# Abstracts of Theses Accepted for the Award of Post-Graduate Degrees in the University of Agricultural Sciences, Dharwad

## DOCTOR OF PHILOSOPHY

## AGRONOMY

### Response of Rabi Sorghum (*Sorghum bicolor* (L.) Moench) to Tillage, Moisture Conservation Practices, Organics and Nitrogen in Vertisols of Semi-aric Tropics

SHEKHARGOUDA L. PATIL 1998 MAJOR ADVISOR : Dr. M. N. SHEELAVANTAR

Investigations to study the "Response of rabi sorghum (*Sorghum bicolor* (L.) Moench) to tillage, moisture conservation practices, organics and nitrogen levels in vertisols of semi-arid tropis" were conducted during 1994-95 and1995-96 at Regional Research Station, Bijapur.

In the first experiment among the different tillage practices, deep tillage increased the soil moisture content, infiltration rate and decreased the bulk density compared to medium and shallow tillage. Deep tillage recorded higher grain yield (1877 kg $ha^{-1}$) by 22 and 45 per cent over medium and shallow tillage, respectively. Increase in depth of tillage increaed the growth and yield component values and increased availability and uptake of major nutrients. Among different organic sources, subabul recorded higher grain yield (1636 ka $ha^{-1}$) by 8 per cent over vermicompost. Subabul application improved the soil physico-chemical properties and nutrient uptake over rest of the organics. Application of 50 kg N $ha^{-1}$ increased the grain yield (1708 kg $ha^{-1}$) by 6 and 23 per cent over 25 and `O' kg N $ha^{-1}$, respectively. Increase in N dose upto 50 kg $ha^{-1}$ increased the availability and uptake of nitrogen, phosphorus and potassium.

In the second experiment, formation of ridges and furrows and compartmental bunding increased the soil moisture content and recorded 1603 and 1567 kh $ha^{-1}$ of grain yield which was higher by 26 and 23 per cent, respectively over flat bed (1267 kg $ha^{-1}$). Higher nutrient uptake was observed with *in situ* moisture conservation practices over flat bed. Subabul application increased grain yield by 12 per cent (1570 kg $ha^{-1}$) over vermicompost. Increase in nitrogen application upto 50 kg $ha^{-1}$ improved the root growth, increased the nutrient availability and their uptake. Application of 25 and 50 kg N $ha^{-1}$ increased in grain yield by 20 and 31 per cent, respectively over control.

### Studies on Teak (*Tectona grandis* Linn. F) Based Agroforestry System and Fertigation

S. M. MUTANAL 1998 MAJOR ADVISOR : Dr. A. S. PRABHAKAR

Field experiment on performance of crops (Sorghum/groundnut) in teak based agroforestry system was carried out for two years (1996 and 1997) on red gravelly soils, MRS, University of Agricultural Sciences, Dharwad. Effects of three agroforestry systems were compared with sole crop in combination with two directions and five distances from teak alley. Second experiment on 'response of teak to fertigation' was conducted on medium black soils of 'Teak Farm' Murakatti, Dharwad during 1995 to 1997. The experiment consisted three levels of fertilizers ($D_1$ - 100: 50: 100, $D_2$ - 200:100:200, $D_3$ - 300:150:300, N; $P_2O_5$ : $K_2O$ kg/ha) and four fertigation splits (2, 3, 4, 6) and soil application in two splits.

In agroforestry experiment, grain/pod yield of sorghum/groundnut was higher in sole crop as compared to sorghum/groudnut with teak, teak + grass, teak + subabul. Grain/pod yield was higher on western side as compared to eastern side of teak alley. Grain/pod yield was increased with increase in distance fromt teak alley. Marketable timber volume was higher in groundnut + teak and sorghum + teak as compared to other treatments. Field crops with teak recorded higher net income compared to inclusion of pasture with teak.In second experiment, grain/pod yield of teak to fertigation, both height and dbh were significantly higher with application of $D_2$ and $D_3$ level during 20, 24, 28 MAP of teak as comapred to $D_1$ level. Fertigation in six splits had recorded higher height and dbh as compared to two splits of fertigation or soil application. Both volume and basal area were increased with $D_3$ and $D_2$ level of fertilizers and six splits of fertigation as compared to $D_1$ level and soil application. Biomass production (29 MAP) was increased by 9.6 and 6.1 per cent in $D_2$ and $D_3$ level as compared to $D_1$ level. Fertigaiton in six splits a year had increased by 36 per cent as compared to two splits of fertigation or soil application. Nutrient status of soil was improved with higher level of fertilizer and splits of fertigation. Fertilizer use efficiency in teak decreased by 45.2, 64.7 per cent in $D_2$ and $D_3$ level, respectively as compared to $D_1$ level. Fertigation in six splits was recorded higher FUE as compared to soil application.

### Studies on Potato (*Solanum tuberosum* L.) Based Cropping System in Vertisols Under Rainfed Conditions

RAMESH BABU 1998 MAJOR ADVISOR : Dr. A. S. PRABHAKAR

Agronomic investigations on potato based cropping systems, *viz.*, cropping sequences and intercropping systems were carried out on vertisols from 1993-94 to 1995-96 at Main Research Station, UAS, Dharwad. There was improvement in the soil fertility status when compared to initial status with respect to organic carbon and available N, P and K soon after potato harvest. The rabi crops viz., wheat, chickpea and safflower grown in sequence with kharif potato responded upto 50% recommended dose of nitrogen (RDN), with grain yield of 1967, 1857 and 1619 kg/ha, respectively in these crops). Rabi sorghum succeeding kharif potato recorded significantly higher grain yield of 2404 kg/ha with the application of 100% RDN compared to 2188 kg/ha with 50% RDN and 2129 kg/ha with 50% RDF (Recommended dose of fertilizer) and 1706 kg/ha with control. Among the cropping sequences, potato-chickpea sequence was significantly higher with respect to production potential in terms of potato equivalent yield (252.25 q/ha), gross returns (Rs.63046/ha) net returns (Rs. 40246/ha) and B:C ratio (1.76) than other sequences. In studies on intercropping systems, the tuber yield of sole potato and intercropped potato with 100 per cent population in skip row system did not differ significantly. Various intercrops viz., cotton, pigeonpea, sunflower and maize with either 50 or 100 per cent population did not influence the yield of potato, while the yields of these intercrops were significantly higher at 100 per cent population with 115.8, 48.4, 46.7 and 46.5 per cent increase, respectively over 50 per cent population. Intercropping realized significantly higher yield advantage in terms of LER (1.76), ATER (1.126) and SPI (205.43) over sole potato. Potato + pigeonpea recorded maximum LER (1.80), while potato + maize and potato + sunflower were superior in ATER (1.262 and 1.241, respectively). The net returns were higher in intercrpping systems with 100 per cent intercrop population.

### Conjunctive Use of Sewage and Borewell Water on Performance of Wheat (*Triticum aestivum* L.) at Varied Fertility Levels

S. R. SALAKINKOP 1999 MAJOR ADVISOR: Dr. C. S. HUNSHAL

An investigation was conducted to study the conjuctive use of sewage and borewell water on performance of wheat at varied fertility levels on farmers fields near Agriculture Research Station, Dharwad during two consecutive rabi seasons of 1996-97 and 1997-1998. Field experiment was laid out in split-plot design with sewage and borewell irrigated land as main plots, sources of irrigation (sewage irrigation, alternate irrigation and borewell irrigation) as sub plots and four fertilizer levels (0, 50%, 75% and 100% RDF) in sub-sub plots in three replications.

The sewage irrigated land recorded significantly higher (about 23%) grain (43.7 q $ha^{-1}$) and straw (54.6 q $ha^{-1}$) yield than borewell irrigated land. It also recorded higher growth rate interms of CGR, RGR, NAR and dry matter and yield attributes. Sources of irrigation differed significantly producing higher grain yield in sewage irrigation (41.9 q $ha^{-1}$) and alternate irrigation (39.5 q $ha^{-1}$) compared to borewell irrigation (35.5 q $ha^{-1}$). Straw yield also followed the same trend recording 57.7, 50.6 and 46.8 q $ha^{-1}$ in sewage, alternate and borewell water irrigation, respectively. The grain yield was influenced mainy by yield components *viz.*, ears $m^{-2}$, ear weight, seeds $ear^{-1}$ and test weight which were higher under sewage and alternate irrigations.

Among the fertilizer levels, 100% RDF (45.1 q $ha^{-1}$) and 75% RDF (43.0 q $ha^{-1}$) were on par with each other. This emphasised the importance of sewage irrigation in saving 25 per cent cost on fertilizer. Application of 75% RDF and 100% RDF to sewage irrigated land under sewage irrigation resulted in higher but similar grain and straw yield over other interactions. Same trend was noticed in both the lands wherever sewage and alternate irrigations were provided indicating saving of 25 per cent RDF with use of sewage water. Quality of crops interms of protein, gluten improved due to sewage water application and there was no accumulation of heavy metals (Cr, Ni, Pb and Cd) in plant parts above the threshold limit. Soil under sewage irrigated land contained significantly higher N, P, K, S and micronutrients (Cu, Fe, Mn and Zn). Also soil maximum water holding capacity, BD and pH were improved. Content of toxic heavy metals in both lands did not increased significantly. Microbial population and their activity interms of dehydrogenase, phosphatase increased due to sewage application.

**Sustainable Production of Planted and Ratoon Crop of Hybrid Rice Under Lowlands in Hill Zone of Karnataka**

K. MANJAPPA 1999 MAJOR ADVISOR: Dr. A. S. PRABHAKAR

Field experiments were conducted at Agricultural Research Station (Paddy), Sirsi, University of Agricultural Sciences, Dharwad on Sustainable Production of Planted and Ratoon Crop of Hybrid Rice Under Lowlands in Hill Zone of Karnataka during kharif and rabi seasons of 1997-98 and 1998-99. The trial on fertilizer management in main and ratoon crops consisted of seven fertilizer levels of main crop (RDF alone, RDF + FYM 10 $ha^{-1}$, RDF + Vermicompost, RDF + Eupatorium, RDF + Glyricidia, RDF + Sunnhemp and RDF + Paddy straw) and three fertilizer levels of ratoon crop (no fertilizer, 50% RDF and 100% RDF). In second trial, performance of main and ratoon crops as influenced by sprays of growth regulators *viz.*, $GA_3$ (25 ppm), benzyladenine (100 ppm), kinetin (50 ppm) and nutrients *viz.*, urea (2%), $KNO_3$ (0.5%), $ZnSO_4$ (1%) was evaluated along with control (no spray) under four irrigation levels (residual moisture, irrigation at critical stages, irrigation at hair cracking stage and irrigation at saturation point). In third trial, the performance of ratoon crop as influenced by two levels each of main crop population (normal and 33% higher), stages of harvesting (physiological and harvestable maturity), cutting height (10 and 20 cm) and cultural practice (planking soon after harvest crop and no planking) was evaluated.

The grain yield of main crop increased by 31.1, 24.2 and 24.1 per cent, respectively, with sunnhemp, glyricidia and eupatorium applied along with RDF when compared to RDF alone. Integrated use of organics along with RDF also maintained higher soil fertility. The residual effect of RDF + organics was also more interms of ratoon yield as compared to RDF alone. Application of 100 per cent RDF to ratoon crop recorded higher grain yield over 50% RDF and no fertilizer. Among different combinations, RDF+Sunnhemp to main crop and 100% RDF to ratoon crop recorded significantly higher grain yield. The grain yield obtained with RDF + Sunnhemp to main crop and no fertilizer to ratoon crop was significantly higher when compared to grain yield obtained with RDF alone to main crop and 50% RDF to ratoon crop.

In main crop, the grain yield recorded with application of $GA_3$ was maximum, but, net returns was maximum with urea spray. In ratoon crop, the grain yield as well as net returns was maximum with $GA_3$ treatment. Among the irrigation levels, irrigation at saturation point recorded significantly higher grain yield than other levels. The grain yield and net returns were higher with 33% higher population, 20 cm cutting height, planking and physiological maturity when compared to normal population, 10 cm cutting height, planking and harvestable maturity, respectively.

**Performance of Cotton Genotypes Under Varied Water Supply Situations and Water Saving Techniques in Malaprabha Command Area**

A. B. KHOT 1999 MAJOR ADVISOR: Dr. A. S. PRABHAKAR

Two field experiments were conducted during 1993-94 and 1994-95 to evaluate the performance of cotton genotypes, water supply and water saving techniques in Malaprabha Command area in deep black soil at Water Management Research Centre, Belvatagi. In first experiment, treatments comprised of three water cut off periods as main plots and four cotton genotypes in sub plots and in other experiments three water cut off periods were in main plots and five water saving techniques (mulching maize straw @ 5 t/ha, additional dose of potash @ 40 kg/ha, alachlor spray @ 50ppm, silica spray @ six per cent and kaoline spray @ 5 per cent) as sub plots. Both experiments were laid out in split plot design with three replications.

The results revealed significantly higher *kapas* yield (2217 kg/ha) under water supply upto the end of February than water supply upto January end (1794 kg/ha) and December end (1428 kg/ha). Higher *kapas* yield in late water cut off was due to higher yield components like total number of bolls, number of good bolls, number of total opened bolls harvested, *kapas* yield per plant, test weight and ginning percentage over water supply upto end of December and January.

Newly released cotton genotype DGB 105 produced significantly higher *kapas* yield (2298 kg/ha), net returns by 36, 38 and 18 per cent more and benefit cost ratio by 12, 18 and 61 per cent over RAMPBS 155, AH 107 and DCH 32 genotypes, respectively. In pooled analysis, signifcantly higher *kapas* yield (2790 kg/ha) was observed in interaction between late water cut off situation and with DHB 105 genotype over other treatment combinations. Foliar spray of kaoline @ six per cent on DCH 32 cotton produced 49, 12, 38 and 26 per cent more *kapas* yield over mulching with maize straw, additional dose of potash, alachlor spray and silica powder spray, respectively.

### Production Potential and Economic Feasibility of Rice Based Cropping Systems in Low Rainfall Hill Zone of Karnataka

GOVIND V NAYAK 1999 MAJOR ADVISOR: Dr. S. S. MELI

An investigation was initiated at Agricultural Research Station, Mundagod from 1994-95 to 1996-97 to findout the production potential of different rice based cropping systems in low lands and uplands of low rainfall hill zone of Karnataka. Different sequences *viz.*, rice-blackgram, rice-redgram, rice-groundnut, rice-soybean, rice-aware and rice-sunflower were tried with organic and biofertilizer treatments in low lands. In uplands several crops and intercropping systems have been included Rice yields were highly affected by rainfall and its distribution during the season. The extent of rice yield increase by use of organics and biofertilizers was 17.94, 10.65, 10.63 and 9.21 per cent under glyricidia, azolla, eupatorium and vermicompost treatments, respectively as compared to only recommended dose of fertilizers. Rice yield and net returns were also higher under proceedings crops of blackgram and redgram. The highest percentage increase of net returns recorded under glyricidia treatment (24.83) followed by eupatorium (15.92) over control. All organic and biofertilizer treatments given to preceeding crop of rice will have significant effect on the yield of suceeding crops. Groundnut yield (4445 kg/ha) in terms of rice grain equivalent was found to be significantly higher over other crops and the rice grain equivalent higher over other crops and the rice grain equivalent yields of redgram (3639 kg/ha), blackgram (3639 kg/ha) and avare (3330 kg/ha) were found to be on par. Among the different cropping sequences studied, rice-groundnut sequence (10942.9 kg/ha) recorded highest grain yield in terms of paddy grain equivalent but the net returns of rice - blackgram (Rs.40617/ha) rice - redgram (Rs.40606/ha), rice - groundnut (Rs. 40617/ha) were higher compared to other sequences. In upland cotton + soybean and cotton + rice intercropping systems were found to be better compared to sole rice.

### Intercropping Studies in Short Duration Compact Cotton (*Gossypium hirsutum* L.)

M. T. SANJAY 1999 MAJOR ADVISOR: Dr. V. B. NADAGOUDA

A field experiment were conducted at Agricultural College Farm, Raichur on black clayey soils during 1998-99 to study the effect of intercropping on growth and yield of compact cotton and to find out profitable cotton based intercropping system for sustained yields and income of the farmers in the irrigated tract of TBP command area. There were ten treatment combinations comprising of two methods of planting (normal and paired row method) and five intercropping treatments (intercropping of chilli, onion, cowpea and greengram compared with sole cotton). The experiment was replicated three times in factorial randomized block design.

Sole cotton recorded significantly higher seed cotton yield (1912 kg/ha) compared to cotton intercropped with onion (1713 kg/ha), green gram (1646 kg/ha), cowpea (1410 kg/ha) and chilli (1286 kg/ha). The differences in the seed cotton yield due to two methods of planting was not significant. Intercropping of cotton with onion, chilli, cowpea and greengram resulted in significantly higher seed cotton equivalent yield of 3657, 2970, 2152 and 2064 kg per hectare, respectively, compared to sole cotton (192 kg/ha).

Intercropping of onion with cotton gave highest gross and net returns (Rs.54855/- ha and Rs.32460/ha, respectively) followed by cotton + chilli (Rs.44555/ha and Rs.21060/ha, respectively), cotton + cowpea (Rs.32280/ha and Rs.16665/ha, respectively) and cotton + greengram (Rs.30960/ha and Rs.15115/ha, respectively) intercropping systems compared to sole cotton (Rs.28687/ha and Rs.14292/ha, respectively). Higher benefit: cost ratio was observed in cotton + onion (Rs.2.45) intercropping system followed by cotton + cowpea (Rs.2.07), sole cotton (Rs.1.99), cotton (Rs.1.96), cotton + greengram (1.96) and cotton + chilli (Rs.1.90). Higher income equivalent ratio was observed in cotton +onion (1.92), cotton + chilli (1.56), cotton + cowpea (1.13), cotton + greengram (1.08) intercropping systems compared to sole cotton (1.00).

**Integrated Nutrient Management for Sustainable Production in Soybean Based Cropping Systems**

H. B. BABALAD 1999 MAJOR ADVISOR: Dr. C. J. ITNAL

Field experiments were conducted at the Main Research Station, University of Agricultural Sciences, Dharwad during 1993-96 on integrated nutrient management for sustainable production in soybean based production systems. The investigations comparised of use of crop residues (CR), cellulose degrading organism (*Phaenrochaete chrysosporium* (PC), vermicompost (V), vermiculture (VC) and FYM in combination with inorganic fertilizers in soybean + cotton and soybean - safflower cropping systems.

The data over a period of 3 years revealed that the influence of crop residues in the first year was not appreciative. While, its efficacy on crop growth was manifested conspicuously in the second year and reached a level of significance during third year. Incorporation of crop residues regardless of treatment had adverse effects on safflower performance when averaged over two years.

Application of RDF + FYM recorded 17 and 11.7 per cent higher yield of soybean and cotton kapas, respectively over RDF alone with pooled analysis. Continous application of FYM facilitated the reduction of fertilizer levels with on par productivity of the crop. Similarly, vermicompost with RDF and 50% RDF had significantly appreciative influence on crop yields over their individual application.

The economics of various cropping systems indicated that net returns were significantly higher (Rs.30,950/ha) with intercropping of soybean + cotton over sequence cropping of soybean - safflower (Rs.25,502/ha). Incorporation of crop residues with and without PC recorded signifcantly higher net returns (Rs.29,710 and Rs.29,220/ ha, respectively) as compared to residue (Rs.25,760/ha). Among the manurial treatments, RDF + FYM and 50% RDF + FYM recorded significantly higher net returns (Rs.33,430 and Rs.31,970/ha, respectively) over rest of the manurial treatments and RDF.

The combined application of crop residue, manures and their interactions exhibited significant improvement on organic carbon, available soil N, P and K and as well soil microflora. Similarly, physical properties of the soil such as aggregate stability and infiltration were also improved with integrated nutrient management practices.

## SOIL SCIENCES

**Potassium Dynamics in Soils Under Cotton Based Cropping System of North Karntaka**

B. M. HIREKURBAR 1998 MAJOR ADVISOR : Dr. T. SATYANARAYANA

Seventy two soil samples from eighteen profiles belonging to order Vertisol under cotton based cropping system of North Karnataka were collected to investigate distribution of forms of potassium, K content in soil textural fractions, K fixation and release characteristics and Quality-Intensity (Q/I) parameters of potassium in these soils. The range in contents of various forms of potassium in the soil profiles were 8.00 to 20.25 ppm, 102 to 285 ppm, 445 to 1125 ppm, 0.454 to 1.328 per cent, 0.523 to 1.469 per cent and 306 to 770 kg $K_2O$ $ha^{-1}$ of water soluble, exchangeable, non-exchangeable, lattice, total and available potassium, respectively. The average contribution of water soluble, exchangeable, non-exchangeable and lattice K to total soil K varied from 0.09 to 0.30, 1.21 to 3.33, 5.97 to 11.90 and 85.00 to 92.30 per cent, respectively. The potassium content in coarse sand, fine sand, silt and clay ranged from 0.15 to 0.42, 0.32 to 1.19, 0.46 to 1.33 and 0.63 to 1.65 per cent, respectively. The mean potassium contribution from coarse sand, fine sand, silt and clay towards total soil K were 3.85, 5.36, 22.86 and 67.93 per cent, respectively. The K fixation capacity of surface soils varied from 0.78 to 1.34 c.mol ($p^+$) $kg^{-1}$. The per cent K fixation varied from 15.60 to 27.20. The cumulative K release, step-K and constant rate K values ranged from 537 to 1157, 400 to 747 and 13 to 44 ppm, respectively. The Q/I parameters viz., $ARc^k$, $K_t$, $K_x$, $K_o$, $PBC^k$ and - G values ranged from 1.45 to 3.10 $(ML^{-1})$ $1/2^*$ $10^{-3}$, 0.80 to 1.30, 0.50 to 0.76, 0.30 to .054 c.mol (p+) $kg^{-1}/(ML^{-1})^{1/2}$ and 3421 to 3871 cal. $e^{-1}$, respectively. The soils under present study were high in available and step K. However, the crops may face deficiency of potassium due to lower immediately available K ($ARe^k$). Hence, K fertilization is necessary to maintain higher level of immediate available K to cotton crop.

**Studies on Potassium Dynamics in Rice Soils of Different Agro-climatic Zones of Karnataka**

S. K. GALI 1998 MAJOR ADVISOR : Dr. T.SATYANARAYANA

An investigation was carried out to study the potassium dynamics in rice soils of different agro-climatic zone of Karnataka. The soils used in the study varied widely in their characteristics. The water soluble, exchangeable and non-exchangeable K contents of soils varied from 2 to 7, 31 to 232 and 60 to 982 ppm, respectively. While, lattice and total K contents varied from 0.297 to 2.818 and 0.306 to 2.876 per cent respectively. On an average, water soluble, exchangeable, non-exchangeable and lattice K constituted 0.02, 1.02 and 96.02 per cent of total K. Coarse sand and fine sand fractions were the dominant contributors to total K in coarse textured soils while, silt and clay were the major contributors to total K in fine textured soils. The cold $H_2So_4$ extractable K was found to be a better availability index for these soils. The higher K releasing power was noticed in soils of Belgaum, Bhadravati, Hiriyur and Kathalgere. The soils of hilly and coastal zones exhibited poor K releasing power. The smectitic black soils showed higher K supplying power than kaolinitic red and lateritic soils and a distinct difference between K releasing power and K supplying power of soils was brought out in this study. Green house studies indicated that the kaolinitic soils, particularly, soils of hilly and coastal zones would respond well to application of K at higher level (50 ppm) whereas the smectitic black soils may need only maintainance dose (25 ppm) of potash fertilizer. The potassium fixation capacity of soils ranged from 0.16 to 1.53 c mol ($p^+$) $kg^{-1}$, the black soils showing higher fixation capacity than red and lateritic soils. Illite, the K bearing mineral was present as an associated clay mineral in all the soils except in soils of Bhadravati and Hiriyur where, it occurred as co-dominant mineral along with kaolinite.

## AGRICULTURAL ENTOMOLOGY

**Studies on the Insect Pests of Turmeric, *Curcuma longa* L. with Particular Reference to the Rhizome fly, *Mimegralla coeruleifrons* Macq. (Micropezidae : Diptera)**

Y. K. KOTIKAL 1998 MAJOR ADVISOR : Dr. K. A. KULKARNI

Investigations were undertaken at K.R.C. College of Horticulture, Arabhavi (Tq. Gokak) and other turmeric growing areas of northern Karnataka.

Turmeric was prone to attack by 63 phytophagous species, of which 22 belonged to Coleoptera, 14 to Hemiptera, 10 to Lepidoptera, four each to Thysanoptera, Orthoptera, Diptera and five were non-insects. Of these, 26 species are new to this crop, 28 are new to Karnataka and one is new to India. Eighteen natural enemies were recorded on different pests of turmeric, of which 10 are entirely new records and eight are new to Karnataka.

Life cycle of the rhizome fly varied from 28.30 to 38.00 days, incubation period from 3.40 to 4.10 days, larval period from 13.50 to 15.80 days and pupal period from11.00 to21.00 days. The fecundity ranged from 83.80 to 110.60 with hatching percentage of 87.07 to 89.87. The life fecundity tables were developed. Accordingly, when length of generation was 27.54 days with an innate capacity to increase by 0.18 and finite rate of increased by 1.19 females per day. Economic injury level was 0.34 maggots per plant, i.e., one maggot per three plants. Yield reduction due to fly infestation was 17.81 to 30.33 quintals per hectare.

Genotypes BSR-1, CO-1, Cuddapah and Salem emerged as less susceptible and better yielders under pesticide free conditions. Pongamia cake and neem cake, applied to soil were as effective as phorate application in checking the rhizome fly and shoot borer with cost benefit ratio of 1:7.47 and 1:7.37, respectively.

Soaking seed rhizomes in insecticides solutions of imidacloprid, quinalphos, dimethoate, monocrotophos, phosphamidon and endosulfan for 8h resulted in checking the pests carried through seed materia, better germination and establishment of the crop.

**Integrated Management of Pigeonpea Pod Borer, *Helicoverpa armigera* (Hubner) with Special Reference to *HaNPV* and Insectivorous Birds**

J. B. GOPALI 1998 MAJOR ADVISOR : Dr. S. LINGAPPA

Female to male moths in 10:13 ratio in a oviposition cage increased fecundity (504 eggs) and hatchability of eggs (64.2%) after incubating them in earthen pot covered with cloth and kept in moist sand in plastic basin. Rearing of neonate larvae on chickpea seedlings upto four days in group, and thereafter individually on artificial diet afforded highest survivability. Fourth instar larva was found ideal for large scale production of virus (2.81 x $10^9$ POB/larvae). Plant shaking method was found to be most productive to collect the larvae in pigeonpea ecosystem. Cost of production of 100 LE from laboratory reared larvae was Rs. 102.0, being Rs.25.40 more than from field collected larvae (Rs.76.80). *Ha*NPV stored under refrigerated conditions maintained virulence throughout the year as against four and six months, respectively, under ambient and earthen pot conditions. Combined use of both UV portectant (Robinblue 0.05%) and phagostimulant (0.5% of soymilk, or cotton seed kernel exteract or jaggery) not only resulted in higher and quicker mortality, but also increased the persistence of HaNPV. HaNPV @ 500 LE $ha^{-1}$ twice at 15 days interval starting from flowering stage gave satisfactory control *H. armigera*. Application of *Ha*NPV with high volume sprayers (Knapsack, battery operated and fod sprayers) was more effective compared to ULV sprayers. Among insectivorous birds, black drongo, house sparrow, green bee eater and blue jay accounted for 60.3, 19.8, 12.9 and 6.8 per cent of larval predation, respectively. Field evaluation of different perches revealed that animate perch (sorghum variety with bow head) @ 2500 $ha^{-1}$ (300-400 grams of seeds $ha^{-1}$) was found most efficient in reducing the larval number and increasing the grain yield over other types of perches evaluated. Predatory activity was hampered in synthetic insecticide sprayed plots. Bird droppings contained virulent virus particles (7 x $10^8$ POB/ml).

Evaluation of different IPM schedules with sorghum as bird perch, module comprising of HaNPV (500 LE $ha^{-1}$), NSKE (5%) + HaNPV (250 LE $ha^{-1}$), chlorpyriphos (0.04%), alphamethrin (0.01%) and module involving two sprays of HaNPV (500 LE $ha^{-1}$), and one each of chlorpyriphos and alphamethrin (0.01%) were not only cost competitive, but also were socially acceptable, ecologically balanced and easily adoptable.

**Utilization of Fungal Pathogen *Nomuraea rileyi* (Farlow) Samson in the Management of Lepidopterous Pests**

NARENDRA S. KULKARNI 1999 MAJOR ADVISOR: Dr. S. LINGAPPA

Pathogenicity of *Nomuraea rileyi* to important lepidopterous pests under laboratory conditions indicated that the highest concentration of *Nomuraea rileyi* (1.2 x $10^8$ conidia/l) caused highest mortality in *S. litura* and lowest in *G. mellonella* after 10 days of exposure period. Influence of host plants on the response of *S. litura* to *N. rileyi* indicated that larvae fed on groundnut were more susceptible by recording the lowest $LC_{50}$ value followed by soybean, potato and cotton. Treatment effect of fungus on *S. litura* in soybean and potato fields was not noticed at 3 DAS but in increased gradually at 7 DAS and became distinctly evident at 14 DAS. Pod and grain damage to soybean in fungus treated plots at the highest dose was less than in NPV and more than *Bt*, however, the yield was as much as in NPV but lesser than in *Bt*. In potato, the fungus was at par with other two pathogens in reducing the *S. litura* larval population. But the yield realized due to fungus application was less than in both NPV and *Bt*. Comparative analysis of fungual efficacy revealed that it was more effective in soybean ecosystem than in potato. Foliage damage followed the same trend in both crops. Fungus was more effective in reducing *H. armigera* larval population in *Stylosanthes* followed by redgram and cotton. In redgram, the fungus did not contain the pod and grain damage as much as in viral and bacteria treated plots and this was reflected in grain yield. Bollworm incidence in the fungus treated plots was higher than in NPV and *Bt* treated plots. Virus and bacterium produced more number of good opened bolls and conversely less bad opened bolls than *N. rileyi* and consequently, the former bioagents produced higher yield.

Comparative account of efficacy of fungus in all the five ecosystems studied suggest that the fungus was more effective against *S. litura* than *H. armigera* in suppressing the larval population. All the microbial agents failed to overtake the superiority of chemical chloropyrifos in any of the crop ecosystem at all intervals of observation period. Seasonal incidence of *N. rileyi* to *S. litura* in groundnut, soybean and potato was noticed between 32$^{nd}$ (August I week) to 40$^{th}$ (October I week) standard week. Among the three crops, maximum incidence was noticed in groundnut followed by soybean and least in potato. Fungal incidence on *H. armigera* in cotton, redgram and *Stylosanthes* was noticed between 43$^{rd}$ and 51$^{st}$ standard week. Among the three crops *Stylosanthes* proved to be better habitat for the fungal activity followed by redgram and least in cotton. Positive significant correlation was noticed between fungal incidence and afternoon relative humidity in groundnut, soybean and potato.

All insecticides and carbendazim, a test fungicide inhibited the growth of the fungus at the recommended dose

under *in vitro* conditions. Carbendazim was more detrimental and neem based insecticide was the safest to fungus *in vitro* conditions. Adverse effect of fungicide on the infectivity of *N. rileyi* to *S. litura* attenuated with increase in time gap of three days between conidia and fungicide spray under green house conditions. Sorghum and rice grains served as most productive media for conidial growth whereas, ragi and wheat did not serve as efficient food source. Conidia harvested from sorghum grains exhibited higher virulence by recording the lowest $LC_{50}$ value among all the grains tested.

## CROP PHYSIOLOGY

### Influence of Temperature Regimes on Morpho-physiological Traits Associated with Productivity in Groundnut (*Arachis hypogaea* L.) Genotypes

S. J. PATIL 1998 MAJOR ADVISOR : Dr. M. B. CHETTI

Field experiments were conducted during rabi/rabi-summer seasons of 1994-95 and 1995-96 to study the influence of temperature regimes on morphological, physiological, biochemical and yield components in groundnut genotypes at Regional Research Station, Raichur, University of Agricultural Sciences, Dharwad. The experimental consisted of four temperature regimes and ten genotypes laid out in factorial randomised block design with three replications.

Results revealed significant differences between the genotypes, temperature regimes and their interaction with respect to various morphological, physiological, growth and biochemical parameters. Number of branches per plant, dry matter accumulation and growth parameters except BMD decreased with an increase in the growth temperature. Crop took less number of days for initiation and cessation of flowering with an increase in the growth temperature. The genotype Dh-40 took the maximum number of days for flower initiation, while JL-24 took the least number of days. The number of flowers per plant reduced greatly with an advancement of growth temperatures. The genotype R-8808 produced the maximum number of flowers and TMV-2 produced the least number of flowers. The genotypes R-8808 followed by ICGS-11 and R-9251 accumulated more dry matter while the genotypes TMV-2 and JL-24 recorded the least.

The Chlorophyll content and NR activity increased upto 60 DAS and decreased thereafter irrespective of the temperature regimes and genotypes. The extent of decline was more in TMV-2 and Dh-40 and least in R-8808 and R-9214 due to increase in the growth temperatures. The wax content increased with an increase in growth temperature and advancement in crop growth with genotpes R-9214 followed by R-8808 and R-9251 having the maximum values. While the genotypes Dh-8, Dh-40 and TMV-2 had the lower values.

The pod yield, kernal weight, 100 seed weight shelling per cent and harvest index decreased with an increased in the growth temperature. The genotypes R-8808, R-9214 and R-9251 recorded the maximum pod weight in all the temperature regimes and the extent of reduction in various yield components due to increase in growth temperature was less in these genotypes. However, the extent of reduction was maximum in TMV-2 followed by Dh-40.

## GENETICS AND PLANT BREEDING

### Genetics of Yield, Its Components and Sex Expression Over Seasons in Castor (*Ricinus communis* L.)

P. V. KENCHANAGOUDAR 1999 MAJOR ADVISOR: Dr. S. A. PATIL

The present investigation was carried out to understand the behaviour of sex expression and the genetics of yield and its related traits in castor. Studies involving sex expression of seven pistillate lines over three rabi and two kharif seasons, confirmed that three lines *viz.*, VP-1 (NR), NES-19 and LRES-17 had interspersed nature of flowering during summer season and expressed stable pistillate behaviour during the kharif seasons which are of 'S' and 'NES' types.

In another experiment to study heterosis, combining ability and gene action involving eleven hybrids showed significant heterosis over the check GCH-4 with respect to seed and oil yield. Of these, two were early, six were medium and three were of long duration. High oil heterotic cross VP-1 (NR) x RG-202 was consistent in both the seasons. The magnitude of additive variance was much higher than non-additive variance for days to flower initiation, days to 50 per cent flowering, days 100 per cent maturity on primary raceme, 100 seed weight and capsules on primary receme. However, other characters *viz.*, nodes on the primary raceme, average internodal distance, Bartlett's rate of index for yield (BRY) and oil content showed both additive and non-additive variances, while yield per plant and other yield

components were mainly under the control of non-additive gene action. The pistillate lines NES-6 and NES-17 and the testers *viz.*, RG-135, RG-360, Bhagya, Aruna and 48-1 were good general combiners for earliness. While VP-1 (NR) and NES-17 pistillate lines and RG-374, RG-359, 48-1 and SH-53 testers were good general combiners for oil content, seed yield and its related traits.

The estimates of sca effects of seven crosses were significant and they recorded significantly superior seed yield compared to the check GCH-14. Cross NES-17 x RG-360 exhibited significant positive sca effects for early maturity, NES-17 x VP-1 (M) for 100 seed weight and VP-1 (NR) x RG-359 for oil content. These could be considered for simultaneous exploitation of hybrid vigour for earliness, seed yield and oil content. Among the high yielding potential specific cross-combinations, two hybrids *viz.*, NES-17 x 48-1 and NES-17 x RG-360 were early, five hybrids *viz.*, NES-17 x RG-374, NES-17 x VP-1 (M), NES-19 x RG-374, NES-17 x RG-358, VP-1 (NR) x RG-359 and VP-1(NR) x 48-1 were of medium duration and three hybrids VP-1 (NR) x RG-374, LRES-17 x RG-374 and VP-1 (NR) x VP-1 (M) were of long duration. It is suggested to improve NES-6 and NES-17 for femaleness.

**Genetics Analysis of Physico-Biochemical Traits Influencing Drought Tolerance in Rice (*Oryza sativa* L.)**

H. D. MOHAN KUMAR 1999 MAJOR ADVISOR: Dr. P. M. SALIMATH

A study was undertaken to investigate the genetics of physico-chemical traits influencing drought tolerance in rice. Seventeen genotypes and sixty hybrids, obtained by crossing five females with twelve males in a L x T mating design, comprising R x R, R x S, S x R and S x S type of crosses as far as drought is concerned were evaluated in two environments *viz.*, moisture stress-free environment ($E_1$) and moisture stressed at reproductive stage ($E_2$). Analysis of variance revealed highly significant differences for all the characters and in both the environments indicating significant genetic differences among the parents and hybrids. For combining drought tolerance and higher productivity, varieties Rasi, Amruth, Tellavadu, Bilekalavi, MTU-1001, Jaya and Sona Mahsuri were identified as best combiners. The hybrids Amruth x Jaya, Rasi x Jaya, IR-20 x Jaya, Amruth x Sona Mahsuri, Amruth x Annada, Dodiga x Jaya, Rasi x MTU-1001 were identified as the best hybrids to look for good recombinants with high yield and better tolerance to drought. The range of heterosis observed, however, was very narrow for grain yield per cent (-1.10 to 0.76 in $E_1$ and -1.54 to 0.90 in $E_2$). Heterosis for harvest index ranged from -4.06 to 11.34 in $E_1$ and from -3.95 to 5.60 in $E_2$. All the yield components except panicle length were under the control of additive genes. Root characters *viz.*, root length, root thickness, root number, root volume and root dry weight and physico-biochemical characters viz., Relative water content, Epicuticular wax, Proline accumulation and chlorophyll stability index were also under the control of additive genes. Correlation and path-analysis revealed that harvest index, fodder yield per plant and productive tillers per plant were the only characters to show high direct effects on grain yield, both in $E_1$ and $E_2$ along with high positive correlation values. None of the Physico-biochemical and root related characters showed significant relationship with grain yield directly. However, root length followed by root dry weight under drought situation ($E_2$) and root thickness under stress free ($E_1$) situation were found to influence the grain yield indirectly. Hence, for combining drought tolerance and higher productivity in rice, it is suggested to base the selection primarily on harvest index, fodder yield, productive tillers per plant followed by filled grains per panicle and 1000-grain weight.

## HORTICULTURE

**Effect of Growth Regulators on Growth and Flowering of Roses and Postharvest Physiology of Cut Roses**

S. M. F. DIAS 1998 MAJOR ADVISOR : Dr. B. S. REDDY

Experiments were undertaken on rose cv. Gladiator at the College of Agriculture, Dharwad in order to maximise the quality flowers and to enhance the shelflife of roses.

Relatively higher number of basal canes were obtained in plants pruned 45 cm and sparyed with BRs at 5 and 10 ppm. Application of Ga at 200 ppm in plants pruned to 45 cm and BRs at 5 ppm in plants pruned to 25 cm and 45 cm increased the plant spread.

Shoot length, shoot girth, internodal length and pedicel girth were enhanced by BRs at 5 ppm in plants pruned to 45 cm. On the other hand, GA at 200 ppm in plants pruned to 45 cm enhanced the shoot length and girth.

Early flowering was induced by BRs at 5 ppm at all the levels of pruning. Floral attributes, *viz.*, bud length, diameter, number of petals, petal length and width were magnified by BRs and GA at 5 and 200 ppm, respectively on plants pruned to 45 cm. While, only GA (200 ppm) was effective in unpruned plants in increasing the floral quality. The yield of marketable flowers was more in plants pruned

to 45 cm and sprayed with BRs at 5 ppm followed by spraying of GA at 200 on plants pruned to 25 and 45 cm.

Postharvest physiological experiments revealed that, pulsing of cut roses with 5 per cent sucrose + 250 ppm $CoSo_4$ for 12 hours and 7 per cent sucrose + 250 ppm $CoSo_4$ for 9 hours helps in extending the longevity of cut roses. The results on duration of cold storage signified that, the roses can be best stored for 3 days at 4° C and 85% RH. Increased vaselife (more than 11 days) was noticed in the cut roses held in vase solutions 0.5 mM $CoSo_4$ with 4 per cent sucrose. Histochemical studies indicated that chemical preservatives in vase reservoirs reduced the microbial and physiological vascular blockages.

**Standardisation of Production Technology in Daisy (*Aster amellus* L.)**

V. S. PATIL 1998 MAJOR ADVISOR : Dr. U. G. NALAWADI

In order to standardize production technology for profitable cultivation of Daisy (*Aster ammellus* L.) for cut flower production four experiments were conducted at University of Agricultural Sciences, Dhawad during 1996-97. The nutritional experiment showed that application of 150 kg nitrogen and 100 kg phosphorus per hectare significantly increased the flower production as well as growth and yield attributes during both kharif and rabi seasons and also flower quality characters like flower diameter, spike length, keeping quality etc. The economics indicated the realization of maximum net profit with the same nutrient combination. Increased nitrogen and phosphorus application increased the uptake of both the nutrients by plants individually and in combination. Foliar application of growth retardants (MH, CCC and Alar) at 360 days after planting reduced the plant height but increased the number of leaves, suckers, leaf area, leaf area index and dry matter productin. As a result of these flower yield and quality yield increased. Application of CCC 1500 ppm and Alar 1500 ppm significantly increased flower yield and maximum net return was realized with application of CCC. June planting followed by July and May plantings produced maximum number of flower spikes with high quality. Vase life studies indicated that to prolong the shelf life of cut flowers of daisy the chemical preservatives 8 HQS at 0.4 and 0.2 per cent and $Al_2 (So_4)_3$ at 0.4 per cent concentrations have been found to be the best.

**Reduction Potential of Vegetable Crops Under Eucalyptus and Leucaena based Agroforestry Systems**

T. B. ALLOLI 1998 MAJOR ADVISOR : Dr. P. NARAYANA REDDY

Production potential of different vegetables viz., garlic, bhendi, clusterbean and cucumber, under eucalyptus and bhendi in leucaena based agroforestry systems was assessed. Allelopathic potential of both species was also investigated on the aforesaid test crops. It was envisaged to assess the efficiency of different vegetables in eucalyptus based agroforestry systems, interms of per cent attainment of growth and productivity over their respective control, in response to eucalyptus plant management practices viz., felling and trenching. Integration of different plant management practices proved to be most beneficial than adopting single practice. The effect of felling became more effective in conjunction with trenching, as manifested in significantly the highest per cent attainment of yield in all vegetables due to felling and trenching (FT).

Among different vegetables bhendi, proved to be most efficient across the felling and trenching of eucalyptus as reflected in the highest per cent attainment of yield in bhendi. Performance of garlic across the system was extremely poor, as reflected in significantly the lowest attainment of yields over its control. The economic analysis of different systems revealed that growing cucumber and bhendi at FT (felling and trenching) system appeared to be most beneficial economically. On the contrary the cultivation of these vegetables in NFNT (no felling no trenching) and NFT (no felling and trenching) system proved to be unacceptable economically. The highest yield potential of bhendi was realised in leucaena based alley cropping when it was treated with 5 ton/ha of loping and 100 per cent recommended dose of nitrogen. Besides increasing productivity of bhendi, incorporation of loppings also promoted soil fertility on sustained basis resulting in saving of chemical fertilizers.

Allelopathic studies revealed inhibitory effect of eucalyptus on the germination and growth of vegetable seedling. Leaves proved to be the most potent source of allelopathic effects than root and base. All plant extract, showed intense inhibitory influence at higher concentration (10%) than at lower concentration (1%). Among vegetables cucumber was most affected as revealed by lowest per cent germination across the concentration and source. Inhibitory effects were lowest in clusterbean. The magnitude of allelopathic influence of leucaena was not as much as eucalyptus. Among various sources, the leaf extract of leucaena showed relatively more inhibitory effect, compared to root and bark extract.