Agricultural Entomology

Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga

Ph.D. theses abstracts produced in Agricultural Entomology

1. **Studies On Gum Technique For Management Of Coffee Stem Borer, *Xylotrechus quadripes* Chevrolat (Coleoptera: Cerambycidae)**

(AVINASH)

ABSTRACT

Research was conducted to study the novel gum technique against the coffee white stem borer, *Xylotrechus quadripes* in various field locations in Chikkamagaluru, Karnataka during 2019-2021. Among the different methods of gum application tested, the application of gum in helical manner or helix was found to be trapping maximum beetles than other treatments. The results indicated that, the synthetic gum trapped highest beetles (0.71 beetles/plant) than the guar gum (0.14 beetles/plant) due to more stickiness and longevity. Pattern of emergence of *X. quadripes* was studied to identify proper timing of gum application across altitudinal gradients which revealed that, significant beetle emergence was noticed at the middle altitudinal level (0.682 beetles/infested plant) and at lower altitudinal level (0.679 beetles/infested plant), whereas in the higher altitudinal level, comparatively less beetle emergence (0.462 beetles/infested plant) was noticed. The peak beetle emergence was high in the month of October in all three altitudes studied. The evaluation of gum technique with other standard checks showed that, the gum technique evaluated as two-time gum helix and one-time gum helix recorded less number of ridges on main stem during 2020 (3.05 and 3.11 ridges/infested plant, respectively) and 2021 (3.00 and 3.05 ridges/infested plant, respectively) when compared with control plot in 2020 and 2021 (3.73 and 3.32 ridges/infested plant, respectively). Evaluation of gum technique with other techniques showed that, a considerable per cent reduction of infestation over control was seen by adopting two-time gum helix and one-time gum helix (29.41% and 23.52%, respectively). The baseline population of the *X. quadripes* was estimated to be 318.1 beetles/acre and the data on age of the plant, mean *X. quadripes* emerging from it and the relative yield can be used in cumulative loss prediction.

July, 2022

(S. Pradeep.)
Major Advisor

2. Morphological And Molecular Identification Of Earwigs (Dermaptera) Of South India With Insights Into Predatory Potential Against Fall Armyworm, *Spodoptera frugiperda*

(KARTHIK, C. M.)

ABSTRACT

The taxonomy of order Dermaptera has been stagnant from the past two decades. This gap provides an opportunity for exploring, collecting, describing earwig fauna of South India. Surveys undertaken during 2020-22 along the selected parts of South India yielded 32 species of earwigs belonging to 21 genera of eight families including one new species and two new records from India. Among the collected samples, highest samples were represented by Anisolabididae (32.85%) followed by Forficulidae (26.49%), Chelisochidae (20.94%), Labiduridae (9.45%), Spongiphoridae (7.39%), Pygidicranidae (1.85%), Diplatyidae (0.82%) and Apachyidae (0.21%). A new species of earwig, *Diplatys sahyadriensis* Karthik, Kamimura and Kalleshwaraswamy, 2022 was reported for the first time in India from sugarcane and an identification key to *Diplatys* species of India and Sri Lanka was given. *Chaetospania anderssoni* and *Dendroiketes corticinus* were two new records from India. The specific region of mitochondrial COI (*mtCOI*) gene of 13 earwigs DNA was amplified and the accession numbers were obtained by submitting the sequences to the NCBIs GenBank. Phylogenetic analysis using maximum likelihood method based on *mtCOI* gene revealed that species belonging to Labiduridae and Forficulidae formed the basal group, while Anisolabididae formed the sister group with Pygidicranidae and Spongiphoridae. The biology of *Euborellia annulata* was studied on artificial diet (Dog biscuits) under laboratory condition. The incubation period recorded was 10.60 days and total nymphal period was 32.26 days. The *Forficula gravelyi* was tested for its efficacy as biocontrol agent on the eggs of fall armyworm, *S. frugiperda* showed a significant egg predation (t=19.95) (P<0.01) in laboratory. There was a significant reduction in the number of egg masses (t=-2.35) (P<0.01), larval population (t= -6.36) (P<0.01) and increased number of earwigs (t=16.90) (P<0.01) per plant in an augmented plots compared to control indicating the potentiality of *F. gravelyi* for exploitation as biocontrol agent of fall armyworm.

December, 2022

(Kalleshwaraswamy, C. M.)
Major Advisor

3. Investigations On Insecticide Resistance And Development Of Ipm Modules Against Fall Armyworm, *Spodoptera frugiperda* (J. E. Smith) On Maize

(KAVYASHREE, B. A.)

ABSTRACT

Spodoptera frugiperda (J. E. Smith) is an invasive, polyphagous and destructive insect pest that causes considerable damage to maize crops. Studies were undertaken to know the field evolved resistance, enzymes involved in insecticide resistance, genetic diversity and effect of various modules against *S. frugiperda*. The median lethal concentration (LC_{50}) values for *S. frugiperda* collected from different parts of South India and Punjab state were established for five different insecticides by a diet overlay method of bioassay. The LC_{50} of different insecticides ranged from 0.01 to 290.67 ppm. Among the insecticides, emamectin benzoate was more toxic, followed by spinetoram, chlorantraniliprole, novaluran and lambda-cyhalothrin. Emamectin benzoate was the most potent chemical, with relative potency ranging from 171.7 to 53171. In the current investigation, the activity of four detoxifying enzymes viz., carboxylesterase (4885.66 to 103823 n moles of α naphthol formed/min/mg midgut protein), glutathione-S-transferase (33.52 to 486.92 µ mol of CDNB-GSH conjugated/min/mg protein) mixed-function oxidases (0.72 ± 0.471 to 6.17 ± 4.90 p-nitrophenol formed/min/mg protein), and acetylcholinesterase (0.0035 to 0.025 µ mol of thiocholine formed/min/mg protein) were determined in the field populations of *S. frugiperda*. Populations *viz*., Tirupati, Hosur recorded lower LC_{50} values for emamectin benzoate, spinetoram, chlorantraniliprole and these populations have also been recorded with lower activity of glutathione-S-transferase and monoxygenase. The genetic diversity of *S. frugiperda* populations was studied using Cytochrome oxidase subunit I (*MtCO1*), Triose phosphate isomerase (*Tpi*), Carboxylesterase and Glutathione S-transferase. The highest genetic variation (1.043%) was found between the *S. frugiperda* populations of Hosur and Delhi with respect to *Tpi* gene and 0.024 per cent between the populations of Solapur and Hosur for *MtCO1*. Field experiments were carried out to assess the efficacy of various modules against fall armyworm. The bio-intensive module recorded highest number of coccinellids (1.27/plant) and ants (0.42/plant). The chemical control module recorded the highest larval reduction over control (86.04%) and was found superior by recording significantly higher maize yield (53.45 q/ha) with 1.86 B:C ratio followed by the IPM module (48.06 q/ha) with 1.85 B:C ratio.

July, 2022

(Sharanabasappa.)
Major Advisor

4. Morphological And Molecular Identification Of Mealybugs (Hemiptera: Pseudococcidae) In Major Horticultural Crops

(KAVYA YADAV, G. A.)

ABSTRACT

The study on morphological and molecular identification of mealybugs (Hemiptera: Pseudococcidae) in major horticultural crops was carried out in the Department of Agricultural Entomology, College of Agriculture, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga during 2019-2021. During the present study, a total of 19 species of mealybugs *viz*., ***Coccidohystrix insolita***, *Dysmicoccus brevipes*, ***Dysmicoccus neobrevipes***, *Ferrisia virgata*, *Formicoccus polysperes*, *Maconellicoccus hirsutus*, *Nipaecoccus viridis*, *Palmicultor palmarum*, ***Paracoccus marginatus***, ***Phenacoccus solenopsis***, *Phenacoccus madeirensis* , *Phenacoccus manihoti*, *Planococcus citri*, *Planococcus lilacinus*, *Pseudococcus longispinus*, *Pseudococcus jackbeardsleyi*, *Rastrococcus iceryoides*, ***Rastrococcus invadens*** and ***Saccharicoccus sacchari*** infesting 154 host plants belonging to 55 plant families were recorded and maximum hosts were recorded from the family Fabaceae. Among the mealybug species, *P. citri* recorded highest of 17.87 per cent, followed by *F. virgata* and *P. solenopsis* with 15.15 per cent each. *Phenacoccus manihoti* was reported for the first time on tapioca in Karnataka from Udupi district. Mealybugs, *P. madeirensis* and *R. invadens* were reported for the first time on Noni and *R. iceryoides* from Karonda and Wood apple in Shivamogga district. Identification keys were developed for the 19 mealybug species belonging to 13 genera collected from different ecosystem. Using the specific primer pair ITS2 gene, 11 mealybug species were amplified and sequenced. Among 56 species of natural enemies recorded, 25 species were Hymenopteran parasitoids belonging to seven families and 31 species were predators belonging to five orders *viz*., Coleoptera (18 species), Diptera (8 species), Neuroptera (2 species), Lepidoptera (2 species) and Hemiptera (1 species) which were found associated with 15 different mealybug species. A total of 16 species of ants from four subfamilies *viz*., Dolichoderinae, Formicinae, Myrmicinae and Ponerinae were found associated with 19 mealybug species during study period.

June, 2022

(Jayalaxmi Narayan Hegde.)
Major Advisor

5. Molecular Diversity, Distribution, Developmental Biology And Management Of Tomato Leafminer, *Phthorimaea absoluta* (Meyrick) (Lepidoptera: Gelechiidae)

(PAVITHRA, H. B.)

ABSTRACT

Phthorimaea absoluta (Meyrick), an invasive pest that causes considerable damage to tomato crop. Studies on population dynamics of *P. absoluta* in the farmers fields at Davanagere and Chikkamagaluru revealed that the highest pest incidence was recorded in the summer, followed by *rabi* and *kharif* season. The genetic diversity of *P. absoluta* samples from five districts of Karnataka was studied using mitochondrial gene, *i.e.*, Cytochrome oxidase subunit I. The sequence comparison of the mtCOI gene of all the samples exhibited 95 to 100 per cent nucleotide similarity. Dendrogram results of CO1 region of *P. absoluta* samples revealed that there was not much diversity among *P. absoluta* population. Variation in biology of *P. absoluta* was observed when they were reared at five different temperatures in growth chambers. The duration of incubation period, larval and pupal period decreased as the temperature increased. The most conducive temperature for *P. absoluta* fecundity and per cent survival was found to be between 25 ^{0}C (136.73 eggs/female and 90.80 %) and 30 ^{0}C (141.59 eggs/female and 85.00 %). The median lethal concentrations of different insecticides among different *P. absoluta* populations from South India ranged from 1.40 to 106.0 ppm. Chlorantraniliprole showed more toxicity to second instar larvae, while the larvae were least susceptible to neonicotinoids. Evaluation of three modules *viz.*, Bio-intensive IPM module, IPM module and Farmer's practice module for the management of *P. absoluta* revealed significant variation in per cent leaf and fruit damage up to 75 days after transplanting (DAT) which may be due to impact of different treatment components in respective modules, but at 100 and 125 DAT, per cent leaf and fruit damage was on par among modules during *rabi* and summer seasons. IPM module was found to be superior by recording higher B:C ratio (3.85) followed by farmers practice (3.58).

December, 2022

(Sharanabasappa.)
Major Advisor

6. Isolation, Characterization And Evaluation Of Female Sex Pheromone Of Fall Armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae)

(SHARATH, K. N.)

ABSTRACT

The current investigation was carried out during 2020-22 at Department of Entomology, College of Agriculture, Shivamogga to study the geographical variation in sex pheromone composition, female calling behaviour and to evaluate the male moth response under field and laboratory conditions. The GC-MS analysis of the female sex pheromone gland extracts showed the presence of four pheromone compounds *viz*., (Z)-9-tetradecenyl acetate (Z)-7-dodecenyl acetate, (Z)-9-dodecenyl acetate and (Z)-11-hexadecenyl acetate. The relative proportion of these compounds varied significantly across different geographical populations and also elicited a strong antennal response in male moths when tested with GC-EAD. The male moths exhibited dose dependent response which further varied across different pheromone blends tested. The female calling behaviour varied across both geographical population and female calling age. Maharashtra population had the highest onset of calling time (120.75 minutes) and Telangana (69.05 min) and Gujarat (69.07 min) being the lowest did not show any significant variation in onset of calling between them. Similarly, the onset of calling was more in case of emergence day females (160.51 min) in all the four population and increased with age. Likewise, Gujarat population (229.75 min) called for longest duration and least calling duration was observed in case of Maharashtra population (200.25 min). Further, the proportion of calling and non-calling females varied significantly across progressive calling age. During field evaluation with commercial lures, a total of 415 moths were captured in four pheromone baited traps during the *kharif* season of 2021, the highest trap catches of males of *S. frugiperda* were seen during the July fourth week (27.75 moths/trap/week) and had a highly significant and positive correlation with larval infestation (r = 0.819**). The evaluation of different commercial sex pheromone lures to attract *S. frugiperda* showed a significant difference both among the treatments as well as across the different weeks of the crop growth.

December, 2022

(Sharanabasappa.)
Major Advisor

7. Morphological And Molecular Characterization Of Spider Mites In Different Agro-Ecological Situations Of Karnataka

(SAFEENA MAJEED, A. A.)

ABSTRACT

Investigations on integrated taxonomy of tetranychid mites associated with agri-horti and pasture ecosystems of Karnataka included Scanning Electron Microscope (SEM) imaging of distinctive female characters besides illustrations, diagnostic keys, molecular characterization and genetic diversity of major polyphagous spider mite species across geographical locations and host plants using nuclear gene (rDNA). 107 host plants belonging to 31 botanical families were sampled across 41 locations. A total of 35 spider mite species representing six genera (*Aponychus*, *Eutetranychus*, *Petrobia*, *Oligonychus*, *Schizotetranychus* and *Tetranychus*) and two subfamilies *viz*., Bryobinae and Tetranychinae were collected and identified. Of which, genus *Tetranychus* was more abundant (with 15 species), followed by genus *Oligonychus* (9 species) and *Schizotetranychus* (5 species). *T. neocaledonicus* was the predominant species found on 22 plant species in 17 locations. The study has added one new species, *Oligonychus bellarensis* sp. nov. and two new records, *Oligonychus plegas* Baker and Pritchard and *Schizotetranychus approximatus* Ehara to Indian tetranychid mite fauna besides redescriptions of *Oligonychus tylus* and *Oligonychus thelytokus* with several new host plant records. *Oligonychus grypus* Baker and Pritchard is reported for the first time from Karnataka and *Pennisetum glaucum* is its new host record in India, while *Cymbopogon* sp. is its new host record in the world. *Apluda mutica*, *Pennisetum glaucum* and *Rottboellia cochinchinensis* are new host records for *O. tylus* globally. The study deposited 77 DNA sequences (COI & ITS2) of 21 tetranychid species in NCBI-GenBank. Molecular phylogenetic analysis of major polyphagous species revealed clustering of species under genus *Oligonychus* is in line with the morphology-based taxonomic key, while species under *Tetranychus* did not show this clustering. ITS2 based genetic diversity study of major tetranychid species with wide host range revealed phylogenetic tree showing more closer relationship with host plants than the geographical locations.

July, 2022

(Rajashekharappa, K.)
Major Advisor

8. Genetic Diversity, Status Of Insecticide Resistance And Management Of *Leucinodes orbonalis* Guenee (Lepidoptera: Crambidae) In Brinjal

(SOMASHEKHAR V. GADDANAKERI)

ABSTRACT

Investigations were carried out during 2020-22 to know the genetic diversity, field evolved resistance, enzymes governing insecticidal resistance and effect of various modules against brinjal shoot and fruit borer, *Leucinodes orbonalis* in brinjal. The genetic diversity of thirteen *L. orbonalis* populations was studied using Cytochrome oxidase subunit I (*Mt*CO1). The highest genetic variation (0.033%) was found between the *L. orbonalis* of Dharwad and Bagalkot. Certain amino acids were either present or absent in different populations indicating their diversity. A detailed survey on insecticide usage pattern in brinjal across different locations of South India and Maharashtra revealed that eighteen insecticides were used by the farmers to manage *L. orbonalis* out of which chlorantraniliprole 18.5 % SC was highly preferred followed by emamectin benzoate 5% SG. The dose-mortality bioassays on field collected populations of *L. orbonalis* collected across South India and Maharashtra indicated varying levels of resistance development against emamectin benzoate (2.0 to 16.5-fold), chlorantraniliprole (1.7 to 9.7-fold), lambda-cyhalothrin (13.7 to 97.3-fold), indoxacarb (7.3 to 30.2-fold) and spinetoram (1.4 to 5.5-fold) as compared to laboratory reared susceptible population (F_{18}). The biochemical assays revealed that enhanced detoxification of insecticides in field populations mainly occurred through upregulation of midgut metabolic enzymes *viz*., carboxylesterases (1.2 to 2.6-fold), glutathione S-transferases (1.8 to 5.8-fold), cytochrome P-450 (2.9 to 9.0-fold) and acetylcholinesterase (1.8 to 2.8-fold) as compared to susceptible population. Field experiments were carried out during *Rabi* 2020 and *Kharif* 2021 to assess the efficacy of various modules against *L. orbonalis*. The chemically intensive Farmer’s practice module recorded lower shoot (3.10%) and fruit infestation (12.08%) and was found superior by recording higher fruit yield (19.50 t/ha) with 2.84 B:C ratio followed by the adoptive IPM module (18.08 t/ha) with 2.77 B:C ratio.

December, 2022

(S. Pradeep.)
Major Advisor

Agronomy

Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga

Ph.D. theses abstracts produced in Agronomy

1. **Assessment Of Genetic Diversity And Contribution Of Root Traits For Drought Tolerance In Finger Millet (*Eleusine coracana* L.) Genotypes For Yield Sustainance**

(BHAVYA, M.)

ABSTRACT

The present investigation was conducted to assess genetic diversity among 20 finger millet genotypes using 21 drought linked SSR markers. Percentage of polymorphic loci (86.2%) showed threefold variation and clustering based on UPGMA separated 20 genotypes into three clusters. Six tolerant genotypes KMR-204, GPU-45, ML-365, GPU-28, KMR-301 and L-5 as identified by morphological preliminary screening were in same cluster and explored for root traits under field conditions at College of Agriculture, Shivamogga during summer 2021 and 2022 on sandy clay loam soils. Degrees of stress imposed at vegetative, reproductive and grain filling stages for 15 days were tested on selected genotypes by adopting split plot design. Stress imposed at vegetative stage caused highest per cent increase in root characteristics and impacted positively on proline (4.69 folds), SOD (3.21 folds) and CAT (30.31%) over control. However, showed significant decrement in shoot length (28.38%), leaf area (22.96%), shoot dry weight (31.24%) and relative water content (31.65%). Imposition of stress at reproductive stage unveiled significantly highest decrement in grain (26.19 q ha^{-1}) and straw (62.16 q ha^{-1}) yield by 33.19 and 45.76 per cent.

Among genotypes tested, ML-365 showed maximum tolerance across different stages of imposed stress. The observed root length (57.88, 44.89 and 35.10%), surface area (41.08, 35.46 and 24.47%), volume (20.03, 22.49 and 18.85%), diameter (28.94, 29.90 and 19.64%) and root dry weight (37.45, 31.16 and 25.42%) reported highest per cent increase thereby, had a least significant marginal yield (7.10, 21.84 and 12.34%, respectively) reduction across different stages of stress imposition.

Biochemical parameters plays a dominant role for expressing drought tolerance in different finger millet genotypes at different stages of stress imposition. Performance of genotypes based on stress indices indicates, ML-365 as best drought tolerant whereas GPU-28, KMR-301 and L-5 were moderate while KMR-204 and GPU-45 were less tolerant.

November, 2022

(M. Dinesh Kumar)
Major Advisor

2. Studies On Different Agro Techniques For Yield Maximization Of Direct Seeded Rice Under Limited Water Resource In Southern Transitional Zone Of Karnataka

(SATHISHA, G. S.)

ABSTRACT

Three field experiments were conducted at AHRS, Bhavikere on red sandy clay loam soil. The first experiment was conducted during *kharif* 2019 and 2020 in factorial RCBD with three replications and nine treatment combinations to evaluate the varied levels and split application of fertilizers in direct seeded rice. The treatment that received application of 125% RDF with 25% N & K + 100 % P as basal, 25% N & K at 20-25 DAS, 25% N & K at 40-45 DAS and 25% N & K at 55-60 DAS recorded higher grain yield (5611 kg ha^{-1}on pooled basis), net returns (`. 96867 ha^{-1} on pooled basis) and B:C ratio (3.23 on pooled basis).

The second experiment on suitability of rice varieties under different irrigation schedules during *summer* 2020 was laid out in split plot design with three replications and sixteen treatment combinations. Scheduling of irrigation at 1.50 IW/CPE ratio with MAS 946-1 variety recorded highest grain yield (6475 kg ha^{-1}), net returns (`. 110995 ha^{-1}) and B:C ratio (3.21). Scheduling of irrigation at 1.50 IW/CPE ratio in direct seeded condition consumed 1000 mm of irrigation water, while the puddled transplanted rice usually requires 1500 mm. Hence, the direct seeded rice condition at 1.50 IW/CPE ratio saves 33.33 % of water compared to puddled transplanted rice.

The third experiment on effect of drip fertigation schedule and fertilizer sources in direct seeded rice during *summer* 2020 was laid out in split plot design with three replications and twelve treatment combinations. The treatment consisting of drip fertigation scheduling once in five days with 100% RDF through water soluble fertilizer recorded higher grain yield (7859 kg ha^{-1}). However, highest B:C ratio was recorded in scheduling drip fertigation once in fifteen days with 100% RDF through normal fertilizer (2.88).

April, 2022

(Narayana S. Mavarkar)
Major Advisor

Genetics and Plant Breeding

Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga

Ph.D. theses abstracts produced in Genetics and Plant Breeding

1. Environmental Response And Stability Analysis For Grain Yield In Multiparent Advanced Breeding Lines Of Rice (*Oryza sativa* L.)

(NIHARIKA, B.)

ABSTRACT

The present investigation was carried out during *kharif* 2020, summer 2021 and *kharif* 2021 at College of Agriculture, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga. The multiparent advanced breeding lines of the MF_5 and MF_6 generation developed by crossing eight diverse varieties having desirable traits were analyzed in the present investigation. The variability studies among the lines revealed a higher GCV, PCV, heritability and genetic advance as per cent of mean for majority of yield attributing traits. The diversity analysis using Mahalanobis D^2 statistics grouped the MF_5 generation into nine clusters and MF_6 generation into six clusters. Molecular diversity studies using SSR markers grouped the thirty advanced breeding lines along with six checks into eight clusters. The correlation and path coefficient studies on yield and its contributing traits revealed majority of the traits were positively associated with yield.The thirty selected multiparent advanced lines of MF_6 generation were also screened for submergence tolerance and highest survival percentage of 100 per cent was noticed in check Hemavathi, followed by Gandhasali and ML3-5-2-1-105.The stability analysis of the multiparent advanced breeding lines was evaluated at ZAHRS Shivamogga, AHRS Honnavile and AHRS Kathalagere, and the lines which showed high population mean yield and also performed well in all the three environments tested included ML1-6-3-1-23, ML2-5-21-3-154, ML2-7-2-3-160, ML1-8-1-1-31 and ML3-5-2-1-105. These lines could be proposed for farm trials and large scale demonstrations at farmer’s field in zone 7 of Karnataka.

December, 2022

(Dushyantha Kumar, B. M.)
Major Advisor

2. Assessment Of Variability Generated Through Multiparent Cross And Wide Hybridization Studies In Okra (*Abelmoschus spp.* (L.) Moench)

(SANDEEP, N.)

ABSTRACT

The present investigation in okra was carried out during *kharif* and *rabi* seasons of 2020 and 2021 at College of Agriculture, Shivamogga, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga. Thirty commercial cultivars of okra were assessed for their morphological and molecular diversity. The commercial cultivars were grouped into six and eight clusters based on morphological and molecular diversity, respectively. Eight diverse cultivars selected from thirty commercial cultivars were crossed in the structured mating design to obtain 800 F_2 population. The F_2 population were evaluated for variability, correlation, path analysis and transgressive segregants. ANOVA revealed the significant differences among the genotypes. Close correspondence between PCV and GCV was noticed for most characters. High broad sense heritability and GAM recorded for most characters indicated role of additive gene effects. Correlation and path coefficients analysis revealed significant positive association and high positive direct effect of average fruit weight and number of fruits per plant on fruit yield per plant. Superior transgressive segregants were identified for traits *viz.*, number of seeds per fruit, average fruit weight, fruit diameter, number of internodes, test weight, fruit length and fruit yield per plant. Crossability of three wild accessions *viz., A. manihot*, *A. ficulens* and *A. moschatus* with *A. esculentus* (Arka Anamika) revealed that the crosses are successful only when *A. esculentus* was used as seed parent. Higher fruit set and seed germination were obtained from the cross Arka Anamika × *Abelmoschus manihot.* The interspecific F_1s exhibited normal growth, flowering and fruit formation, but the hybrids were completely sterile on selfing. The sterile F_1s were further treated with 0.1 per cent colchicine to restore fertility. Characterization of the wild species and their interspecific hybrids revealed that the interspecific hybrids were generally more vigorous than parents and displayed greater alliance towards their wild parent.

November, 2022

(Dushyantha Kumar, B. M.)
Major Advisor

3. Assessment Of Genetic And Molecular Diversity Of Rice (*Oryza sativa* L.) Genotypes Under Drought Condition

(SUHASINI, B)

ABSTRACT

The present investigation was carried out at ZAHRS, KSNUAHS, Navile, Shimogga. The experiment was conducted using 100 rice genotypes including four checks to screen for drought tolerance. Thirty six genotypes were selected based on yield advantage over standard check Anagha and were evaluated under replicated trials under both control and drought condition in field and PVC pipes. Analysis of variance revealed the presence of significant difference between the genotypes for all the traits studied. Genetic variability studies revealed moderate to high PCV and GCV, high heritability coupled with high genetic advance as percent mean under drought for the characters *viz.*, number of tillers per plant, number of productive tillers per plant, spikelets per panicle, filled grains per panicle, yield, seed filling percentage, test weight, chlorophyll content, root length, shoot length, root to shoot ratio, root volume, relative water content and proline content. Plant yield had significant positive correlation with plant height, number of spikelets per panicle, number of filled grains per panicle, seed filling percentage, test weight, chlorophyll content, root length, root to shoot ratio, root volume, relative water content and proline content. Path analysis revealed that plant height, number of spikelets per panicle, number of filled grains per panicle and seed filling percentage, root length, root to shoot ratio, root volume, relative water content and proline content manifested positive direct effect on yield under drought condition. Using Mahalanobis' D^2 statistics genotypes were grouped into sixteen clusters. Molecular marker analysis using forty five SSR markers grouped the rice genotypes into ten cluster . In the present study rice landraces *viz.*, Kempudoddiga, Rasakadari, Kuruva, Julie and Sampige were identified as drought tolerant. Therefore, these genotypes can be utilized in hybridization programmes for introgression of drought tolerance to promising released rice varieties.

April, 2022

(Dushyantha Kumar, B. M.)
Major Advisor

Plant

Pathology

Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga

Ph.D. theses abstracts produced in Plant Pathology

1. **Studies On Sheath Rot Of Rice Incited By *Sarocladium oryzae* (Sawada) Gams And Hawksworth In Hilly And Coastal Zones Of Karnataka**

(MEGHANA SURESH NAYAK)

ABSTRACT

Rice (*Oryza sativa* L.) crop prone to various fungal, bacterial, viral and nematode diseases. Among fungal diseases, sheath rot incited by *Sarocladium oryzae* is more predominant and causes huge yield loss in hilly and coastal zones of Karnataka. Survey conducted in six districts during *Kharif* 2020-21 and 2021-22 revealed highest and lowest mean per cent disease incidence (27.32 %, 18.97 %) and PDI (25 %, 16.80 %) in Kodagu and Shivamogga district, respectively. Cultural studies revealed the maximum radial growth of *S. oryzae* was observed on PDA (50 mm). Morphologically 20 isolates varied in their conidial size ranging from 0.21-8.26×0.12-2.81 µm. The dry mycelial weight of all isolates was significantly superior at pH 7 (236.23 mg). Among different temperatures tested, Madikeri isolate recorded maximum dry mycelial weight (284.92 mg) at 25ºC. Maximum radial growth (78.33 mm) and sporulation was recorded in Ponnampet isolate with alternate cycle of 12 hours light and 12 hours dark condition. Based on comparison with ITS rDNA sequences, the isolates were confirmed as *Sarocladium oryzae.* RAPD analysis revealed maximum and least genetic similarity of 76 and 39 per cent between Narasimharajapura and Brahmavar and between Sullia and Bhadravati isolates, respectively. Among 192 cultivars/genotypes screened, 48 and 49 genotypes showed resistant and moderately resistant reaction, respectively. Among different botanicals and bioagents tested, neem oil (91.17 %) and *Pseudomonas fluorescens* (87.20 %), respectively showed highest inhibition of fungal growth. *In vitro* evaluation of contact, systemic and combi fungicides revealed that, Copper oxychloride, Propiconazole and Captan + Hexaconazole recorded cent per cent mycelial inhibition of *S. oryzae*. Pooled data analysis (*Kharif* 2020-21 and 2021-22) of field management studies revealed that foliar spray of Propiconazole (1 ml/l) was significantly superior in managing the disease with lowest per cent disease index of 5.44 per cent and highest grain yield (34.07 q/ha).

December, 2022

(G. N. Hosagoudar.)
Major Advisor

2. Probiotics From Different Fruit Plants As Plant Growth Promoting Microorganisms (PGPM) And Biocontrol Agents.

(NAVEESH, Y. B.)

ABSTRACT

The study on probiotics from different fruit plants as plant growth promoting microorganisms (PGPM) and biocontrol agents was carried out during 2019-2021. A thirty probiotic lactic acid bacteria (LAB) isolates showing gram positive and catalase negative that were further subjected to carbohydrates fermentation, antibiotic sensitivity patterns and acidic, bile salt tolerances, cell surface hydrophobicity and resistance to phenol. Among thirty isolates, twenty isolates thrived well at pH 2.0, pH 3.0 and pH 6.0 and exhibited strong resistance up to 0.3 per cent bile salt proving that the isolates were resistance to gastric conditions. Probiotic LAB isolates NRB7, NRB14, NRB15, NRB20, SF3, PE4, PGA1, RC3, BE2 and SF1 showed maximum mycelial inhibition against *Fusarium solani*, *Colletotrichum gloeosporioides* and *Aspergillus flavus*, inciting wilt, anthracnose and aflatoxin contamination in chilli crop respectively. Tested for hydrolytic enzyme activity and plant growth promotion attributes, all isolates showed positive reaction for protease, amylase, cellulase and chitinase activity and siderophore production. Probiotic isolate NRB14 showed highest P solubalization efficiency of (372.4%), maximum IAA production (36.91±1.31µg/ml), highest seed germination (97.78 per cent) and seed vigor index 1081.22. In pot culture experiment, inoculation of NRB14, PGA1 and RC3 increased plant growth parameters and least disease incidence against *F.solani*, *C. gloeosporioides* and *A. flavus.* Based on molecular characterization, effective probiotic isolates namely NRB14, PGA1 and RC3 were identified as *Lactiplantibacillus plantarum.* Different media used for mass multiplication of *Lactiplantibacillus plantarum*, MRS media and molasses+ yeast extract media showed maximum cfu count per ml. Among different carrier materials used, maximum cfu count was observed in liquid formulation followed by talc carrier based formulation. In the induced defense enzyme assay, those seeds treated with probiotic isolates namely NRB14, PGA1 and RC3 showed maximum PO (peroxidase), PPO (polyphenol oxidase), PAL (phenyl ammonia layase) defense enzyme activity against all three tested pathogens.

December, 2022 (M. K. Naik.)
Major Advisor

3. Virulence Profiling Of *Magnaporthe grisea* (Hebert) Isolates Adapted To Pearl Millet And Their Evolutionary Relationship With Isolates From Other Hosts

(PRASAD Y P)

ABSTRACT

The present investigation on pearl millet blast disease was carried out during 2018-2021; the study documented the pathogenic diversity or pathotype groups, genetic diversity and distribution of *Avr* genes and mating type among the isolates from different hosts. Four different pathotypes were identified by using ten host differentials of which majority of the isolates (23) belonged to pathogenic group III were virulent on all the differentials and were collected from Kalaburagi and Raichur districts. Only one isolate (Pg 366) represented group IV that differed from all other groups by showing avirulent reaction on ICMR 06444 and IP 21187-P1. The eleven *Avr* genes showed a distinct pattern of distribution among the isolates from different hosts and these genes could be utilized to differentiate the blast isolates from different hosts. Similarly, isolates from finger millet and rice showed the presence of *MAT1-1* but the isolates from pearl millet, foxtail millet, finger millet and different weeds were amplified for *MAT1-2*. Phylogenetic relationship was studied using β-tubulins, actin and calmodulin genes amplicon sequencing. From β-tubulins sequence similarity, pearl millet isolates were closely related and clustered together with the isolates collected from different weeds, followed by all the *M. oryzae* isolates collected from rice, finger millet and foxtail millet shared a single cluster. Whereas in case of actin and calmodulin, majority of the pearl millet isolates and weed blast isolates showed a close relationship with *Pyricularia pennisetigena* and only few isolates from pearl millet are quite separate and associated with *P. penniseticola*. Interestingly, the remaining isolates from rice, finger millet and foxtail millet were clustered together according to the nomenclature *M. oryzae* and isolates from *Digitaria* sp. as *M. grisea*. This result indicates that within the pearl millet blast isolates there is an existence of variation both in terms of pathogenic and genetic diversity.

December, 2022 (M. K. Naik.)
Major Advisor

4. **Investigations On Plant Probiotics For The Management Of Phytopathogenic Bacteria**

(PRUTHVIRAJ)

ABSTRACT

The present investigation on plant probiotics for the management of phytopathogenic bacteria was carried out during 2020-2022. The study was carried out to isolate lactic acid bacteria from fruits and to evaluate them against plant pathogenic bacteria and to asses for probiotic and explore them for plant growth promoting, bio-control attributes along with pesticide degradation and extension of shelf life of tomato. Sixty lactic acid bacterial isolates showing gram positive and catalase negative reaction were further evaluated against *Ralstonia solanacearum*, *Xanthomonas oryzae* pv *oryzae* and *Pectobacterium carotovorum* sub sp *carotovorum* by paper disc, well diffusion and microplate method under *in vitro* and inhibition zone ranged from 0.65 to 2.2 cm and in microplate method per cent inhibition ranged from 10 to 70 per cent. Ten effective isolates were selected, PCR amplification and subsequent sequencing confirmed the isolates as *Lactiplantibacillus, Limosilactobacillus* and *Enterococcus*. All ten isolates thrived well at pH 2.0 and pH 4.0 and exhibited resistance to bile salts (0.3 %). Isolate NRB 20 (*Limosilactobacillus fermentum*) was very efficient in organic acid, IAA (28.15 µg/ml) and GA3 (22.18 µg/ml) production with good P, K, Zn, Si solubilization efficiency of 175.00, 180.00, 276.92 and 132.55 per cent respectively with highest seed germination (96.66 %) and seed vigor index of 1552.39 along with good bio-control attributes. In pot culture experiment, isolate NRB20 showed higher bio-efficacy against *R. solanacearum* with 45 per cent disease reduction over control and it increased defense enzymes activity in plants such as peroxidase, polyphenol oxidase and phenyl ammonium lyase and was able to degrade hexaconazole up to 76.6 per cent under *in vitro* condition and when tomato fruits were coated with cell free supernatant of NRB 20 it was able to extend the shelf life of fruits up to 34 days compared to control (21 days).

December, 2022 (M. K. Naik.)
Major Advisor

Soil Science

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Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga

Ph.D. theses abstracts produced in

Soil Science and Agricultural Chemistry

1. Soil Characterization And Water Conservation Planning In Gullahalli Sub-Watershed Of Channagiri Taluk, Davanagere District, Karnataka

(BALAJI NAIK. D)

ABSTRACT

A study was undertaken to characterize and classify the soils of Gullahalli sub-watershed in Channagiri taluk, Davanagere district of Karnataka during the year 2019-2021 at Department of Soil Science and Agricultural chemistry, College of Agriculture, Shivamogga, KSNUAHS, Shivamogga.Twenty nine master soil pedons were studied in the Gullahalli sub-watershed based on land heterogeneity and slope. The soils were classified as very shallow to very deep in depth and texture of the soil was sandy clay loam to clay. Based on morphological, physical and chemical properties these soils were grouped in to Alfisols and Inceptisols. Gridwise 349 surface soil samples were collected at 320×320 m interval (0-15 cm depth) and soil fertility status maps were prepared. Soils were moderately acidic to moderately alkaline in reaction, low to high in organic carbon, low to medium in available nitrogen, medium to high in available phosphorus and potassium, exchangeable calcium and magnesium were sufficient and low to high in available sulphur and low to medium in available boron. Iron, manganese and copper were found to be sufficient, while zinc was sufficient in 86.56 per cent and 2.60 per cent area is deficient. Land capability classification showed that majority of soils belongs to class II, III and IV with the limitation of erosion, texture and depth. To study the fractions of carbon, nitrogen and sulphur. Soil samples were collected at 0 to 15, 15 to 30 and 30 to 60 cm depths from the representative 13 series of the selected master profiles. It is indicated that carbon and nitrogen decreasing with increasing depth in all the soil series. The different kinds of conservation structures recommended are graded bund and trench cum bund for the studied micro-watersheds. Boulder checks, vegetative checks were suggested as drainage line treatment structures, whereas check dams were suggested as water harvesting structure in the study area.

February, 2022

(K. T. Gurumurthy)
Major Advisor

2. Effect Of Microbial Enriched Arecahusk Compost On Carbon And Nitrogen Stock Of Soil Under Maize - Green Gram Cropping Sequence

(PRASHANTH, D. V.)

ABSTRACT

Two field experiments were conducted at AHRS, Bhavikere, Chikkamagaluru district of Karnataka to know the effect of microbial enriched arecahusk compost on carbon and nitrogen stock of soil under maize - green gram cropping sequence during 2020-22. The treatments comprised of varied levels of N along with two different organic sources *viz.* farm yard manure (FYM) and arecahusk compost (AHC) with or without microbial enrichment, tried in RCBD with ten treatments which were replicated thrice. The pooled results of two year revealed that combined application of 75 % RDN+ enriched AHC + 25 % N through enriched AHC to soil decreased BD, increased pH towards neutrality and significantly influenced the soil porosity, MWHC, EC, OC, available nutrients status, soil microbial count, soil enzymes, soil carbon, nitrogen pools along with its stock, temporal variability of carbon and nitrogen compared to RDF (100 % RDN + FYM) alone treatment. Similarly, significantly higher maize grain 94.63 q ha^{-1} and stover 113.41 q ha^{-1} yield followed by growth, yield and root parameters, various major, minor nutrients content and uptake by root, stover and grain was found to be in treatment 75 % RDN+ enriched AHC + 25 % N through enriched AHC. Residual effect of applied microbial enriched AHC under green gram showed that treatment of 75 % RDN+ enriched AHC + 25 % N through enriched AHC decreased BD, increased pH towards neutrality and significantly increased the soil porosity, MWHC, EC, OC, available nutrients status, soil microbial count, soil enzymes, soil carbon, nitrogen pools along with its stock, temporal variability of carbon and nitrogen alone treatment higher growth, yield and root attributes of green gram with grain yield 883.0 kg ha^{-1} and stover 1901.0 kg ha^{-1}, nutrient content and uptake as compared to RDF (100 % RDN + FYM) alone treatment.

December, 2022

(G.N. Thippeshappa.)
Major Advisor

3. Influence Of Different Nutrient Management Approaches On Crop Productivity And Pools Of Carbon, Nitrogen, Phosphorus And Sulphur Under Different Cropping Sequences In *Alfisol* and *Vertisol*

(RAGINI PATIL)

ABSTRACT

Two field experiments were conducted during summer and *Kharif* seasons of 2020-21 in *Alfisol* of Zonal Agricultural and Horticultural Research Station (ZAHRS), Shivamogga, and *Vertisol* of ZAHRS, Hiriyur, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Iruvakki, Shivamogga, Karnataka to know the influence of different nutrient management approaches on crop productivity and carbon, nitrogen, phosphorus and sulphur pools under different cropping sequences. The experiments were laid out in randomized complete block design (RCBD) with five replications and four treatments *viz.*, natural farming, organic farming, package of practice and farmers practice under different cropping sequences. Results of the field experiments showed an improvement in maximum water holding capacity, bulk density, porosity, electrical conductivity and pH in soils under organic manure applied treatments in both the cropping sequences. Significantly higher available primary, secondary and micronutrients were observed with combined application of organic manure and fertilizers in *Alfisol*, while different nutrient management approaches did not have significant effect on secondary and micronutrients in *Vertisol*. The application of organic manures (FYM and vermicompst) and concoctions like beejamrutha, jeevamrutha and ghanajeevamrutha certainly had higher organic matter, which rendered maximum enzyme activity and microbial biomass. The soil organic carbon, nitrogen, phosphorus and sulphur contents were significantly higher in organic farming treatment, whereas inorganic nitrogen, phosphorus and sulphur contents were significantly higher in soils under package of practice treatment in both the cropping sequences. Use of organic manures also improved the carbon storage in *Alfisol* and *Vertisol*, but the results were non significant under *Vertisol*. Results of the field experiments showed significant increase in yield and yield attributes due to application of recommended dose of FYM and N, P_2O_5 and K_2O. Higher concentration and uptake of major and micronutrients were recorded with combined application of organic manures and fertilizers in both the cropping sequences.

December, 2022 (B. C. Dhananjaya)
Major Advisor

4. Soil Resource Inventory For Evaluation Of Soil Fertility Constraints And Its Management In Duglapura Mini-Watershed Of Tarikere Taluk, Chikkamagaluru District, Karnataka

(SEEMA ANANTARAJ JUJIN)

ABSTRACT

An investigation was carried out to evaluate soil resource characterization, classification and productivity assessment of Duglapura mini-watershed of Tarikere taluk, Chikkamagaluru District of Karnataka during the year 2020-22 at college of agriculture, Shivamogga. Based on topography and physiological units during field survey thirteen soil profiles were identified. The soils pedons were studied for its morphological, physical and chemical properties and were classified up to the family level. Totally 88 surface soil samples at 0-20 cm depth were collected from the fixed grid points (320×320 m).

The texture of Duglapura mini-watershed varied from sandy clay to clay. The soils were classified under the order of *Alfisols* and *Inceptisols*. Based on the soil capability criteria, the mapping units belonged to land capability class III and class IV. Based on the soil-site suitability criteria, land suitability for crops like sorghum, maize, ragi, fieldbean, soybean, groundnut, chilli, tomato, mango, sapota, guava and pomegranates are marginally to highly suitable.

The soils of study area varied from slightly acidic to slightly alkaline in soil reaction. The soils showed low to high in organic carbon status, low in available nitrogen, low to medium in available phosphorus and medium to high in available sulphur status, whereas available potassium status found medium to high. Whereas DTPA extractable iron, copper and manganese were sufficient, whereas DTPA extractable zinc was deficient in 49.06 ha area.

Application of 150 kg ha^{-1} nitrogen and 12.5 kg ha^{-1} zinc applied through fertilizer significantly increased growth and yield parameters. The highest grain and stover yield (59.11 and 91.02 q ha^{-1}, respectively) of maize were recorded in the treatment that received recommended N, P_2O_5, K_2O+50 per cent extra N+$ZnSO_4$ @ 12.5 kg ha^{-1} as compared to the control. Available zinc showed positive significant correlation with grain (r=0.972*) and stover yield (r=0.973*).

December, 2022

(K. T. Gurumurthy)
Major Advisor