nod$^+$, N=uptake$^+$, Biomass$^+$
2. azi^R, Nod^d, N=uptake$^+$, Biomass$^+$
3. azi^R, Nod^d, N=uptake^d, Biomass$^+$

Interestingly, some of the mutants had enhanced nodulation capability and all of them showed enhanced tolerance to nalidixic acid. A distinct class of mutants with enhanced symbiotic effectiveness has been isolated which have the potential to improve the nitrogen fixation capacity of the plant-legume symbiosis and their agronomic efficiency needs to be confirmed by taking up field studies.

Influence of Inoculation of Efficient Vam Fungi on Onion (*Allium cepa* L.) at Different P-Levels

SHIVAKUMAR KASHAPPANAVAR 1999 MAJOR ADVISOR: Dr. M. N. SREENIVASA

Response of onion (*Allium cepa* L.) cv. N-53 to the inoculation of efficient vesicular arbuscular mycorrhizal (VAM) fungi, *Acaulospora laevis* and *Gigaspora margarita* at different P levels (0, 50, 75 and 100 per cent recommended dose (PRD) (75 kg ha^{-1}) was studied under glass house condition.

The per cent mycorrhizal root colonization, spore count and mycorrhizal inoculation effect increased in the plants inoculated with VAM fungi with addition of P upto 75 PRD (37.5 kg ha^{-1}), while the population of free living N_2 fixers and P-solubilizers increased with addition to P upto 100 PRD of P (50 kg ha^{-1}). Among the VAM fungi, plants inoculated with *Gigaspora magarita* had significantly highest per cent mycorrhizal root colonization, spore count, mycorrhizal inoculation effect, population of free living N_2 fixers and P-solubilizers in the rhizosphere soil as compared to plants inoculated with *Acaulospora laevis* and uninoculated control plants. The shoot P concentration, alkaline phosphatase activity, total soluble solids, ascorbic acid content, plant height, number of leaves, plant dry weight, fresh bulb weight, bulb diameter, bulb length and neck thickness increased with increase in P level upto 100 PRD. The fresh bulb weight, plant height and plant dry matter of onion was maximum in plants inoculated with *Gigaspora margarita* and given 100 PRD of P. However, it did not differ significantly from plants inoculated with *Gigaspora margarita* and given 75 PRD of P, suggesting a net saving of 25 PRD of P with efficient VAM fungi.

CROP PHYSIOLOGY

Effect of Plant Growth Regulators on Growth, Yield and Seed Quality in Cowpea (*Vigna unguiculata* (L.) Walp.)

T. S. GANAGER 1998 MAJOR ADVISOR : DR. B.C. PATIL

A field experiment was conducted at Regional Research Station, Raichur, University of Agricultural Sciences, Dharwad under irrigated condition during summer 1995, to know the effect of growth regulators viz., NAA, TIBA, GA, CCC and Cytozyme on growth, morphophysiological characters, seed quality, yield and yield components in cowpea (Cv. C-152). The experiment was laid out in RBD with three replications. The treatments were imposed at 35 DAS.

Results revealed that the growth regulator TIBA (25 and 50 ppm) reduced the plant height, increased the number

of branches and internodes. The maximum plant height was recorded in GA and cytozyme.

The dry weight of leaf, stem and pod increased due to application of growth regulators. The dry matter distribution was more in leaf at 25 and 50 DAS where as at 75 DAS it was more in pod. In general, the leaf area increased upto 50 DAS and decreased thereafter. Maximum leaf area was observed in GA while least in TIBA. At 75 DAS significantly more LAI was observed in TIBA (50 ppm) followed NAA and Cytozyme compared to control.

The AGR differed significantly at 50-75 DAS. It was highest in NAA but lowest in CCC (50 ppm). In all the treatments CGR increased over control and was highest in TIBA. At 75 DAS to harvest, RGR was signficantly more in TIBA. Cytozyme and TIBA recorded significantly more NAR than control. At 50 DAS, NAA, TIBA an GA (50 ppm) recorded significantly more chlorophyll 'a', Chlorophyll 'b' and total Chlorophyll content.

The yield contributing characters viz., seed yield plant, number of pods per plant, seeds per pod, 1000 seed weight and pod length increased significantly due to growth regulators. Among the growth regulators TIBA (25 ppm), NAA and cytozyme (100 ppm) recorded significantly more seed yield than other treatments.

Although TIBA recorded highest seed yield, cytozyme followed by NAA were found to be economical as they recorded highest benefit : cost ratio (1:10 and 1:9, respectively).

Influece of Clomazone on Nitrogen Metabolism and Weed Control in Soybean (*Glycine max* (L.) Merrill.)

C. N. GUDDAD 1999 MAJOR ADVISOR: Dr. V. P. CHIMMAD

A field experiment was conducted at Main Research Station, University of Agricultural Sciences, Dharwad during kharif 1996, to findout the effect of clomazone on nitrogen metabolism and weed control in soybean genotypes. Five different concentrations of clomazone and two genotypes were laid in factorial randomized block design with four replications.

The growth parameters *viz.*, LAI, LAD, AGR, NAR were highest in clomazone 1.00 kg ai ha^{-1} with photosynthetic rate, transportation. The chlorophyll content and nitrate reductase activity decreased with increase in concentrations. However, the high leghaemoglobin was significantly highest in clomazone 1.00 kg ai ha^{-1}, the genotypes, JS-335, recorded significantly higher values for all these parameters when compared to MACS-124.

The nitrogen uptake in leaf, stem and total plant (g/plant) was highest in clomazone 1.00 kg ai ha^{-1}. Similarly, the absolute nitrogen accumulation rate (ANAR) and net nitrogen accumulation rate in leaf, stem and total plant was significantly highest in clomazone 1.00 kg ai ha^{-1}. Both the harvest index (HI) and nitrogen harvest index (HI) were significantly highest in clomazone 1.00 kg ai ha^{-1}. The yield and yield components were also higher in clomazone 1.0 kg ai ha^{-1}. The genotype, JS-335 recorded higher along with yield components then MACS-124. Though the higher clomazone concentration (above 1.00 kg ai ha^{-1}) controlled weeds (both monocots and dicots) but it had phytotoxic effect on crop by affecting the nitrogen uptake and growth.

Effect of Growth Regulators on Physiological Indices and Reproductive Efficiency in Bell Pepper cv. Tarihal Local (*Capsicum annum* L.)

SRIDHAR GUTAM 1999 MAJOR ADVISOR: Dr. R. V. KOTI

A field experiment was conducted at College of Agriculture, University of Agricultural Sciences, Dharwad during kharif 1998 to find out the effect of growth regulators on physiological and biochemical parameters and reproductive efficiency in Bell pepper (cv. Tarihal local). The experiment consisted of fifteen treatments comprising of naphthalene acetic acid (NAA) and Mepiquat chloride (MC) at different concentrations and was laid out in randomised block design with three replications.

The plant height increased significantly due to NAA and decreased with mepiquat chloride. The application of growth regulators significantly increased the per cent fruit set, number of branches stem dry weight, dry matter production in reproductive parts and total dry matter. The leaf area, LAI, LAD, SLA were significantly more with NAA, while treatments with MC reduced the same. AGR, CGR, RGR, NAR, SLW and BMD increased significantly due to the application of growth regulators.

The total chlorophyll content, nitrate reductase activity and ascorbic acid content increased significantly due to the application of growth regulators. All the growth regulator treatments significantly increased fruit yield/plant, number of fruits/plant, average fruit weight, 1000 seed weight and number of seeds/fruit. The fruit yield was

significantly higher with MC @ 1500 ppm at 45 + 65 DAT followed by MC @ 1500 ppm at 45 DAT as compared to control. The fruit yield was positively correlated with number of branches, total dry matter in reproductive parts, SLW, NAR, total chlorophyll content, nitrate reductase, ascorbic acid content and yield components *viz.*, average fruit weight, test weight and seed number/fruit. From the economic point of view, Mepiquat chloride @ 500 ppm at 45 DAT was more profitable.

Morpho-Physiological Traits Associated with Yield and Quality in Sugarcane (*Saccharum officianarum* L.) Genotypes

M. DAYANAND 1999 MAJOR ADVISOR: Dr. M. B. CHETTI

A field experiment was conducted at the Karnataka Institute for Applied Agriculture Research (KIAAR) of Godavari Sugar Mills Ltd., Sameerwadi during 1998-99 to study the genotypic variation for morpho-physiological indices, growth and quality parameters in sugarcane genotypes. The experiment consisted of twenty one genotypes (early and midlate maturity groups) laid out in randomised block design with three replications.

The genotypes differed significantly for germination per cent, number of cane formed shoots and these parameters were more in midlate group. The morphological parameters *viz.*, plant height, number of internodes, internodal length, stalk diameter, number of tillers/clump and number of green leaves differed significantly among the genotypes. The genotypes CoC 671 (early) and Co 86032 (midlate) recorded significantly higher values for these traits except for internodal length.

The growth analysis parameters *viz.*, LAI, LAD, BMD, AGR, CGR, LAR differed significantly among the genotypes. AGR and CGR were positively correlated with cane yield. The high yielding gentoypes possessed higher LAI and LAD values. The number of stomata, veinload frequency, interveinal distance, vein thickness differed significantly among the genotypes and all these parameters were more in CoC 671 and Co 86032 except IVD which was less.

The total chlorophyll content and nitrate reductase activity were significantly higher in CoC 671 and Co 86032 and were positively correlated with cane yield. These genotyeps also recorded significantly higher cane yield over other genotypes and the genotype CoC 671 recorded the maximum single cane weight.

The genotypes differed significantly for quality parameters *viz.*, Brix, sucrose content and commercial cane sugar (CCS) per cent. Among early genotypes, Co 92008 recorded the maximum Brix, sucrose and CCS per cent whereas, among midlate group, Co 92012 recorded highest brix and sucrose per cent. Brix and sucrose content were found to have significant positive association with each other and the yield was negatively correlated with quality parameters.

Physiological Investigations on the Productivity Potential of Different Plant Types in Cotton Genotypes

T. S. ADARSHA 1999 MAJOR ADVISOR: Dr. B. C. PATIL

A field experiment was conducted during 1998-99 under rainfed conditions at Agricultural Research Station, Dharwad to study the productivity potential, physiological and biophysical basis of yield variation of different plant types in cotton genotypes. The experiment consisted of twenty genotypes laidout in a ranodmised block design with three replications on medium black soil. Robust and compact and *G. herbaceum* genotypes were selected based on growth and morphological characters like, plant height, number of leaves, number of nodes, sympodia and monopodia. Robust genotypes produced higher seed cotton yield as compared to compact and *G. herbaceum* genotypes. Among the genotypes, DHH-11 produced significantly higher seed cotton yield (1395.5 kg/ha), which was mainly attributed to its close association with yield components and other characters such as boll number (r=0.732), harvest index (r=0.535) and photosynthetic rate (r=0.526).

Gentoypes showed significant differences in their growth pattern, phenological characters and physiological parameters. Robust genotypes possessed higher dry matter at all the stages mainly because of higher AGR, NAR and number of leaves per plant as compared to compact and *G. herbaceum* genotypes. Correlation studies indicated highly significant positive association of yield with TDM (r=0.761), AGR (r=0.681) and NAR (r=0.535). With regard to biophysical characters, robust genotypes possessed higher photosynthetic rate and moderate respiration rate as compared to compact and *G. herbaceum* genotypes.

It is inferred that robust genotypes were morpho-physiologically efficient interms of growth and yield components and biophysical characters due to which they were able to escape drought and produced higher seed cotton yield.

Influence of Growth Regulators and Nutrients on Productivity Potential and Quality in Chilli (*Capsicum annuum* L.)

SANGANABASAV G. GOLLAGI 1999 MAJOR ADVISOR: Dr. S. M. HIREMATH

A field experiment was conducted at College of Agriculture, University of Agricultural Sciences, Dharwad during kharif 1998 to find out the effect of growth regulators and nutrients on productivity potetnial and quality in chilli (cv. Byadagi). The experiment consisted to fifteen treatments comprising of four growth regulators and three nutrients at different concentrations and was laid out in randomised block design with three replications.

The plant height increased significantly due to NAA and decreased with cycocel. The application of growth regulators and nutrients significantly increased leaf dry weight, stem dry weight, dry matter production in reproductive parts and total dry matter content.

The growth parameters *viz.*, AGR, CGR, RGR, NAR, SLW and BMD increased significantly due to the application of growth regulators and nutrients. The leaf area, LAI and LAD were significantly higher with NAA while, treatments with CCC reduced the same. The photosynthetic rate and transpiration rate increased significantly due to both growth regulators and nutrients. The application of growth regulators and nutrients significantly increased the total chlorophyll content, nitrate reductase activity, ascorbic acid and carotene contents in fruits.

The growth regulator treatments significantly increased the fruit yield, number of fruits / plant, average fruit weight, number of seeds/fruit, stalk length, fruit girth, fruit volume and harvest index. The fruit yield was significantly higher with CCC (1000 ppm) followed by CCC (500 ppm) and NAA (100 ppm). The fruit yield was positively correlated with dry matter accumulation in reproductive parts AGR, CGR, NAR, BMD, photosynthetic rate, transpiration rate, total chlorophyll content, nitrate reductase activity, carotene content and yield components viz., number of fruits/plant, fruit girth, number of seeds per fruit, fruit length, fruit volume, average fruit weight. From the economic point of view, foliar application of cycocel (1000 ppm) at 45 and 65 days after transplanting was found more profitable.

Morpho-Physiological Traits Associate with Drought Adaptation and Physiological Basis of Heterosis in Sorghum

ASHOK SURWENSHI 1999 MAJOR ADVISOR: Dr. V. P. CHIMMAD

Field experiments were conducted during rabi season of 1998-99 at Main Research Station, University of Agricultural Sciences, Dharwad to evaluate the relative performance of different sorghum parents and their hybrids with respect to different morpho-physiological traits under receding soil moisture situation.

Among the parents, RS-615, C-43, 296-B, RS-29 recorded maximum leaf, stem, panicle and total dry matter (TDM) at both 50 per cent flowering and harvest. The total chlorophyll and its components were higher in RS-29, RS-615, 117-B, C-43 and 296-B. The genotypes (RS-29 and RS-615) maintained higher photosynthetic rate and low transpiration rate indicating their drought tolerant character. Maintainance of high relative water content (RWC) and epicuticular wax in gentoypes RS-29, C-43, RS-615 and RS-585 is also a drought tolerant character. Hence, these gentoypes (RS-29, RS-615, C-43 and RS-585) recorded higher yields and yield components.

In parents and hybrid trial, both M-35-1 and 9-13 recorded higher plant height, days to 50 per cent flowering and days to maturity. There was low and negative heterosis for over better parent these parameters and there was significant and positive heterosis for most of the hybrids for leaf area index (LAI). Both the parents, M-35-1 and 9-13 maintained high photosynthetic rate, transpiration rate, relative water content (RWC) and epicuticular wax content at 50 per cent flowering and dough stage. The hybrids P_3A x M-35-1, P_3A x 9-13 and P_5A x 9-13 with M-35-1 and 9-13 as one of the parents also maintained higher value for these physiological traits and also yielded more. The hybrids, P_2A x 9-13, P_5A x 9-13 and P_3A x M-35-1 recorded significantly higher on par yields when compared to their one of the parents (9-13 and M-35-1). Five out of seven hybrids showed positive heterosis (2.30 to 52.49%) for yield. A wide range of heterosis was observed among hybrids with respect to morphological, physiological and biochemical characters.

Impact of Nutrients and Growth Regulators on Drying of Reproductive Structures in Cotton (*Gossypium barbadense* L.)

L. P. HANUMANTHAREDDY 1999 MAJOR ADVISOR: Dr. B. S. JANAGOUDAR

A field experiment was conducted at Agriculture, Research Station, University of Agricultural Sciences, Dharwad during kharif 1998-99 to find out the effect of growth regulators and nutrients on drying of reproductive structures in cotton cultivar SB (YF)-425. The experiment consisted of twelve treatments comprising of seven nutrients, four plant growth regulators at different concentrations and different combinations and was laid out in randomised block design with three replications.

Results revealed that plant height increased significantly due to NAA in combination with $MgSO_4$ and decreased with Lihocin. The application of NAA in combination with $MgSO_4$ increased the number of monopodial and sympodial branches while, cobalt chloride treatment reduced the same.The application of growth regulators and nutrients significantly decreased the number of dried squares, dried bolls, number of bad bolls per plant except Acetyle salicylic acid which resulted in significantly higher values for these parameters.

There was an increase in the nitrogen content in leaf, stem and bolls due to growth regulators and nutrients except cobalt chloride which reduced the same. Whereas, growth regulators and nutrients significantly decreased the starch content in stem and bolls except cobalt chloride which increased the same.

The yield and yield components were significantly influenced by the use of growth regulators and nutrients. In general, all the treatments increased the kapas yields,number of good bolls per plant, average boll weight, seed weight per plant and number of seeds per boll except cobalt chloride. Among the treatments, the highest yield and yield components were recorded in $MgSO_4$ (1%) + NAA (10 ppm) followed by GA (20 ppm) + NAA (10 ppm).

The kapas yield was found to be positively with plant height, number of monopodial and sympodial branches, number of good bolls per plants, boll weight, seed weight, number of seeds per plant and N content in leaf, stem and bolls. However, kapas yield was negatively associated with number of dried squares, bolls and bad bolls, starch content in leaf, stem and bolls.

GENETICS AND PLANT BREEDING

Evaluation of Spanish Type Groundnuts for Resistance to Stem and Pod-Rot Caused by *Sclerotium rolfsii* Sacc.

A. KRISHNA KANTH 1998 MAJOR ADVISOR : Dr. M. V. C. GOWDA

Sclerotium rolfsii incited stem and pod rots is a major constraint to groundnut production in many groundnut growing regions of India. Though considerable research has been carried out on the management of the disease, information on the reaction of the currently grown Spanish type cultivars to the fungus in India is lacking.

Evaluation of 13 genotypes along with resistant (ICGV 86590 and GBFDS 272) chekcs under artificially inoculated conditions indicated significant difference among genotypes and seasons as well as genotype x season interaction for disase, yield and yield related parameters. Majority of ruling Spanish type cultivars of Karnataka (TMV-2, JL-24, Dh-40, KRG-1 and R-8808), two germplasm lines (ICG 5125 and ICG 5247) and three leaf spot resistant Spanish mutants (VLI-28-2, VLI-45 and VLI-110) were susceptible, while a released cultivar Dh-8 was comparable or superior to the resistant checks.

To assess the scope for selection in hybrid populations, two crosses were generated using JL-24, a popular but susceptible Spanish type cultivar and Dh-8, a resistant but deficient in shelling outturn and hundered seed mass. The crosses exhibited significant variability for all characters and it was highly heritable for disease incidence and yield per unit area. The frequency of superior segregants were high for disease resistance (48%), but low for shelling out turn (7%) and hundred seed mass (11%) leading to recovery of very few desirable lines.

None of the genotypes tested in the present study was completely resistant. Other control measures (cultural, chemical and biological) when applied individually are known to be imcompletely effective, necessitating integration of different approaches to achieve effective control of the pathogen. Drastic reduction and complete control of disease was observed in Dh 8 under chemical (propiconazole) and bio-control (*Trichoderma harzianum*) measure as compared to the incomplete control in JL 24 indicating the superior response of partially resistant genotype.

Heterosis and Combining Ability in Castor (*Ricinus communis* L.)

K. MAHANTASHIVAYOGAYYA 1998 MAJOR ADVISOR : Dr. S. N. NAIK

The study was undertaken to assess magnitude of heterosis, combining ability and nature of the gene action in respect of yield and its components in castor. A line x tester set was obtained by crossing three lines with eight diverse testers Twentyfour F_1's along with their parents and five commercial checks were planted in a randomised block design during kharif 1997-98 at Regional Research Station, Raichur.

Hybrids exhibited significant variability for 16 quantitative characters studied. Significant *per se* performance and standard heterosis in desirable direction were recorded in several crosses. The crosses DPC-9 x SKI-122, DPC-9 x DCS-91R and DPC-9 x SKI-80 expressed heterosis to the extent of 64.54, 58.47 and 57.61 per cent respectively over commercial check (GCH-4) and seed yield These were found suitable for commercial exploitation.

The estimated components of general and specific combining ability (gca and sca) variances showed the preponderance of additive gene action for seed yield per plant and most of yield attributing characters, whereas non-additive gene action chiefly controlled the inheritance of days to flowering, physiological maturity of primary receme and oil content.

The parents DPC-9, SKI-122 and SKI-80 were the best general combiners for seed yield, oil content and other important yield attributing characters. The crosses DPC-9 x DCS-91R, DPC-9 x SKI-122 and DPC-9 x SKI-80 exhibited desirable sca effects and higher *per se* value for seed yield and oil content. The high yielding ability of these crosses was due to additive gene effects. These crosses can be exploited directly as hybrids or selection in the segregating population can be practised to identify any stable high yielding genotypes.

Stability of Morpho-Physiological Traits Influencing Seed Yield in Blackgram (*Vigna mungo* L. Hepper)

M LALAHAMED 1998 MAJOR ADVISOR : Dr. P. M. SALIMATH

The main objective of the present investigation was to confirm the potentiality of 16 productive genotypes identified by the previous work (Patil, 1996) and to assess their stability over locations in respect of yield and other morpho-physiological characters. Evaluation was done at Dharwad, Bheemrayanagudi and Bidar during kharif, 1997 along with checks TAU-1 and MANIKYA. Observations were recorded on dry matter accumulation, physiological and growth parameters as well as on seed yield and its components traits. Among the characters studied, number of pods per plant, pod yield per plant, seed yield per plant, leaf area duration (LAD) (3050 DAS), relative growth rate (50 DAS harvest) and net assimilation rate (30-50 DAS and 50 DAS harvest) showed high estimates of variability, heritibility and expected genetic advance. At all the three locations, harvest index was very strongly and positively associated with seed yield. Harvest index and biomass duration (BMD) (50 DAS harvest) showed higher positive direct effects on seed yield over locations. Linear component of genotype x environment interaction was significant for all the morphological characters except number of pods per plant and for some physiological characters like total dry matter (50 DAS), LAD (30-50 DAS and 50 DAS harvest), crop growth rate (30-50 DAS) and BMD (50 DAS harvest) indicating that the expression of these characters is predictable over locations. Two of the test entries gave significantly higher yield than the best check variety. Of them, 4-41-3 had significant deviation from regression line and hence, unstable. It needs further thourough adaptability test. 662-24-8 showed adaptability to rich environments. Few of the genotypes viz., 70-PLU-149, 449-1416, 946-PLU-58, 447-2 and AB-14 yielded numerically higher than the yield of checks and were also stable. To achieve further gains in productivity, increasing the biomass to these potential genotypes and retaining their relatively higher harvest index value has been suggested.

Heterosis and Combiling Ability Analysis in Three-Way Cross Hybrids of Sunflower (*Helianthus annuus* L.)

SUJIT S. TARIWAL 1998 MAJOR ADVISOR : Dr. K. GIRIRAJ

In the present study, three-way cross (TWC) hybrids were evaluated for the extent of heterosis for seed yield, component characters and combining ability of parental lines. The base material consisted of three male sterile single crosses as females and eight restorers crossed in all possible combinations. A total of 11 parents and 24 TWC