

ABSTRACTS OF THESES

Accepted for the award of post-graduate degrees in the University of Agricultural Sciences, Dharwad

DOCTOR OF PHILOSOPHY

AGRICULTURAL BUSINESS MANAGEMENT

Dynamics of coffee marketing and export : An agribusiness approach

N. ASHOKA

2013

MAJOR ADVISOR: Dr. BALACHANDRA K. NAIK

In India, Coffee occupies a pride position among plantation crops grown. The investigation was conducted in Karnataka state with overall objectives of studying dynamics of coffee marketing and export from India. The secondary data were collected mainly from Coffee Board of India, Bangalore and primary data from 30 coffee curing units of Chikmagalur, Kodagu and Hassan districts. The analytical techniques included trend analysis, co-integration technique, ARIMA, CAGR, NPC, Markov chain and descriptive statistics. The results revealed that, Arabica coffee growing regions witnessed declining trends in area, production and productivity except in non-traditional areas. Annual increase in price of Arabica and Robusta coffee was highest at ICO and similar trends witnessed in case of domestic prices during the study period. An international coffee price determines Indian coffee prices to a greater extent for both Arabica and Robusta coffee but not the other way round.

The wholesale and retail prices of seed and powder coffee in Hyderabad and Chennai markets heavily depend on Bangalore market prices. Chikmagalur is the lead market for farm gate prices of uncured coffee as it influences the rest of farm gate markets. The forecast prices shown an increasing trend in the next months in different markets studied. Robusta cherry coffee forms lion share in export market from India both in quantity and value terms. Coffee exports in terms of quantity and value terms increased at the rate of 1.60 and 12.10 per cent per annum respectively, during the study period. Italy is the most competitive destination for export of major types of coffee in India. Italy and Germany are the most stable importers of Arabica coffee and Robusta parchment coffee with greater retention of previous imports. Russian Federation is the most competitive and stable destination for export of Instant coffee from India.

AGRICULTURAL ECONOMICS

Impact assessment of technology mission on oilseeds and pulses in Karnataka

K. R. NETHRAYINI

2013

MAJOR ADVISOR: Dr. S. M. MUNDINAMANI

The present study was conducted to examine the impact of Technology Mission on Oilseeds and Pulses in Karnataka. Karnataka state was selected as it is one of the major oilseeds and pulses growing state in the country and covered under Technology Mission on Oilseeds and Pulses scheme. Secondary data was collected from DES, Bangalore and Department of Agriculture, Bangalore. Multistage sampling technique was adopted for selection of the sample farmers. Primary data were obtained for the year 2011-12 from the selected sample farmers with the help of pre-tested and well structured schedule. The analytical tools employed were compound growth rate, tabular analysis, budgeting technique, Hazell's Decomposition analysis and Total Factor Productivity analysis. The growth in area, production and yield was positive during Pre TMO in oilseeds whereas negative growth was observed during Post TMO

period. The growth in area, production and yield was positive both during Pre TMOP and Post TMOP in pulses. In selected oilseeds and pulses costs, net returns and gross returns were more in beneficiaries as compared to non-beneficiaries. The change in mean area was the major contributor for increased average production in both oilseeds and pulses. Synchronized movements in area and yield contributed for instability in oilseeds and pulses. Technology has played an important role in groundnut and pigeon pea production whereas in sunflower and chickpea input was the major contributor for output growth. Overall internal rate of return was 31 per cent for groundnut, 22 per cent for sunflower crop, 28 per cent for pigeon pea and 18 per cent for chickpea crop showing that investment on oilseeds and pulses during the past 23 years and 19 years respectively has provided attractive returns.

AGRICULTURAL ENTOMOLOGY

Impact of turmeric and ginger intercropping in mulberry on cocoon production under INM

G. S. CHANDRASHEKAR

2013

MAJOR ADVISOR: Dr. G. M. PATIL

Field experiment was conducted to study the impact of turmeric and ginger intercropped in paired row system of mulberry (V-1) plantation on yield, quality, pest incidence and cocoon production in Northern Transitional Zone of Karnataka, at Main Agricultural Research Station (MARS), Dharwad during 2009-10 and 2010-11. Pooled and individual year results showed that paired sole mulberry (T_0) recorded significantly higher plant height, number of branches, maximum number of leaves, leaf area, leaf weight, leaf area index, shoot length, shoot weight and leaf yield compared to rest of the treatments. However, among the intercropped mulberry treatments, T_3 i.e., 5 t VC ha⁻¹ + 75 per cent recommended inorganics ha⁻¹ to mulberry + 12.5 t FYM ha⁻¹ to turmeric recorded significantly higher growth and yield parameters of mulberry. Carbohydrate, crude protein, total chlorophyll, total sugar and nitrogen content in leaf of mulberry intercropped with turmeric and ginger varied significantly with respect to INM at 60 days after pruning in all the five crops. Pooled results showed that T_3 recorded significantly higher leaf quality parameters

compared to rest of the treatments. Significantly lower leaf quality was recorded with paired sole mulberry. The larval weight, larval duration, pupal weight, pupal duration, cocoon weight, shell weight, shell ratio (%), silk filament length (m), silk filament weight (g), denier, effective rate of rearing (%), silk productivity (cg/day), fecundity (eggs/laying), hatching (%) and moth emergence (%) of silkworm (CSR_2) fed on leaves of mulberry intercropped with turmeric and ginger varied significantly in all the five rearings. Pooled and individual year results showed that T_3 recorded significantly higher growth and yield parameters of silkworm, cocoon parameters compared to rest of the treatments. Significantly lesser growth and yield parameters of silkworm, cocoon parameters recorded with silkworm fed on leaves of paired sole mulberry. There was non-significant effect for flacherie, grasserie and muscardine diseases in 4th and 5th instar larvae. The intercropped turmeric and ginger recorded minimum pest incidence compared to sole crops. Among the intercropped mulberry, T_3 recorded higher net returns (₹ 3,63,637) and B:C ratio (3.27).

Investigations on seasonal incidence and management of mirid bug, *Poppiocapsidea biseratense* Distant in Bt cotton

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2013

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Investigations on seasonal incidence and management of mirid bug, *Poppiocapsidea biseratense* (Distant) in Bt cotton was carried out at MARS, UAS, Dharwad during 2011-12 and 2012-13 indicated that the incidence of mirid bug started during 38th Meteorological Standard Week (0.17 bug/10 squares) and reached maximum population 5.74 bugs at 47th MSW. Thereafter, the population declined to 3.12, 1.25, 0.79, 0.57 and 0.15 bugs between 48th and 52nd standard weeks of November and December month. During roving survey the highest population of mirid bug was observed in Haveri (average of 8.26 and 6.80 bugs/10 squares) whereas, the lowest incidence was recorded in Bagalkot district with an average of 4.02 and 3.20 bugs during 2011-12 and 2012-13, respectively). In fixed spot survey, the peak incidence of the pest was observed during November II fortnight (8.80 bugs/10 squares) in Dharwad. But, in Belgaum and Haveri district the peak incidence registered (6.20 and 12.2 bugs/10 squares)

during October II fortnight, respectively. The effect of different dates of sowing on incidence of mirid bug revealed that the early sown cotton crop (June 1st and June 15th) had registered lowest mirid bug population with highest GOB and yield. The late sown crop suffered much with the increased incidence followed by lowest yield. Field screening of cotton cultivars for their reaction to mirid bug damage revealed that, Chiranjeevi (HxH BG-II), RCH-2Bt and Bunny (NBt) appeared as less prone to mirid bug attack with highest yield. While, the lowest yield was recorded in Nathbaba, DHB-915 and DHH-11 which were more prone to mirid bug. The amount of phenol, gossypol and tannin had a negative and total sugar had a positive correlation with incidence of mirid bug. The efficacy of different components tested against mirid bug revealed that the fipronil 5 SC @ 1 ml/lit found to be superior followed by acephate 75 WP @ 1.0 g/lit in suppressing the mirid bug population.

Studies on life tables, crop loss estimation and management of maize stem borers with special reference to *Chilo partellus* (Swinhoe)

MANJUNATH CHOURADDI.

2013

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Investigations on life tables, crop loss estimation and management of maize stem borers with special reference to *Chilo partellus* (Swinhoe) were carried out at Main Agricultural Research Station, Dharwad during *kharif* and *rabi*-summer 2010-11 and 2011-12. During the survey, major pests noticed included two species of stem borers viz., *C. partellus* and *Sesamia inferens* Walker. The maximum infestation by both the stem borers was noticed in Haveri district while, the minimum was observed in Belgaum district. Among the two species, *C. partellus* was found predominant at several places during *kharif* whereas, during *rabi*, *S. inferens* dominated. Relatively more infestation was observed during early stages of crop growth (36-45 days). During the survey, two larval (*Cotesia flavipes* Cameron and *Sturmiopsis inferens* Tns.) and two pupal (*Tetrastichus howardi* Olliff and *Xanthopimpla stemmator* Thunberg) parasitoids were recorded on *C. partellus*. On *S. inferens* one larval (*C. flavipes*) and two pupal (*T. howardi* and *X. stemmator*) parasitoids were recorded during both *kharif* and *rabi* season. Pest infestation was maximum on the crop sown during October while June month sown crop prone to least infestation. Egg density was negatively correlated with

unknown causes, infertility, average relative humidity and total rainfall. Whereas, the remaining meteorological parameters were found to be positively correlated. Twelve life-tables were constructed for *C. partellus*. Major mortality factors influencing population fluctuation included parasitoids particularly *C. flavipes* during larval stage and unknown causes. The survivorship and death rate curves drawn for all the generations in each year indicated that the mortality rate was higher at the early stage intervals (egg and larva). The per cent grain yield loss increased with increase in larval density. The maximum yield loss was occurred in the treatment with 9 larvae/pl. The economic injury level was worked out at 2.42 and 2.09 larvae per plant during *kharif* and *rabi*, respectively. Release of *Trichogramma chilonis* @ 50,000/ha each at 12 and 20 DAS, whorl application of carbofuran 3 G @ 7.5 kg/ha at 25 DAS, maize + cowpea intercrop (1:1), maize + cowpea intercrop (1:1) + napier grass border crop, emamectin benzoate 5 SG @ 0.2 g/l at 25 DAS, spinosad 45 SC @ 0.2 ml/l at 25 DAS as well as one spray of nimbecidine 0.03% @ 5 ml/l at 25 DAS were found superior in reducing the stem borer damage with higher grain yield and net profit.

Biology of *Cryptolaemus montrouzieri* Mulsant and management of grapevine mealybug, *Maconellicoccus hirsutus* (Green)

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2013

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The investigation on "Biology of *Cryptolaemus montrouzieri* Mulsant and management of grapevine mealybug, *Maconellicoccus hirsutus* (Green)" were conducted during 2009 to 2011. The *C. montrouzieri* took 3.68, 4.68, 5.80 and 5.58 days to complete first, second, third and fourth instar by feeding 3.02, 7.52, 47.03 and 83.75 mealybugs, respectively. Predatory adult male and female survived for 58.18 and 62.48 days by feeding 38.00 and 42.97 mealybugs, respectively. Among the prediction models developed, the model $L_{WI} = 68.03 - 0.6X_3$ (X_3 = morning relative humidity) could be used by substituting current week's weather data, to predict mealybug population a week ahead so as to enable for initiating its management well in time. Seven predators (coccinellids (*Scymnus nubilus*, *Nephus regularis*, *Scymnus coccivora* and *Cryptolaemus montrouzieri*, dipterans (*Leucopis* sp.) and (*Cacoxenus perspicax*) and lepidopteran (*Spalgis epieusi*) and twelve hymenopterans parasitoids (*Coccophagus pseudococci*, *Coccophagus* sp. near *sextatus*, *Coccophagus* sp. near *javensis*, *Promusciae infasciatiiventris* and *Euryischomyia* sp., *Aenasius bambawalei*, *Leptomastix dactylopii*, *Leptomastix lyciae* and *Homalotylus eytelweinii*, *Oomyzus* sp., *Centiste* sp. and *Metastenus concinnus*) were recorded on grape vine mealybug. Among them, *Leucopis* sp.,

A. bambawalei and *Oomyzus* sp., *Centiste* sp. and *M. concinnus* are new records. The combinations of NSKE @ 5 per cent and neem oil @ 2 % with Dhanuvit @ 1 mll resulted in higher mortality of mealybugs. Where, NSKE and neem oil with *Lecanicillium lecanii* @ 2 gil + FORS @ 5 ml/l recorded higher mortality of all the instars of mealybugs at five days after treatment (DAT). The combination of insecticides (bifenthrin 10 EC @ 1 mll, imidacloprid 70 WG @ 0.3 gil, imidacloprid 17.8 SL @ 0.3 mll and dichlorvos 76 EC @ 0.5 mll) with Dhanuvit @ 1 mll recorded highest mortality of all the instar mealybugs at three DAT under laboratory conditions. The insecticides (imidacloprid 70 WG @ 0.3 gil, bifenthrin 10 EC @ 1 mll and imidacloprid 17.8 SL @ 0.3 mll) along with Dhanuvit @ 1 ml/l afforded 95.75 to 92.10 per cent protection against mealybug on vines and bunches, respectively. The insecticides viz., imidacloprid 70 WG (37.92 t/ha), bifenthrin (37.21 t/ha) and imidacloprid 17.8 SL (36.21 t/ha) along with Dhanuvit @ 1 mll recorded highest fruit yield. Among the biorationals, application of NSKE @ 5% + Dhanuvit @ 1 ml/l (29.82 t/ha), neem oil @ 2% + FORS @ 5 ml/l + *M. anisopliae* @ 2.0g/l (29.69 t/ha) and neem oil @ 2% + Dhanuvit @ 1 ml/l (29.51 t/ha) registered highest fruit yield.

AGRICULTURAL MICROBIOLOGY

Studies on pink pigmented facultative methylotrophs of major chilli growing areas of North Karnataka

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Investigations were carried out to study the plant growth promotional ability and management of anthracnose by native pink pigmented facultative methylotrophs (PPFMs) of major chilli (*Capsicum annuum* L.) growing areas of North Karnataka. As many as 200 PPFM isolates were isolated and subjected to rapid screening for antibiosis against *Colletotrichum capsici* (*C. capsici*) and qualitative assay for production of Indole acetic acid (IAA). They were characterized based on morphological and biochemical characteristics. Selected isolates were further screened for beneficial characters. Highest IAA and GA production was recorded in PPFM6 (19.77 and 128.28 µg/ml of culture filtrate respectively) and highest zeatin production was recorded in PPFM170 (2.54 µg/ml). Some of the isolates were positive for phosphate solubilization and antagonistic against *Sclerotium rolfsii* and *Fusarium oxysporum*. These antagonistic isolates produced catechol type of siderophores whereas

production of HCN and volatile antibiotics was not displayed. Based on *in vitro* studies, six promising isolates were selected for pot culture experiments. The pathogen (*C. capsici*) was challenge inoculated and ISR activity was estimated. The defence molecules tested were significantly influenced by PPFM isolates. The peroxidase and PALase activity was increased from one DAI up to 7 DAI whereas chitinase, PPO and phenol contents increased up to 5 DAI, after which gradual decrease was noticed. Inoculation of PPFM isolates to chilli crop significantly improved plant height, dry matter and chlorophyll content. Significantly lesser disease incidence, more yield and more capsaicin content was observed with application of carbendazim followed by inoculation of PPFM6 + PPFM170 + PPFM35 and PPFM6 both under pot culture and field conditions. The results of the present study clearly indicated that PPFM6 is a very good plant growth promoter and have biocontrol efficiency against *C. capsici*.

AGRONOMY

Effect of *in-situ* green manuring of legumes, NP levels and organic manures on growth and yield of safflower under rainfed condition

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2013

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Two field experiments were conducted to study 1) Effect of *in-situ* leguminous green manures and N and P application on growth and yield of rainfed safflower and 2) Effect of leguminous green manures on growth and yield of organic safflower crop at Agricultural Research Station, Annigeri, University of Agricultural Sciences, Dharwad during 2011-12 and 2012-13. Both the experiments were laid out in split plot design which comprised of four green manures assigned to main plots (sunn hemp, greengram, cowpea and fallow) and four N: P levels assigned to sub-plots in first experiment (0:0, 20:20, 30:30 and F_4 : 40:40 N: P_2O_5 kg ha⁻¹) and five organic manures assigned to sub-plots in second experiment (No fertilizer, 100% N through FYM, 100% N through vermicompost, 50% N through FYM + 50% N through vermicompost (VC) and RDF (40:40:12 kg N, P_2O_5 , K_2O ha⁻¹)). Cowpea and sunn hemp green manures performed significantly superior in terms of phytomass, biomass and nutrients (NPK) accumulation than greengram. In the first experiment, seed yield of safflower (10.67 q ha⁻¹) with application of 40:40 N: P_2O_5 kg per ha (RDF) without green manuring was comparable to *in-situ* incorporation of cowpea and sunn hemp green manure applied with 50 per cent recommended dose

of NP (20:20 N: P_2O_5 kg ha⁻¹) to safflower (11.54 and 10.44 q ha⁻¹, respectively) indicating saving of N and P to the tune of 50 per cent. Further, seed yield of safflower could be increased to 15.71 q ha⁻¹ and 14.22 q ha⁻¹ by cowpea and sunn hemp green manuring, respectively coupled with RDF. These treatment combinations also recorded significantly higher net returns (₹ 30,227 and 26,263 ha⁻¹, respectively) and B:C ratio (3.85 and 3.45, respectively) over other combinations. In second trial, significantly higher safflower seed yield (10.08 q ha⁻¹) was recorded in RDF without green manuring compared to fallow with no fertilizer/manure. Further the seed yield of safflower increased with incorporation of cowpea and sunn hemp with the application of RDF to safflower (13.54 and 12.91 q ha⁻¹, respectively) than other combinations except cowpea and sunn hemp coupled with 50 % N through FYM + 50 % N through VC (12.41 and 12.31 q ha⁻¹, respectively). Maximum net returns per ha was recorded with cowpea coupled with RDF (₹ 21,851) or cowpea applied with 50 % N through FYM + 50 % N through VC (₹ 19,934) or sunn hemp green manure applied with RDF (₹ 19,658). This clearly indicates the possibility of growing safflower organically without affecting its productivity and profitability.

Agronomic investigations on tall chickpea genotypes suitable for mechanical harvesting

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Field experiment was conducted during *rabi* seasons of 2011-12 and 2012-13 at International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh, India. The experimental was laid out in split plot design. The treatment consisted of four tall chickpea genotypes *viz.*, ICCV-11601, ICCV-11602, ICCV-11603, ICCV-11604 and one semi-erect genotype, JG-11 with three plant densities *viz.*, normal plant density (3.33 lakh ha⁻¹), 20 per cent higher (3.99 lakh ha⁻¹) and 40 per cent higher than normal (4.66 lakh ha⁻¹). The crop was raised under both rainfed and irrigated ecosystem and harvested by manual and combine harvester. Planting semi-erect genotype JG-11 at 40 per cent higher density produced significantly higher seed yield under rainfed and irrigated ecosystems (2570 and 3048 kg ha⁻¹, respectively) compared to rest of the interactions. However, the tall genotype ICCV-11604 with 40 per cent higher plant density (2258 kg ha⁻¹) recorded on par seed yield with JG-11

planted at normal density (2299 kg ha⁻¹) under rainfed ecosystem, but under irrigated ecosystem, the former combination recorded significantly higher seed yield (2840 kg ha⁻¹) than planting JG-11 at normal density (2666 kg ha⁻¹) and on par seed yield with JG-11 at 20 per cent higher plant density (2882 kg ha⁻¹). All the five chickpea genotypes were evaluated for mechanical and conventional harvesting under rainfed condition with normal plant density (3.33 lakh ha⁻¹). Total harvest losses were less in mechanical harvesting of tall genotypes (2.64 to 4.96%) compared to semi-erect genotype JG-11 (20.03%). Planting tall chickpea genotype ICCV-11604 at 40 per cent higher density under irrigated ecosystem recorded significantly higher seed yield (2840 kg ha⁻¹) and net return (₹ 62,058 ha⁻¹) compared to JG-11 at normal density (2666 kg ha⁻¹ and ₹ 58,810 ha⁻¹, respectively) by minimizing the harvesting losses and harvesting cost under mechanical harvesting.

CROP PHYSIOLOGY

Physiological basis of zinc biofortification in bread wheat (*Triticum aestivum* L.)

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2013

MAJOR ADVISOR: Dr. R. V. KOTI

Wheat serves as the main staple food for a large proportion of the world population but has the shortcoming, from a nutrition perspective, of being low in zinc and other essential nutrients. In an attempt to study the physiological basis of zinc nutrition, 298 NBPGR lines along with Lok-62 and C-306 were screened for grain zinc content. The grain zinc content ranged from 5-45 mg kg⁻¹. Twenty seven lines (6 low, 7 medium and 14 high lines) were field evaluated using factorial RBD with 3 treatments (control, with soil application of zinc sulphate @ 10 kg ha⁻¹ and with foliar application twice at 30 and 60 DAS @ 0.5%) for various physiological, biochemical and quality parameters during *rabi* 2011-12 and 2012-13. Results revealed that foliar application of zinc increased leaf area, TDM, SPAD values, chlorophyll content, grain yield and grain and leaf zinc content compared to soil application and control irrespective of germplasm lines. Foliar application of zinc increased leaf zinc content

at pre and post anthesis period, which lead to higher zinc content in grains. The anti-oxidative enzymes such as superoxide dismutase (SOD) and peroxidase (POX) activity increased significantly due to foliar application of zinc and showed that increased zinc has got the mechanism to counter the ill effects of active oxygen species. In addition to increase in grain zinc content, there was increase in grain protein, gluten and zeleny content revealed beneficial effect of foliar application of zinc sulphate. The lines 636, 127, 606 and Lok-62 are the probable better germplasm lines with high grain zinc and fairly good amount of grain yield. The lines viz., 554, 12, 734, 279, 422, 127, 723 and 822 are more zinc efficient than others with ability to grow and maintain yield under low zinc availability. Foliar application of zinc sulphate can be a better option in mitigating the zinc deficiency both from the context of plant and human nutrition.

Identifying drought tolerant cotton (*Gossypium hirsutum* L.) genotypes by physiological and molecular approaches

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2013

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A field experiment was conducted during 2011-12 for the evaluation drought tolerance using thirty *Gossypium, hirsutum* L. genotypes in RBD design at ARS Dharwad and ARS Annigeri. Ten best (CPD-750, Sahana, ARB-9701, CNH-120MB, GIHV-218, BS-279, RAH-101, GJHV-477, F-2228 and KH-155) and two least (L-761 and LH-2076) performed genotypes were selected from these experiments based on drought tolerant physiological traits viz. SLW, water potential, SPAD values, gas exchange parameters and yield. Simultaneously 600 cotton germplasms lines were also evaluated for drought tolerance by physiological traits at ARS Dharwad. Based on the SPAD, SLW and gas exchange parameters 24 germplasm lines were showed significantly on par for the most of the physiological traits. During 2012-13, the selected twelve genotypes were evaluated for performance under different concentrations of PEG-6000 osmotic solutions at germination stage by slanting glass plate technique. The germination per cent, shoot length, seedling vigour index and shoot vigour index decreased

as the PEG 6000 concentration increase from 0% to 27% in all genotypes, while the root length and root: shoot ratio increased. These genotypes were further evaluated at rain out shelter for drought tolerance by morphological, physiological, biophysical, biochemical, root architecture (length, volume and lateral roots) yield, yield components and fibre properties. The genotypes viz. CPD-750, Sahana, ARB-9701, CNH-120MB, GIHV-218, and BS-279 were found relatively drought tolerant. Further these twelve genotypes were studied for genetic diversity study using 79 cotton specific RAPD molecular markers. There was 79.56 per cent genetic polymorphism/diversity. The primers OPI 4 and OLIGO 652 amplified 800 bp and 400 bp respectively were specific to relatively drought tolerant genotypes. The dendrogram revealed that the primers were able to group the genotypes in to three major clusters. From the overall present investigation, the genotypes viz. CPD-750, Sahana, ARB-9701, CNH-120MB, GIHV-218, BS-279 and RAH-101 were identified as drought tolerant lines.

FOOD SCIENCE AND NUTRITION

Storage quality of little millet (*Panicum miliare*) and diversification of utilization of little millet through hydrothermal and baking technologies

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2013

MAJOR ADVISOR: Dr. NIRMALA. YENAGI

The study was undertaken to evaluate local cultivars (*Malli savi* and *Kari savi*) and high yielding varieties (Sukshema, COSa-(4) and JK-8) for physico-chemical and nutritional qualities and to develop of value added little millet products through hydrothermal and baking technologies. The local cultivar *Malli savi* was found to be superior followed by high yielding variety Sukshema. The storage of local cultivar of little millet for duration of 18 months exhibited better nutritional, milling and cooking qualities. The significant changes were observed for protein content, total dietary fiber total phenols and phytic acid content during storage. Significant decline was also observed for *in vitro* protein digestibility, *in vitro* starch digestibility, amylose, soluble amylose, swelling power, solubility and soluble proteins. The hydrothermal treatment with initial soaking temperature of 70°C for 3 hr and steaming at

110°C for 20 min was found to be optimum with improved head rice yield (92.39 %) with lower breakage (0.98%). Hydrothermally treated little millet rice was translucent shiny, firm, fluffy and non sticky. These characteristics were preferred properties by the consumer. Hydrothermal treatment improved the nutritional profile and enhanced therapeutic property, processing quality and shelf life. Incorporation of little millet at 10 and 30 per cent was organoleptically acceptable and enhanced the nutritional profile by increasing dietary fiber, iron, zinc, copper and phosphorus by 19, 94, 29, 70 and 28 per cent respectively. The study concludes that economic value of the local staple cereal can be enhanced through suitable technologies as therapeutic food and little millet has potential of designing basic functional food for better health.

GENETICS AND PLANT BREEDING

Pyramiding of leaf rust resistance genes, *Lr24* and *Lr28* Into bread wheat variety, DWR 162 (*Triticum aestivum* L.) Through marker assisted selection

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2013

MAJOR ADVISOR: Dr. R. R. HANCHINAL

The present investigation was undertaken to pyramid two effective leaf rust resistance genes *Lr24* and *Lr28* for genetic enhancement of a ruling variety of Peninsular Zone using marker assisted selection. 'PBW 343' near isogenic lines with both *Lr24* and *Lr28* genes were used as

donor for introgression of these two genes into DWR 162 employing marker assisted backcrossing. The SCAR markers, SCS1302₆₀₇ and SCS421₅₇₀ linked to *Lr24* and *Lr28* genes facilitated the identification of individual plants possessing the targeted genes. BC₁F₂ and BC₂F₁ generation plants

had high resemblance with recurrent parent 'DWR 162'. DUS characterization revealed that six plants in BC_1F_2 and 132 plants in F_2 were highly resembled 'DWR 162' with phenotypic rust resistance and better yield potential. Further, molecular characterization of these plants with SCAR markers revealed that four plants in BC_1F_2 and 38 plants in F_2 had both *Lr24* and *Lr28* genes. Plants selected with both leaf rust resistance genes *Lr24* and *Lr28* showed enhanced leaf rust resistance without much deviation in the traits of adaptation. High genetic variability, heritability and genetic advance in F_2 population of DWR 162 X PBW 343 and high frequency of transgressive segregants recorded over better parent for

spike length, spikelets per spike, plant height and grain yield per plant with upper class values for yield related traits and leaf rust resistance indicated the potentiality of this population for yield and leaf rust resistance. Genetic variability studies in F_3 population indicated high potentiality of this population for grain yield per plant and leaf rust resistance. Nine recombinant lines were identified in F_3 that were superior in yield parameters with both leaf rust resistance genes which had high resemblance of 'DWR 162'. These lines were also found to be superior in agronomic traits depicting the potentiality of these lines in developing genetically enhanced DWR 162 with leaf rust resistance.

Studies on genetic enhancement of sugarcane (*Saccharum officinarum* L.) Productivity for organic jaggery production

SOMASHEKHAR GUDDADAMATH

2013

MAJOR ADVISOR: Dr. B. M. KHADI

The present investigation was taken up to elucidate the information on the variability present in the component traits of cane, sugar and jaggery yield and the amount to which it is heritable. Inter and intra class correlation was also studied across generations. The genetic and molecular diversity to assess the contribution of characters towards the divergence to classify the clones was also studied. Further genotype x environment interaction was studied to assess the relative stability of sugarcane genotypes for productivity traits of cane, sugar and jaggery yield. The GCV and PCV for total shoots, cane height, internodal length, number of millable canes (NMC), cane yield and HR brix%, were higher, whereas moderate variability was observed for cane girth and single cane weight (SCW). The association studies revealed that, single cane weight, number of millable canes and cane height were the strongest with cane yield. The path analysis shows that,

NMC and SCW showed higher direct effect on cane yield. The repeatability studies indicated that NMC, SCW and HR brix % were significantly repeatable across generations. Diversity analysis indicated NMC, SCW and cane height contributed maximum to the total divergence. Molecular diversity using SSR markers detected 95.9 per cent polymorphism and primers NKS 6, 7, 23, 30, 32, 34 and 38 were particularly useful in diversity studies. The stability analysis for cane and jaggery yield revealed that the genotypes viz., SNK 07680 and SNK 07337 and SNK 07658 were stable across environments. Among the genotypes for jaggery quality parameters, SNK 07680 was significantly superior compared to Co 86032 followed by SNK 07337 and SNK 07658. SNK 07680 and SNK 07337 are non flowering across generations and locations, whereas SNK 07658 is very late to non flowering in all the locations studied for flowering behavior.

Development and exploitation of heterotic pools of *hirsutum* and *barbadense* for developing potential inter specific hybrids, molecular marker and genetic transformation study in cotton

YANAL ALKUDDSI

2013

MAJOR ADVISOR: Dr. S. S. PATIL

Reciprocal selection for improving combining ability was modified to suit cotton and tested. Based on earlier studies DB 533 and DB 534 the selected barbadense elite combiners were crossed and advanced to F_4 generation for creating recombinational variability for combining ability against the *hirsutum* testers (DH 98-27, ZCH 8, 178-24 and DH 18-31). In line x tester study, DB 533 and DB 534 were compared with barbadense lines in developing productive inter specific hybrids. Both of them recorded positive GCA effects for seed cotton yield confirming potentiality to form heterotic groups of *hirsutum* vs barbadense cottons. Of the 23 *hirsutum* testers, four testers mentioned above exhibited positive GCA values for yield. The potentiality of the heterotic box was also confirmed by comparing these eight bench mark crosses with 49 inter specific crosses and checks. Among the 53 F_3 barbadense lines, DB 533 x DB 534 F_3 IPS 18

showed exceptional superiority for productivity and fiber quality traits. Among three methods of determining pooled score, weighted percent GCA approach was efficient in identification of potential combiners. Based on mean and co-efficient of variability for productivity DH 98-27 was found to be efficient tester. Sub grouping the F_4 lines against pairs of *hirsutum* testers was done. Among the population used four F_4 lines revealed transgressive positive segregation for combining ability against all the four testers and the lines DB 533 x DB 534 F_4 IPS 49 and DB 534 x DB 533 F_4 IPS 22 were selected for developing sub populations against *hirsutum* testers. With the help of 40 SSR markers, molecular diversity was assessed and positive correlation was found between genetic distance (GD) and seed cotton yield of F_1 and heterosis over checks. In vivo transformation was attempted in *hirsutum* variety.

Genetic enhancement of oleic acid content in groundnut (*Arachis hypogaea* L.)

K. GANGADHARA

2013

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Investigations were carried out to study the inheritance pattern of high oleic acid and genetic variability for oil quality and agronomic traits in direct and backcross populations of groundnut from 2010 to 2013 at MARS, UAS, Dharwad. Inheritance studies revealed a simple recessive inheritance pattern of high oleic acid content. In F_2 generation, individuals segregated in 3:1 (low and medium) ratio in crosses of low x medium and medium x high crosses and 15:1 (low and high) ratio in low x high crosses indicating that high oleic acid content phenotype was governed by two recessive genes in groundnut. This simple duplicatory recessive ($ol_1ol_2ol_3ol_4$) inheritance pattern of high oleic acid content in new sources of high oleic mutants (GM 4-3, GM6-1) and germplasm line ICG 2381 would help to plan for genetic improvement of nutritional and storage stability of groundnut oil. Evaluation of backcross populations for oil quality and agronomic traits indicated the superiority of backcross method

for transfer of high oleic acid trait along with other economic traits. In general, higher frequencies of desirable segregants were identified in second backcross derived populations (BC_2) compared to direct F_2 and first backcross (BC_1) populations. The backcross population (GPBD 4 x GM 4-3)-38 x GPBD 4 was superior with higher frequency of desirable recombinants compared to another (GPBD 4 x GM 4-3)-34 x GPBD 4 backcross population. Higher heritability and genetic advance were recorded for oleic acid to linoleic acid ratio, linoleic acid, pod yield per plant, plant height, primary branches per plant, reaction to rust, late leaf spot and *Spodoptera litura* indicating predominance of additive gene effects. Superior high oleic (>72%) recombinant lines (75-4-3-3 and 76-2-1-5) were identified with better agronomic traits of pod yield and foliar disease resistance that can be tested on large scale over locations for their commercial exploitation.

PLANT PATHOLOGY

Mechanism of slow leaf rust, molecular characterization in bread wheat and variability in *Puccinia triticina* eriks

G. S. ARUNAKUMAR

2013

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Off-season survey in Chikmagalur and Chitradurga districts of Karnataka revealed the absence of wheat crop. Three years normal season survey indicated the presence 20 different pathotypes. The pathotype 121R63-1 (77-5) was dominant and molecular profiling of 25 different isolates showed high genetic variability. UAS-326, UAS-315, VL-616, VL-924, HD-2189, HD-2932, HD-3091, NI-5439, HI-977, HS-420, DBW-16, KRL-210, Pavon-76, RL-6077 and Parula were identified as slow leaf rusters and Agra Local, Lal Bahadur, Lok-1, Sonalika, C-306, DWR-162, PBW-343, DBW-17 and HS-240 were identified as fast leaf rusters. Molecular characterization of bread wheat showed 12 genotypes with *Lr34/Yr18/Pm38*, seven genotypes with *Lr46/Yr29/Pm39* and none of the genotypes showed *Lr67/Yr46*. However, five genotypes (HD-2189, UAS-315, VL-616, NW-4091 and RAJ-4270) carried both *Lr34/Yr18/Pm38* and *Lr46/Yr29/Pm39* genes. Isozymes study revealed a

higher variation of peroxidase and polyphenol oxidase at different growth stages under inoculated and uninoculated conditions. Pre-penetration processes of uredospore were not a good criterion for selection of slow leaf rusters. Loss of total grain protein content (GPC) was either increased or decreased or no significant changes observed when compared with protected and unprotected conditions among all the three group of genotypes. No significant difference was observed in the mean damaged starch of slow leaf rusters, whereas susceptible genotypes showed significant differences. Wet gluten and dry gluten content (%) was affected by leaf rust. Slow leaf rust genotypes showed an average highest content of three micro-nutrients, viz. zinc, iron and copper. The average yield loss was minimum in resistant and slow leaf rusters. However, it was very high in susceptible genotypes. A combi- product (Pyraclostrobin 13.3% + Epoxiconazole 5%) @ 0.1 % was found to be the best alternative to the propiconazole.

Role of nematodes in soil health sustenance: Relating their assemblages to soil types and cropping systems

KUMARI

2013

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Nematodes are functionally diverse. Most research on them is focused on plant-parasitic nematodes that attack the roots of cultivated crops. Less attention has been given to nematodes that are not plant-feeders and play beneficial roles in soil environment. Therefore, the present study was taken up with the objective of determining nematode assemblages in different soil types and cropping patterns. Two agro-ecological Zones of Karnataka were selected (Zone III and IX): soils were vertisols and alfisols. The dominant cropping patterns were cotton, onion+chilli, paddy-paddy-paddy and paddy-paddy-paddy respectively. In addition to this, a field trial was taken up at MARS, UAS Dharwad in two consecutive seasons, viz. *Rabi-2011* and *Kharif-2012* with major cropping pattern of this area (chickpea and soybean respectively) to know the influence of fertilizers and manures (singly and in combinations) on nematode assemblages. Also influence of soil physical and chemical properties were studied during the course of present investigation employing the soil samples which were collected

during surveys and during field experimentation. Differences in nematode assemblages were observed during the study in different soil types with respect to trophic groups across different agro-ecological zones and during field study. MWC had positive correlation with nematode assemblages. BD on total nematode abundance was negative and showed significant positive correlation. Whereas pH showed negative correlation and effect of EC was negligible. Under field study, both FYM and vermicompost singly and in combination increased the numbers of bacterivores and fungivore nematodes and lowered that of plant parasitic nematodes. Different indices, viz. NCR, NGR, *H'*, combined maturity index (MI) were calculated- a slight change across the sampling period was noticed. Results suggested that a bacterial decomposer pathway dominated, mediated by bacterivorous nematodes. In a microcosm experiment, it was observed that there was increase in total available nitrogen from 12 to 14 kg/ha over control in presence of bacterivorous nematodes.

SEED SCIENCE AND TECHNOLOGY

Effect of fruit position and fruit retention load on seed yield and quality and seed invigouration treatments on seed quality in okra [*Abelmoschus esculentus* (L.) Moench]

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2013

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Studies on effect of fruit position and fruit retention load on seed yield and quality and seed invigouration treatments on seed quality in okra were made at Main Agricultural Research Station, Dharwad during 2011 and 2012 kharif seasons. Results of the experiment involving two fruit retention loads and seven fruit positions revealed that retention of fruits borne on 1-8 nodes for the seed purpose and harvesting remaining fruits for vegetable purpose recorded significantly higher fruit length (27.54 cm), number of seeds per fruit (60.16), seed yield (659 kg/ha), economic yield (146350 ₹/ha), B:C ratio (2.44) and seed quality parameters viz., normal seedling percentage (84.67%), seedling vigour index-I (3030) and lower hard seed percentage (5.37%) dead seed percentage (9.96%). Results of the experiment involving seven foliar insecticides sprays indicated that lamda cyhalothrin 30 g a.i/ha recorded significantly lower per cent fruit damage per plant (18.44), per cent seed

damage per fruit (10.03), higher seed yield per ha (1548 kg), germination (85.46%) and seedling vigour index-I (3100). Results of the experiment involving hydropriming revealed that soaking the seeds for twelve hours and drying back to original moisture content recorded significantly higher germination (79.75%), seedling vigour index-I (2731) and field emergence (77.93%). Results of the experiment involving osmopriming indicated that osmopriming of seeds with PEG 1.00 Mpa and drying back to original moisture content recorded significantly higher germination (84.75%), seedling vigour index-I (3048) and field emergence (81.30%). Results of the experiment involving chemopriming revealed that chemopriming of seeds with KI @ 1.0% and drying back to original moisture content recorded significantly higher germination (83.25%), seedling vigour index (2944) and field emergence (79.50%).