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COMPiled & EDITED BY

Dr. K. VEERANJANEYULU
UNIVERSITY LIBRARIAN

Dr. P. CHANDRAseKHAR RAO
DEAN OF AGRICULTURE i/c

Y. UMA DEVI
ASSISTANT LIBRARIAN

N. P. RAVI KUMAR
ASSISTANT LIBRARIAN

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Basmati rice is a unique varietal group that had gained wider acceptance as specialty rice all over the world by virtue of its unique quality traits. Grain size plays a crucial role in determining the grain quality in Basmati rice. Genetic control of basmati grain quality traits is quite complex. But breeding of new varieties having Basmati grain quality characters can be greatly facilitated by the use of molecular markers tightly linked to these traits. Hence, in the present investigation 155 recombinant inbred lines (RILs) developed from a cross between Basmati370 and Jaya were used for confirmation and fine mapping of a major QTL for grain size in Basmati rice using SSR markers derived from inside and near the genomic region associated with grain size in the marker interval of EM289 and RMI8600 on chromosome 5, that was already identified by Vemireddy (2008) using F2 population developed from the same cross.

The parents used for mapping, Basmati370 and Jaya differed significantly with respect to all the three traits viz., grain length (GL) grain breadth (GB) and Length-Breadth ratio (LBR). Transgressive of 45.8% in grain length 21.93% in grain breadth and 12.25% in LBRatio was observed in the RILs. All the three traits exhibited normal distribution in the RIL population indicative inheritance of these traits. Correlation analysis among the grain characters studied in RILs revealed a highly significant negative association of LBRatio with grain breadth and significant positive correlation with grain length.

Out of 52 SSR and 1 INDEL markers used, 23 (43.40%) were polymorphic 27 (39.62%) were monomorphic and 9 (16.98%) were not amplified between Basmati370 and Jaya. The RILs were genotyped for these 23 polymorphic markers and the linkage map employing haplontypic and genotypic data of the RILs was constructed using MAPMAKER v 3.0. The QTLs were identified using interval mapping (IM) and composite interval mapping (CIM) methods of QTL Cartographer v 2.5 software with 2.5 as LOD threshold for detecting a QTL A minor QTL for grain length qGL5.1 was detected for grain Variance (PVE) of 307 % A single QTL as Qgb5.1 was detected for grain MAPMAKER v 3.0. The QTLs were identified using interval mapping (IM) and composite interval mapping (CIM) methods of QTL Cartographer v 2.5 software with 2.5
as LOD threshold for detecting a QTL. A minor QTL for grain length \( qGL5.1 \) was identified by IM in the marker interval of RM6024 and RM1237 with Phenotypic Variance (PVE) of 3.7 %. A single QTL designated as \( qGB5.1 \) was detected for grain breadth in the marker interval of RM1237 and RM18582 with PVE of 3.58 % in CIM and 4.51 % in IM and a QTL \( qGLB5.1 \) for Length-Breadth Ratio was identified with PVE of 11.8 %.

The genetic distance of the flanking markers harbouring QTL cluster in the previous study was 26.5 cm whereas in the present study it was narrowed down to 15.7 cm. The physical distance also has come down from 11,128 kb to 685 kb. Comparison of rice genome database revealed that LOC_OS05g31920 (zinc ion binding protein), LOC_OS05g31930 (retrotransposon protein, putative, unclassified), LOC_OS05g31940 (retrotransposon protein, putative, unclassified), LOC_OS05g31950 (retrotransposon protein, putative, Ty3-gypsy subclass), LOC_OS05g31959 (hypothetical protein) and LOC_OS05g31970 (expressed protein) genes are present at this region. Interestingly, two predicted genes closure to this region \( \text{viz.} \), AP2 transcription factor and RING E3 ligase were reported to be involved in controlling the seed size and weight by earlier studies.

In the present study, one microsatellite marker i.e., RM18582 showed close association with the grain size QTLs. This marker has potential to be used in marker-assisted improvement of the grain size in Basmati rice. Though the present study was carried out in single environment, together with the results of F\(_2\) population of the same cross, it could be concluded that these three QTLs associated with grain size traits of Basmati could be considered as stable QTLs. These QTLs, apart from their suitability in improvement of the traits concerned, can also serve as potential candidates for fine mapping. These stable QTLs also facilitate development of Near-isogenic lines and advanced breeding lines.
Assessment of the genetic relationship of the cultivars is an important step to select the parents for targeted plant breeding. As of now no attempt was made to understand the genetic relationship of major Indian rice cultivars as a whole and decadal period wise. Hence, the present study carried out to estimate the genetic diversity of the major cultivars of India released during 1970 - 2010.

Fifty-two of the 64 rice SSR primer pairs showed polymorphism, while only twelve markers were monomorphic in 88 rice cultivars tested (81.25%). A total of 170 alleles were identified from the 52 polymorphic SSR loci among 88 rice cultivars. The average number of alleles per locus was 3.3. The genetic relationships of all 88 genotypes were grouped into 4 major clusters and one single solitary cluster with a genetic similarity range of 21% to 66%. Cluster ‘A’ represents 22 genotypes largely constitute varieties released during 1970s and 1980s. This cluster was further subdivided into two sub clusters i.e., A1 and A2 exhibiting a similarity range of 29% to 55%. Cluster ‘B’ primarily composed of varieties released in 1990s and 2000s. It can be again divided into sub clusters B1, B2, B3 and B4. Sub cluster B1 comprised of popular variety like Samba Mashuri and Rasi whereas B2 comprised of thirteen varieties, of which most of them are popular especially in 1990s decadal period and their grain size was ranging from LS and MB. In case of Sub cluster B3, thirteen varieties are present and all are most popular in 2000s decade. Sub cluster B4 represents varieties having long slender grain and cultivated in irrigated ecology. Cluster ‘C’ comprises of five varieties with a genetic similarity ranging from 29 to 65%. Interestingly all these five varieties are released for rainfed shallow lowland ecology. Another major cluster ‘D’ consisting of varieties released in 1970s and 1980 except one variety i.e., Haryana Basmati. The cluster ‘D’ further divided into sub clusters D1 and D2, where sub cluster D2 having only two genotypes. Similarly D1 again divided into D1a and D1b. The sub cluster D1a possess ten genotypes which is having almost same durations and short bold grain size as IR8 was the parent for 7 of 9 genotypes in the cluster. Likewise sub cluster D1b having eight genotypes. The most of the popular varieties of 1980s decadal period had fallen in the major cluster of ‘D’ while ‘VL Dhan 221’ deviated from all the genotypes forming a solitary cluster ‘E’.
The genetic diversity of 88 major Indian cultivars (Na=3.3 and He=0.59) estimated in the present study is slightly higher than the world indica sample (n=79, Na=7.3 and He=0.55) and overwhelmingly high compared to the world temperate japonica sample (n=41, Na=4.9 and He=0.39). The current study once again provided evidence that indica cultivars are more diverse than japonica. Genetic diversity within decadal period was determined on the basis of the Na values which were increased by 5.63% and 2.74%, respectively for the two categories of rice varieties i.e., popularity wise and year of release wise from the 1970s to the 2000s. Of four decades, 1970s and 1990s had low Na values while 1980s and 2000s showed high.

Overall, the PIC values were unchanged in both the categories of varieties from 1970s to 2000s in fact slightly increased in year of release wise category after dropped in 1980s. However, in popularity wise the PIC values are drastically reduced from 1990s to 2000s. In case of gene diversity, there was a clear increase from 1970s to 2000s popularity wise category while slight decrease in year of release wise category over the decadal periods. Analysis of the trend of appearing and disappearing alleles over decadal period showed during 1970s there was fast disappearance of alleles compared to other decades in both the categories of varieties. Genetic diversity among decadal period showed that most of the variation of SSR markers was within the decadal periods i.e., 98.5% and 95.11% for both the categories of varieties. The genetic variation among the decadal period was very low i.e., 0.8% for varieties classified as popularity wise compared to varieties classified as the year of release wise (4.84). The genetic differentiation (Fst) among four decades was not significant when varieties are classified as popularity wise but significantly in year of release wise category. The pair wise comparison of Fst revealed that significant genetic differentiation existed only between the 1970s and 1990s and 1980s and 1990s in popularity wise category while significantly differentiated among all decades except between 1980s and 2000s in year of release wise category.

In the present investigation, based on the results of allele number (Na), polymorphism information content (PIC) and genetic diversity (He), it is obvious that genetic diversity of major Indian rice cultivars has increased from 1970s to 2000s decadal periods.
The present investigation was undertaken with the objectives to study the polymorphism existing between biotic stress Brown Plant Hopper, Gall midge, Bacterial Leaf Blight, Blast resistant donor parents and recipient elite varieties by screening with 150 Hyper variable SSR markers and to find markers which are showing high polymorphism for their use in background selection of recurrent parents. The study also attempted to compare the genetic relatedness among the donor and elite recipient parents.

A total of 150 Hypervariable SSR markers were analyzed with sixteen parental lines and of which 105 markers showed polymorphism. Among 105 markers, 85 markers are polymorphic to some of the genotypes and 20 markers are highly polymorphic to all the genotypes. The markers HRM 10167, HRM11111, HRM11570, HRM12469, HRM14250, HRM15727, HRM16649, HRM400, HRM19697, HRM5720, HRM6697, HRM6699, HRM22977, HRM23146, HRM24217, HRM25796, HRM26086, HRM26213, HRM28157, HRM28580 were observed to be highly polymorphic. The target chromosomes where the resistance genes are located in donor rice genotypes are chromosome 6, 7, 8, 9, 11, 12. Of the 20 polymorphic markers, 12 markers were lying on target chromosomes. These include HRM400 and HRM19697 on chromosome 6, HRM5720 and HRM6697 on chromosome 7, HRM6699, HRM22977 and HRM23146 on chromosome 8, HRM24217 on chromosome 9, HRM26086 and HRM26213 on chromosome 11, HRM28157 and HRM28580 on chromosome12.

The data obtained from SSR markers were utilized for calculation of Jaccard’s similarity co-efficient using UPGMA cluster analysis. The similarity co-efficient ranged from 0.15 - 1 and genotypes were grouped into two major clusters. The Polymorphic Information Content (PIC) values of 20 polymorphic primers ranged from 0.33 to 0.75 with a mean PIC value of 0.551 and it is considered informative for genetic studies and the polymorphism shown by the markers can be used for background selection of the recurrent parents.
The yield potential of NTJ 2, a popular rabi season sorghum variety of Andhra Pradesh can be enhanced by improving it for shoot fly resistance. This can be achieved through introgression of a QTL on SBI 05 governing leaf glossiness from the donor, J2779-P4, obtained from ICRISAT using marker assisted backcrossing (MABC). In the present study, foreground and background markers were identified, F1 plants (of the cross, NTJ 2 X J2779-P4) were confirmed for hybridity using markers, and 12 F2 plants that are homozygote’s for the target QTL were selected. Thus, the results from this study have set a stage for the proposed MABC program. A set of 17 and 170 SSR primer pairs were evaluated in the parents for identification of foreground and background markers respectively. Five foreground markers for the target QTL and 35 background markers that distinguish the genome of recipient and donor parent were polymorphic. These polymorphic markers can be used in the MABC. The background markers were distributed on all the 10 chromosomes. The F1 plants derived from the cross, NTJ 2 x J2779-P4 were confirmed for hybridity using five foreground markers and the confirmed F1 plants were both selfed and backcrossed to NJT 2. A total of 12 plants, homozygotes for the target QTL were selected among 83 F2 plants using the identified foreground markers. The F2 plants were selected, if only all foreground markers tested amplified the donor type alleles (B-type). Further phenotypic selection of these 12 F2 plants is under progress to identify the segregants that are close to NTJ 2 phenotype; they will be advanced to derive both, F3 progenies by selfing and BC1F1 generation by backcrossing to NJT 2.
Rice (Oryza sativa L.) is a widely adapted cereal crop grown almost throughout the world. Rice is the most important staple food grain with regard to human nutrition and calorie intake providing more than one-fifth of the calories consumed worldwide. Biofortification of staple food crops has been considered a sustainable strategy to overcome the problem of micronutrient deficiencies.

The present study was carried out at Directorate of Rice Research (DRR), Rajendranagar using an advanced back cross population derived from four consecutive back crosses of a recipient parent Samba Mahsuri (BPT 5204), an elite indica cultivar and common wild rice Oryza rufipogon with the prime objective of screening brown rice for micronutrient (iron, zinc) concentration and identification of SSR (Simple Sequence Repeats) DNA markers closely linked with high micronutrient content.

128 BC$_4$F$_4$ lines were estimated for iron and zinc concentration using atomic absorption spectrophotometry. The iron and zinc concentration of 128 rice lines ranged from 6.4 to 106.6 μg g$^{-1}$ and 15.5 to 52.05 μg g$^{-1}$, respectively. The top ten lines showed iron and zinc ranging from 24 to 106.6 μg g$^{-1}$ and 31.5 to 52 μg g$^{-1}$, respectively. In most of the lines, iron ranged between 13-24 μg g$^{-1}$ and zinc ranged from 26 to 30 μg g$^{-1}$. Interestingly, the top five high iron lines showed high zinc also but the reverse was not true. Grain Fe and Zn contents exhibited non-significant association among themselves and also with other grain traits.

Parental polymorphism survey was conducted to identify the polymorphic markers between the parents. Out of 188 rice micro satellite markers 51 (27 %) were polymorphic and among 36 gene specific markers 3 (8%) were polymorphic. Out of 128 lines only 5.2 % plants were homozygous for O. rufipogon alleles and 9.5 % were heterozygous. Introgression from O. rufipogon ranged from 0 % to 66.7 % with an overall mean introgression of 14.7 %. Highest introgression (%) was observed in line no. 6 (66.7 %). The percentage introgression for the locus RM279 on chromosome 2 was 47 %, while the percentage of introgression of the gene specific primer ZIPRM5511 was 14.8 % in the mapping population. The marker RM5699 on chromosome 2 was linked to
iron concentration in brown rice and RM448 on chromosome 3 was linked to zinc concentration in brown rice. Earlier studies on the linkage analysis showed that these two markers were linked to important agronomic traits such as yield, biomass, heading dates, harvest index, panicle characteristics and also to the salt and salinity tolerance in rice.

This study demonstrated that introgressions of the *O. rufipogon* alleles can increase the Fe and Zn concentration in brown rice of *indica* cultivar Samba Mahsuri significantly. This is an acceptable non-transgenic way of increasing iron and zinc concentration in brown rice.
Pigeonpea is the one of the reliably productive pulse crops in the rainfed conditions of semi-arid tropics (SAT), where it is vital source of dietary proteins. Developing the resistant varieties against biotic stresses like *Fusarium* wilt (FW) and sterility mosaic disease (SMD) is very important for increasing the production of pigeonpea in this region. Identification of molecular markers linked to *Fusarium* wilt (FW) and sterility mosaic disease (SMD) resistance genes/QTL and their deployment into elite pigeonpea cultivars will facilitate the development of new versions of these cultivars improved for FW and SMD. Therefore, as a preliminary step, we surveyed SSR polymorphism with 3072 primer pairs between the two parental genotypes viz. ICPL332 and ICPL20096, of an intra-specific mapping population (188 individuals), segregating for *Fusarium* Wilt (FW) and Sterility Mosaic Disease (SMD) resistance followed by marker genotyping of F2 population with 10 polymorphic markers. Using genotypic data of mapping population and data on FW and SMD, single marker analysis (SMA) was conducted, which leads to the identification of only marker showing significant association with SMD. However, no marker was found associated with FW. The results showed there is need of developing more SSR markers for the preparation of framework linkage map and identification of QTL/genes for FW and SMD in future.
Rice (Oryza sativa L.) is the most important food crop in the world and feeds more than half of the global population. The productivity of rice is being affected by a number of insect pests, bacterial, fungal and viral diseases. The development of host-plant resistance is considered as the most economical, effective means to control the important pests and diseases. In order to achieve durable resistance, gene pyramiding or gene stacking or both together is advisable to develop new rice varieties with multiple pest and disease resistance or to improve the existing high yielding varieties (HYVs) and hybrids by introgressing the genes for pests and diseases. With the advent of molecular markers, marker assisted selection or marker assisted back cross breeding allows the identification of plants carrying multiple resistance genes through foreground and background selection.

A research project has been initiated in the department of Agricultural Biotechnology to introgress four resistance genes (xa13, Xa21, Pi-kh and Gm4) into the genetic background of a popular rice variety Jagtial Sannalu (JGL 1798). The present investigation was aimed to survey the SSR polymorphism between parents linked to the four biotic stress resistance genes viz., xa13, Xa21, Pi-kh and Gm4 and also to screen with hyper variable rice SSR markers to study the polymorphism between recipient parent, Jagtial Sannalu (JGL 1798) and donor parents (GPP1 and NLR 145) in order to identify markers for use in foreground as well as background selection. Three gene specific primer pairs viz., xa13 promoter, pTA248 and RM547 that are closely linked to the resistance genes viz., xa13 (BLB), Xa21 (BLB) and Gm4 (Gall midge), respectively were validated by comparing with the check materials, B 95-1 for BLB and Abhaya for gall midge resistance genes. RM 206 is another primer pair that is closely linked to blast resistance Pi-kh was validated by comparing with that of Tetep, the source material for Pi-kh gene. The target genes xa13 and Gm4 are located on chromosome 8, while Xa21 and Pi-kh genes are located on chromosome 11.

Once the validation was done for the target genes, the SSR polymorphism for the parental lines (recurrent and donor parents) with respect to the target resistance genes was
done. The results revealed that clear polymorphism was observed between the donor and recipient parents for susceptible and resistant alleles for all the target genes.

One hundred and twenty eight hyper variable SSR markers were analyzed in three parental lines (JGL 1798, GPP1 and NLR 145) to assess the polymorphism between parental lines in order to use them in background selection. Among the 128 primer pairs, 92% primers (118) showed clear amplification pattern in all the three genotypes. Thirty six primer pairs demonstrated polymorphism among the parental lines. Out of 36 polymorphic primer pairs, a maximum of seven primer pairs were observed on chromosome 3, followed by four primer pairs on chromosome 4, three each on chromosomes 1, 2, 6, 8, 9 and 12, two each on chromosomes 5, 7 and 11 and one on chromosome number 10. Among 36 primer pairs, AT repeats were maximum in number (18) followed by 14 AAT, 2 AGAT and 2 AC repeats. Twenty two primer pairs viz., HRM 10936, HRM 10167, HRM 11111, HRM 13659, HRM 14250, HRM 15855, HRM 16153, HRM 15679, HRM 17405, HRM 16652, HRM 18939, HRM 20583, HRM 20710, HRM 21881, HRM 22622, HRM 23146, HRM 23578, HRM 25310, HRM 27323, HRM 28110, HRM 28202, and HRM 28800 were detected as polymorphic in nature between JGL 1798 and GPP1 (B 95-1 × Abhaya).

Thirty one primer pairs viz., HRM 10167, HRM 11111, HRM 13154, HRM 12469, HRM 13659, HRM 14250, HRM 15626, HRM 15831, HRM 15855, HRM 16153, HRM 15337, HRM 17405, HRM 16913, HRM 16652, HRM 16649, HRM 18939, HRM 18770, HRM 19697, HRM 21539, HRM 21881, HRM 22622, HRM 23146, HRM 23578, HRM 24481, HRM 24542, HRM 24199, HRM 27323, HRM 25970, HRM 28110, HRM 28202 and HRM 28800 were observed as polymorphic markers between JGL 1798 (Jagtil Sannalu) and NLR 145 (Swarnamukhi).
Rice is cultivated in more than 100 countries around the globe and its significance as food crop is ever increasing as the world population continues to explode. Insects are a serious threat to cereal crops and cause significant damage to crop production annually. Rice crop is host to a large number of insects that feed on rice. Of the six kinds of planthoppers, brown planthopper (BPH; Nilaparvata lugens Stål) (Homoptera: Delphacidae) is the most damaging insect pest of rice in Asia. Earlier studies documented tremendous genetic variation for BPH resistance existing in rice germplasm. Knowledge on the molecular markers linked to genomic regions associated with BPH resistance to enable marker assisted selection in breeding programmes.

In this study, an attempt was made to trace BPH resistance loci from BM 71, a derivative of MTU4569/ARC6650//Bunnan///IR64, a medium duration, high yielding culture resistant to BPH using simple sequence repeat (SSR) markers. MTU 3626, a semi dwarf, medium duration, high tillering, coarse grain, high yielding variety susceptible for BPH developed from the cross IR8/MTU3 was crossed to BM71 to produce F$_{2:3}$ population. A total of 170 F$_{2:3}$ population were used for screening against BPH using Standard Seed Box method. The parents, BM 71 showed moderate resistance (damage rating of 3.3) to BPH when MTU 3626 showed complete susceptibility (damage rating of 9). The damage rating of F$_{2:3}$ population ranged from 2.69 to 9.0 with an average of 6.36. Genetics of BPH resistance in the cross MTU 3626/ BM 71 did not show Mendelian segregation. Quantitative and transgressive nature of BPH resistance was observed in the F$_{2:3}$ segregating population.

Parental polymorphism survey was conducted between the parents MTU 3626 and BM 71. A total 235 markers were tested, of which, 46 (19.57%) of the markers showed polymorphism. Bulked segregant analysis using phenotypic extremes was carried out by using 46 polymorphic SSR primer pairs in bulks (resistant and susceptible) made based on F$_{2:3}$ phenotypic extremes. Out of 46 polymorphic primer pairs, 2 primer pairs i.e., RM 19660 (chromosome 6) and RM 20037 (chromosome 6) were polymorphic in bulks. Single marker analysis was done by using genotypic and phenotypic data of entire population and found that the markers RM 19660 and RM 20037 were significantly associated with BPH resistance at <0.01 probability and contributing 40.1 % and 25.7%
of total phenotypic variation. Linkage analysis of two polymorphic marker data showed significant linkage between RM19660 and RM20037 at <0.001 probability and the distance between markers was 28.5 cM. In simple interval mapping, the threshold LOD for BPH resistance at 0.05 and 0.01 levels are 8.28 and 11.78 respectively. Simple interval mapping has identified a major QTL between RM 19660 and RM 20037 with a LOD value of 54.39 at a peak position 15 cM distance. The QTL is placed at 12 cM away from left side of RM19660 and 11cM away from right side of RM20037. This QTL has explained 32% of total phenotypic variation with additive and dominance variance of 1.33 and 1.75 respectively.

Overall results of the study suggested the possibility of a genetic locus on chromosome 6 significantly associated with BPH resistance in the mapping population of the cross MTU 3626/ BM 71. Fine mapping of the genomic region influencing BPH resistance in the present study may be taken up by developing RILs for identification of closely linked markers which can be used in Marker Assisted Breeding programmes.
Development of QPM (Quality Protein Maize) with high lysine and tryptophan is foremost important task in maize breeding programme. Marker assisted selection is the easiest way of developing QPM hybrids in short time. Our investigation deals with identification of suitable donors for QPM hybrid development. 60 germ plasm lines have been screened with gene specific SSR marker: umc1066. SSR markers are known to distinctly identify the differences among opaque-2 alleles. The opaque-2 mutant allele with larger distance from wild type allele on the agarose gels is preferred as a donor in conversion of non QPM lines. However, the highest quantity of lysine and tryptophan should be kept in mind in such conversion programmes. Seven lines have shown distinct allelic differences to wild type allele in the non QPM lines. In order to identify the ease with which the seven potential donors could be used in conversion programs, they have been crossed with BML 2, BML 6, BML 7 and BML 15. The molecular weight of all the seven opaque-2 mutant alleles in the donors appears to be same (~156 bp) on agarose gels with metaphor: merc agarose(1:2). There appears to be a difference of less than ten bases between wild type and mutant alleles. In order to assess the visibility and feasibility of using these donors, CML181 and CML186 have been crossed with a few important non QPM inbred lines like BML 2, BML 6, BML 7 and BML 15. The gel patterns revealed a satisfactory resolution between the alleles. Since SSR markers are co-dominant, we preferred to use them in our studies as they are found to be the best under the existing laboratory conditions next to SNPs which are costly.
The present study was undertaken to study the cost and returns, resource use efficiency, production trend, and the production problems.

The investigation was carried out in Kunduz province of Afghanistan which is purposively selected for the present study as a considerable area is found under almond cultivation in Afghanistan. Two districts (Chahardara, Qalazal) and centre of Kunduz were selected and Three villages namely from each districts MaMakhail, Hazrat ha, Ainul majar, Kakar, Ortaboz, Aqtapa, Gultapa larkhaby, Chemtapa were purposively selected as they ranked good under almond cultivation in their respective districts. List of all farmers cultivating of almond in the selected villages was made. These farmers were stratified into three size groups i.e. small, medium and large on the basis of operational holding as per criterion adopted by villagers. The data collected was subjected to tabular, percentage and average analysis, functional analysis, discounted and undiscounted cash flow techniques were used.

The establishment costs of almond orchard were the costs incurred in raising the orchard as well as the costs incurred to maintain the same till it comes to bearing. The average establishment cost of almond orchard during first year in 62858.04 Afg per hectare. The average total maintenance cost during pre-bearng period from second to fourth year was 53228.75 Afg, 60827.37 Afg, and 61758.06 Afg per hectare respectively. Material cost is more during second year when compared to first year, indicating that growth phase requires more nutrition. During pre-bearng period cost of material increased as the year passed and labour cost decreased. The total labour requirement for the cultivation of almond during its life period was 3993.94 man-days per hectare and during a year were 160 maydays. Indicating that this fruit crop generates good employment.

The total annual maintenance costs incurred from 5th to 10th year was 70213.80 Afg, 72187.32 Afg, 73241.48 Afg, 79306.07 Afg, 74274.68 and 76106.07 Afg respectively. Similarly from 11th to 15th year total maintenance costs was 367618.2 Afg, the total maintenance cost from 16th to 20th year was 361832.5 Afg and from 21st to 25th
The year total maintenance costs incurred was 361832.5 Afg. The total annual cost of cultivation inclusive of direct and indirect costs was estimated to be 126111.5 Afg per hectare. The Cost A (81123.71 Afg) was in almond orchard. The cost B per hectare was estimated at 104063.4 Afg. The cost estimates showed that the total cost of cultivation (Cost C) per hectare was 126111.5 Afg. However labour cost is stable during bearing period. The average gross and net incomes from almond orchards were worked out to be 242793.33 Afg and 116681.83 Afg per hectare per annum respectively.

Undiscounted and discounted cash flow techniques like net present worth (NPW), benefit-cost ratio (BCR) and internal rate of returns (IRR) were considered at 12 percent. Net present worth of almond was found 702084 Afg, benefit- cost ratio was found to be 2.31 at 12 per cent discount rate. Similarly internal rate of return was 39 per cent. Almond in Afghanistan is economically feasible if financial support is given through bank.

Cobb Douglas production function analysis revealed that the variables plant and materials, FYM, fertilizers and plant protection costs were found to be positive and significant. The sum of production elasticities indicated increasing returns to scale indicating the possibility of increasing the yields by adding more inputs. The co-efficient of multiple determinations is significant explaining 98.8 percent variability in the gross returns by all categories. MVP/OC ratio revealed that all variables had high degree of resource use efficiency.

In the year of 2000 the total production of almond was 12000 ton, while compared with 2009 year the total production is 46400 ton it shows positive growth in production of almond. In the year of 2000 almond contributed by 0.6 % to total export and in 2009 year increased to 14.7 percent of total export. So almond is an important export potential crop.

The major constraints of production and marketing were uncertainty of weather/climate attack of pest and diseases, non availability of better plant protection, no bank loan and subsidy, lack of awareness among farmers about new methods of production, lack of good seeds, fertilizers, high cost of inputs and input services. With respect to marketing, fluctuation in price, presence of too many middlemen, lack of proper storage, inadequate transport facilities, absence of packing, packaging and processing, were identified as constraints by almond growers.

The findings of study indicated that the almond production was more profitable, economically viable and it has international market, thus there is greater scope to bring more area under almond. Farmers are uneducated and unaware of the importance of maintaining optimum plant population, need to be trained, Afghanistan almond has better international market and domestic market requirements. Therefore obtaining high yield per hectare, with less cost of cultivation is needed. To expand the area both public and private sectors have to be encouraged. Government should provide almond growers loan and input subsidy, since the use of fertilizer is less than recommendation dose. Availability of credit will also encourage farmers to use more inputs to maximize yields and to grow new orchards. Since, almond is proven to be economically profitable, new areas suitable may be brought into almond cultivation orchards by providing bank loans.
at a cheaper rate of interest. The market networks and development of infrastructure to facilitate storage and transportation can reduce the marketing constraints pertaining to almond.
The present study was undertaken mainly to study the costs and returns and economic feasibility of mango cultivation, along with processing aspects. The study was undertaken in Chittoor district, which was purposively selected for the study as it has highest area under mango in Andhra Pradesh. Six mandals with highest area under mango were purposively selected. Two villages from each selected mandal were chosen and 80 farmers from the selected villages were randomly chosen for studying the production aspects of mango. From the list of 75 processing units, 12 processing units were randomly selected. Tabular analysis and discounted project evaluation techniques were used to study costs, returns, economic feasibility of the mango orchard and costs and returns in mango processing.

The total human labour utilization per hectare of mango orchard was 3343.55 man days during its economic life period of 40 years. Harvesting was the most labour absorbing operation with 1089.29 man days (32.57 per cent) followed by watch and ward with 997.72 man days (29.84 per cent) respectively. The total cost of cultivation per hectare of mango orchard was Rs.1677974.38. The gross and net returns obtained per hectare of orchard during its economic life period of 40 years were Rs.5917160 and Rs.4299224.83 respectively. The calculated NPV, B-C ratio and profitability index at a higher discount rate of 20 per cent were Rs.33043.89, 1.15 and 0.3669 respectively. Internal rate of return stood at 23.17 per cent. All these measures indicated economic feasibility of investment in mango orchard.

The total investment was Rs.226.09 lakh on canning and processing units and Rs.376.40 lakh on medium scale aseptic processing units. Total cost of mango processing amounted to Rs.73.24 lakh in small scale canning units and Rs.642.53 lakh in medium scale aseptic processing units. The net returns were found to be Rs.257.47 lakh in medium scale units and Rs.18.76 lakh in small scale units.
AGRICULTURAL ECONOMICS

Author : BABAR ASHOK BALIRAM
Title of the thesis : “ECONOMIC ANALYSIS OF CROP INSURANCE
SCHEMES AND PAYOUTS IN SUSTAINING RICE PRODUCTION
DUE TO CLIMATE CHANGE IN THE KRISHNA RIVER
BASIN OF ANDHRA PRADESH”
Major Advisor : Dr. G. RAGHUNADHA REDDY
Degree : M.Sc. (Ag.)
College : AGRICULTURAL COLLEGE, BAPATLA
Accession Number : D 9037

The agriculture is subjected to vagaries of adverse weather conditions which result in volatility in farm production and income which in turn may adversely influence the food security of nation. Hence, there is need to give adequate attention to tackle the problems arising from different risks such as production risk, price risk, financial risks etc. Risk management strategies like different financial risk transfer products will provide resilience mechanism system in agriculture and will enable to continue agricultural production over extended period of time.

The study was conducted in Nagarjunasagar Right Canal (NSRC) command area of Guntur district and pertains to the agricultural year 2010. Both primary and secondary data were used for present study. Multistage sampling design was adopted to obtain a representative sample of 240 paddy farmers and primary data were collected through a well structured interview schedule. The Double bound dichotomous model of contingent valuation method was used to elicit farmers Willingness-to-Pay (WTP) for weather based crop insurance scheme (WBCIS). Statistical tools used in data analysis were compound growth analysis, loss ratio, break-even ratio, arithmetic mean, standard deviation, frequency and percentage, percentile and percentile ranks, and log-likelihood model. The log-likelihood model was estimated using ‘STATA’ data analysis software tool pack which uses a maximum likelihood method of estimation.

The study revealed that farmers do not have in-depth awareness about crop insurance scheme. The coverage of non-loanee farmers in the state was very low as compared to loanee farmers. The financial viability of National Agricultural Insurance Scheme (NAIS) is very poor as it assumes loss ratio greater than ‘one’ for overall figure and for paddy alone in state but the financial viability of scheme is considerably good in Guntur district. The compound growth rate in number of paddy farmers and paddy area covered under NAIS is low in state and need to increase it. More number of farmers are
not interested to take part in crop insurance as it does not pay out even if farmers incur yield loss. Distribution of payouts’ structure of WBCIS for red chilli (irrigated) is such that it pays out in extreme weather events of heavy rains, severe drought and high relative humidity over extended period of time. The farmers’ WTP for WBCIS scheme is about 4.73% of sum insured for paddy. Among the major factors affecting farmers’ WTP are farmer age, education and awareness about crop insurance.

The present study suggests for re-insurance facility for Agriculture Insurance Company of India Ltd. (AIC) from government, mass awareness programme planning, no-claim bonus for the farmer if insured farmer was not eligible to get compensation for consecutive three years, revision of NAIS structure, revision of strike levels and distribution of compensation per ‘mm’ deficit or excess rainfall in WBCIS, and fixing premium rates for WBCIS at around 5% of sum insured.
The present study was undertaken to study the prospects of broiler production under contract and non-contract farms situation.

This study was undertaken through a survey method by contacting 30 broiler farms, representing non-contract and contract broiler farms.

The average number of broilers per farm per cycle were 7800 and 26000 in non-contract and contract farms respectively. All the contract farms (100 per cent) took broiler farming as main occupation in contrast to non-contract farms (53.33 per cent). Among different strains of broilers Vencob and Ross 360 were the most popular strains reared by broiler farmers of Tirupati Rural mandal under contract and non-contract farm situation. The average production cost per 1000 broilers/cycle were phenomenally higher (Rs.112875.26) on contract broiler farms over that of non-contract broiler farms (Rs.93473.19). The average gross return per 1000 broilers/cycle were distinctly higher on contract broiler farms (Rs.151474.93) than that of non-contract broiler farms (Rs.117019.75).

The return/rupee of investment was higher on contract broiler farms (1.34) over that of non-contract farms (1.25) indicating the profitability and economic of contract farms due to the following reasons such as better growth broiler in chicken weight, low rate of mortality, better management and timely vaccination and provision of highly nutrient poultry feeds and supplements.

The break-even sale weight in kilograms per 1000 broilers per cycle was less on contract broiler farms (152.20 kg) than that of non-contract broiler farms (154.16 kg). The margin of safety was more for contract broiler farms in contrast to non-contract broiler farms indicating better risk bearing capacity in the case of contract broiler farms.
The Multiple Linear Regression (MLR) analysis revealed that X1 input i.e. feed input had positive impact on chicken weight of broilers (i.e. 0.581 kg/per one kg of feed) and X2 input i.e. electricity charges per unit of 1000 birds were excessively incurred resulting in negative impact (-0.271 X2) on broiler chicken weight. The dummy variable X3 input has impact on chicken weight (X3 = 183 kg) in broiler production indicating relative profitability of broiler production under contract farms.

The total labour employed in mandays and woman days per 1000 broilers per cycle were higher on contract broiler farms (18.56 days) over that of non-contract broiler farms (15.98 days). This indicates that employment generation was more in contract broilers farms over that of non-contract broiler farms.

Hence, this study as a whole revealed that with contract broiler farms, growers achieved more incomes and profits, having better prospects and profitability and it is more efficient than non-contract broiler production.
The present study was undertaken to study the overall development of water resources. The objectives of the study include to study the source-wise water resources and to estimate the growth rates for different sources, to study the issues pertaining to water resource potential, and to suggest suitable policy measures for overall balanced development of water resources.

Time series secondary data on area irrigated, sources-wise area irrigated and region-wise area irrigated, over the period from 1955-56 through 2008-09 were analyzed. Data on investment in irrigation (plan-wise) from the period of first five year plan (1951-1956) to tenth five year plan (2002-2007) and data on plan-wise major, medium and minor irrigation potential created and potential utilized for the period of (pre-plan period up to 1951) to eleventh annual plan (2008-09) were collected from Directorate of Economics and Statistics, Government of Andhra Pradesh. Data were also collected from Central Water Commission, Irrigation Department of Government of Andhra Pradesh and E-Resources of the ANRAGU university library. Per cent change over previous years, compound growth rates and mean were used as analytical tools.

The results revealed that the investment trend in irrigation sector has been increasing since first five year plan. The canal irrigated area has been stagnant in Telangana and Rayalaseema, whereas it has been increasing with high and significant growth rate in Coastal Andhra and Andhra Pradesh during the study period.

The well irrigated area has been increasing with high and significant growth rate in all three distinct regions of Andhra Pradesh and the entire state of Andhra Pradesh. Irrigated area under other sources has been increasing with slow growth rate in Coastal Andhra, Telangana and Andhra Pradesh, whereas it has been decreasing in Rayalaseema during the study period.

Net irrigated area has been increasing slowly with non-significant growth in Coastal Andhra and Rayalaseema whereas it has been increasing with high and significant growth rate in Telangana and Andhra Pradesh during the study period. The
gross irrigated area has been increasing with high and significant growth rate in Telangana and the state of Andhra Pradesh whereas it has been increasing with slow and non significant growth rate in Andhra Pradesh. On an average there has been 9.6 per cent gap between potential created and potential utilized on irrigation potential in Andhra Pradesh. The study suggests a balanced development in water resources across regions.
The present study was undertaken to overview the resource use efficiency, marketing costs, margins and price spread in different channels of turmeric marketing, to study different price forecasting models to predict turmeric prices, to identify the problems in turmeric marketing and suggest suitable remedial measures.

The study was undertaken in the Warangal district of Andhra Pradesh, which was selected for the study as it is one of the most important turmeric growing districts in Andhra Pradesh. A sample size of 90 farmers consists of marginal and small and large farmers i.e. 30 each were identified for the present study. Three mandals were purposively selected based on the highest area under turmeric cultivation. In each mandal 3 villages were selected based the highest area under turmeric cultivation. The ultimate sample of 90 farmers was randomly selected from marginal, small and large farmers 10 each from each village to elicit the primary data for the present study. The intermediaries involved in marketing of turmeric namely local traders, commission agent, wholesaler, and retailer were also selected at the rate of five from each category making the total sample size twenty. Thus the total sample included 90 farmers and 20. The primary data pertains to the agricultural year 2009-10 and secondary data were collected over a period of time for the past five years (2005-06 to 2009-10) from agricultural market committee.

The required information was elicited through personal interview method from respondents by means of specially designed and pretested schedules. Schedules were designed to elicit information from farmers, middlemen and commission agents. Secondary data was collected from sources like market committee records, CMIE and indiastat.com etc. The data collected were processed through tabular and statistical analyses. The collected data were analyzed by adopting average and percentage analyses, Cobb- Douglas production function.

The total cost of production was Rs 344767.77 for marginal farmers, Rs 320297.67 for small farmers and Rs 314730.24 for large farmers. The OLS estimates of Cobb-Douglas production function for turmeric cultivation by marginal farmer revealed...
that the coefficients of planting material, Labour and organic manure were positive and significant. The OLS estimates of Cobb-Douglas production function for turmeric cultivation by small farmer revealed that the coefficients of inorganic fertilizer and irrigation were positive and significant. The OLS estimates of Cobb-Douglas production function for turmeric cultivation by large farmer revealed that the coefficients of human labour and irrigation were significant at one percent level of probability.

Three types of marketing channels were identified in the study area and price spread was estimated for each of the four marketing channels. From the analysis of price spread the marketing channel III namely Farmer- Regulated market - Retailer- Consumer was the efficient marketing channel.

Pest and disease, high labour cost, water scarcity, and low price were some of the problems faced by sample farmers. The most important constraints identified by the turmeric growers were higher price fluctuation and storage loss. The intermediaries expressed that the lack of storage facility was the most important problem followed by high marketing cost and poor quality of turmeric.

Based on the performance results of different forecasting models, ARIMA 110 was preferred mainly because of the lowest Mean Absolute Error, lowest Akaike Information Criterion, lowest Schwarz’s Information Criterion and highest Adjusted $R^2$ value.

Turmeric crop was found to be profitable with the benefit cost ratio of 1.93. So the Horticulture Department has to take major initiatives to increase area under turmeric cultivation in Warangal district. Higher price fluctuation was the major constraint in the turmeric marketing. Hence establishing contract farming between turmeric growers and turmeric processing units will reduce price fluctuation and provide remunerative price to the turmeric growers during peak season. The State Government may provide appropriate storage facilities. The farmers felt that high labour cost was the second most important problem in cultivation of turmeric. It is proposed that employment generation programmes may not be implemented in peak agricultural season.
The present study was undertaken to study the costs, returns, resource use efficiency and processing aspects of soybean. The study covered two blocks and four villages with 80 farmers growing soybean. The sample farmers were stratified into small (up to 2 hectares) and large (more than 2 hectares). The data pertained to 2009-2010 were collected through survey method with the help of pretested schedules. Conventional and functional analysis was used to analyze the data and to arrive at valid conclusions.

The per hectare cost of cultivation of soybean was estimated at Rs.30,740.85, Rs.28,466.26 and Rs.29,587.43 on small, large and pooled farms respectively and thus exhibiting inverse relationship with the size of the farm. The cost of producing a quintal of soybean showed direct relationship with the size of the holding as it was Rs.1,727 on small farms, Rs.1,848.45 on large farms and Rs.1,793.20 on pooled farms. The net income decreased from Rs.13,342.47 on small farms to Rs.8,986.56 on large farms. The same on pooled farms was Rs.10,999.42. The break-even analysis indicated that the break-even output per hectare on small, large and pooled farms was 12.96, 13.13 and 13.10 quintals respectively. The actual output obtained by the farmers exceeded the break-even output. The results of allocative efficiency highlighted that the MVP/MFC ratios were more than unity for human labour and fertilizers on small farms, human labour on large farms and human labour on pooled farms indicating the scope of their further use. The quantity of soybean crude oil and de-oiled cake obtained from crushing 5.6 tonnes of soybeans was one tonne of oil and 4.6 tonnes valued at Rs.39,000 and Rs.64,400 respectively. The net returns obtained per tonne of crude oil were worked out to Rs.1,301.
AGRICULTURAL ECONOMICS

Author : KIRAN KUMAR, G.

Title of the thesis : “AN ECONOMIC ANALYSIS OF SEED AND COMMERCIAL CULTIVATION OF COTTON AND JOWAR IN KURNOOL DISTRICT OF ANDHRA PRADESH”

Major Advisor : Dr. T.V. NEELAKANTA SASTRY

Degree : M.Sc. (Ag.)

College : S.V. AGRICULTURAL COLLEGE, TIRUPATI

Accession Number : D 8986

The present study was undertaken to examine costs, returns, resource productivity and constraints in the production of cotton and jowar seed and non-seed. Multistage stratified purposive cum random sampling technique was used for the selection of mandals, villages and the farmers. A sample of 120 farmers was selected at random from 8 villages. The primary data for the year 2009-10 were collected through a pre-tested schedule by survey method. Both conventional and functional analysis were used to analyse the data and to arrive at valid conclusions.

The total human labour employment in the cultivation of seed cotton, seed jowar, cotton commercial and jowar commercial was 808.34, 85.76, 81.54 and 31.08 mandays per hectare respectively.

On an average, the cost of cultivation of seed cotton, seed jowar, cotton commercial and jowar commercial was estimated at Rs. 2,07,875.76, Rs 67,594.78, Rs 65,455.29 and Rs. 36,339.36 per hectare respectively. Thus the cost of cultivation was highest on the cotton seed farms and lowest on jowar non-seed farms. The cost of cultivation on cotton seed and non-seed farms was higher than that of jowar seed and non-seed farms. The gross and net returns per hectare of seed cotton, non-seed cotton, seed jowar and jowar non-seed farms were Rs. 4,70,400 and Rs. 2,62,524.24, Rs. 1,37,500 and Rs. 69,905.22, Rs. 1,23,750 and Rs. 58,294.71, and Rs. 60,931 and Rs. 24,591.64 respectively. The returns per rupee of investment were Rs. 1.26, Rs. 1.03, Rs. 0.89, and Rs. 0.68 on the above said categories of farms. The regression analysis indicated that there was under utilization of tractor power and fertilizers on seed cotton farms, cattle labour and fertilizers on cotton non-seed farms, cattle labour and tractor power on seed jowar farms and cattle labour, tractor power and fertilizers on jowar non-seed farms.
In Andhra Pradesh, migration from rural areas is an important issue that is gaining more significance year after year. Moreover, the extent, nature, characteristics and pattern of migration have been evolving over time. In fact, the larger part of the migration taking place is seasonal and cyclical in nature. Seasonal or short duration migration is certainly not a new phenomenon in Andhra Pradesh. However, the magnitude of rural labour circulation is of recent origin, and a direct consequence of structural changes in the economy. Seasonal or circular migration could be largely distress driven and stimulated by the partial or complete collapse of rural employment generation, economic difficulties of cultivation and absence of alternative employment opportunities in underdeveloped regions of the Andhra Pradesh. In reality, it has become an integral part of livelihood strategies pursued by a large number of poor people living in agriculturally underdeveloped areas.

For the purpose of present study three districts namely Anantapur from Rayalaseema, Mahabubnagar from Telangana and Srikakulam from Coastal Andhra regions were selected based on the level of irrigation which is taken as a proxy for the level of development. A multistage random sampling was adopted in the study to select 360 sample households migrants and non migrants pertaining to the year 2008-09. Standard pre-tested schedule was used for both migrant and non-migrant households to elicit information covering family details, migration particulars, labour, and number of days of employment, inside village and destination place, type of migration, pattern of migration, income, and expenditure levels of migrant and non-migrant households through personal interview method. Different analytical tools were used for analysis that includes averages, percentages, frequency tables, multiple linear regression, z test and paired t test. The pattern of migration is measured through averages, percentages, frequency tables. Multiple linear regression model is used to measure the factors influencing migration. Statistical comparison of income, expenditure, and savings of migrant and non-migrant households are measured with z test and paired t test was used to measure the impact on income of migrant households before and after implementation of the Mahatma Gandhi National Rural Employment Guarantee Scheme.
An analysis of the pattern of migration of agricultural labour revealed that, about 61 percent of the migrant agricultural labourers are belonged to the lower age group of 26-40 years. Migrant households of Scheduled Caste group are contributing 60 percent to the total migrants. In Srikakulam district, among the total migrants 50 percent migrants are belonged to Backward Classes. About 46 percent of the migrant households in the study area are educated at primary level, 42 percent are illiterates and 12 percent of migrants are having higher secondary education. Further, it is found that 54 percent households are landless farmers. About 58 percent of the migrant households are migrating from joint family system. Males are migrating more than females. Migration of whole family is very low which only 8.33 percent. Due to higher wages of non-agricultural activity, 55 percent of migrant households are working on non-agricultural activities and 44 percent of migrant households are working on agricultural activities at the destination place. Inter district migration is seen to be the dominant flow in the direction of urban areas. It is more in Anantapur and Mahabubnagar districts with 56.67 and 51.67 percent, where as in Srikakulam district intra-district migration is predominant, to an extent of 30 percent. Migrant households of all the districts are migrating to other states. Factors influencing migration are of two types, namely the push and pull factors. Lack of employment and poverty are the major push factors, which shows 38 percent and 32 percent of the total respondents. While the pull factors are better opportunities and connection of friends or relatives at the destination place showed 40 percent and 35 percent of the total respondents. The regression coefficient of age, family size and family income are high in Mahabubnagar district with -0.259, 0.260 and -0.174 and they are statistically significant. While, employment ratio is highly significant at one percent level in Anantapur district with a regression coefficient of 0.577.

The income of migrant households was improved due to migration and the income of migrants over non-migrants is statistically significant. The mean difference in income of migrants over non migrants income is high in Anantapur district with Rs. 4035. The expenditure levels of migrant households have improved due to migration. The mean expenditure of migrants over non-migrants is high in Mahabubnagar district with Rs.7869. The expenditure on food, ceremonies, health, and education are high in migrant households than their non-migrant counter parts. Migrant households have acquired fixed and durable assets due to migration. The income, expenditure, savings of migrant households over their non-migrant households is statistically significant. Because of migration, about 19 percent of the migrant households acquired new skills on transplantation, fertilizer and pesticide application. About 28 percent of migrant households know about the various government schemes and their benefits. About 17 percent of migrant households acquired knowledge on hygiene and health and only 8 percent migrant households are aware of about minimum wages at different locations on different operations at the destination places.

The analysis indicated that after implementation of the MGNREG scheme, the income of migrant households in Mahabubnagar district is increased from Rs. 26,250 to 32,790. Among the non-migrants, in Anantapur district, income increased from Rs.24,934 to Rs.31,717. In Anantapur district, 75 percent of households are working under MGNREGS. The participation rate of BC community in the National Rural Employment Guarantee Scheme is higher in Srikakuklam, Anantapur and Mahabubnagar districts with
50 percent, 31 percent and 19 percent respectively. The female labour participation is more in the scheme than the male labourer. The major works confined to water harvesting and soil conservation in the study area. About 66.39 lakh rupees were spent on wages for water harvest and soil conservation. After implementation of the scheme there is an increased demand for agricultural labourers in the village in peak seasons.

It can be concluded from the study that the migration has helped migrant households to avoid hunger and prevented starvation deaths. Though it failed to improve the economic well-being of all the migrant households in the study area, it helps to sustain in the drought periods. Income of migrant households has increased substantially than their non-migrant counter parts. Continuous migration leaves people out of developmental programmes. To alleviate poverty, the government’s attention should be directed towards combating migration via rural development.
Rice is the staple food crop of India, providing 30% of calorie requirement for more than 70% of Indian population. It occupies highest area among the crops grown in the country. India stands first in rice area with 41.85 million hectares (m ha) and second in production with 89.13 million tons (m t) after China (196 m t). To meet the demands of increasing population the present production level of around 90 million tons, needs to be increased up to 120 million tons by the year 2020. To achieve this production, hybrid rice technology is the most feasible and readily adoptable option, among the various genetic approaches possible, as has been amply demonstrated in the People’s Republic of China, during the last two decades. During the year 2010, hybrid rice was planted in an area of 1.3 m ha and additional rice production of 1.5 to 2.5 m t was added to our food basket through this technology.

Uttar Pradesh and Jharkhand have been selected to assess the impact of hybrid rice technology, as these are the major hybrid rice growing states of the country. The state of Andhra Pradesh has been selected to study the economics of hybrid rice seed production. Two districts from each of the two selected states viz., Uttar Pradesh and Jharkhand were selected purposively. Ambedkar nagar and Bahraich districts of Uttar Pradesh and Ranchi and Khunti districts of Jharkhand were purposively selected as hybrid rice accounts for majority of rice area in these districts.

The yield hike due to hybrid rice cultivation was 26.43 per cent and 49.27 per cent when compared to HYV rice cultivation in case of Uttar Pradesh and Jharkhand respectively. The total returns obtained per hectare were 12.66 per cent and 29.72 per cent higher for hybrid rice than the HYV rice cultivation in case of Uttar Pradesh and Jharkhand respectively.

Out of the hundred sample rice farmers in Uttar Pradesh, 67 percent are very efficient, i.e., more than 90 per cent technically efficient in hybrid rice cultivation, whereas for HYV rice only 44 per cent were operating with more than 90 per cent technical efficiency. Sixty one per cent of the sample farmers who cultivated hybrid rice were above 90 per cent technical efficiency in case of Jharkhand and 33 per cent were more than 90 per cent technically efficient for HYV rice.
The gini coefficient for Uttar Pradesh was 0.14 for HYV rice cultivation and 0.07 for hybrid rice cultivation. In case of Jharkhand gini coefficient for HYV rice cultivation was 0.32 and the value got reduced to 0.05 for hybrid rice cultivation.

The average net returns obtained from hybrid rice seed production per hectare in Andhra Pradesh were around 130 per cent higher when compared to average net returns obtained from HYV rice cultivation. The relative importance of the discriminators revealed that machinery labour, bullock labour, human labour, plant protection chemical and fertilisers contributed mostly to discriminate between the two groups of hybrid rice seed production and HYV rice cultivation by the sample farmers in Andhra Pradesh.

The number of farmers willing to continue hybrid rice next season were more in both Khunti and Ranchi districts of Jharkhand when compared to Ambedkarnagar and Bahraich districts of Uttar Pradesh. This may be due to the fact that in Jharkhand, where majority of the farmers are having small holdings of half to one acre and growing rice for household consumption and have distinct preference for hybrid rice.
The present study was conducted in Karimnagar district of Andhra Pradesh with the major objective to estimate and compare the costs and returns for Seed and commercial maize cultivation on different size groups, to evaluate the resource use pattern and their efficiencies, to estimate marketing margins and to identify the problems if any faced by the farmers and to give suitable measures to boost up the yields and returns. A total of 80 sample maize growing farmers were selected, 40 each for seed and commercial farms respectively by adopting purposive random sampling technique. The selected farmers were post classified into different size groups based on their size of holding. A Pre tested schedule was used to collect data through survey method related to the rabi season of the agricultural year 2010-11. Both conventional and functional analytical tools like simple mean, averages, percentages, cost concepts, farm income measures, Discriminant functional analysis, Cobb- Douglas production function etc., were used to arrive at valid conclusions.

This study compares the costs and returns and resource use efficiency of maize seed farms and commercial farms. The study was based on input-output data from 80 sample maize farmers i.e., 40 each adopting seed and commercial production were selected randomly in Karimnagar district of Andhra Pradesh during rabi season of 2010-11. They were classified into three size groups viz., small (below 1ha), medium (1 to 2 ha) and large (above 2 ha). The total cost of cultivation worked out to be Rs.25,099.15, and Rs.21,030.49 per acre for seed and commercial maize farms, respectively. The net returns were estimated to be Rs.23,568.34 and Rs.6,154.8 per acre for seed and commercial maize farms, respectively. The production function analysis indicated in maize seed production bullock labour, machine power, manures and irrigation whereas, in commercial production fertilizers and plant protection chemicals showed significant influence on gross income.

The study reveals that the total cost of cultivation was more for Seed production (Rs.25,099.15/acre) compared to commercial production (Rs.21,030.49/acre) of maize.
This was mainly because of high human and machine labour costs. Maize seed production requires more labour for operations like detasseling and roughing. This was followed by machine power cost as the shelling and transport were carried out by employing equipment and machinery like shellers and tractors.

The benefit cost ratio for maize seed production and commercial production was estimated to be to be 0.94 and 0.29, respectively. It means that for each rupee invested the profits obtained are Rs.0.94 for seed and Rs.0.29 for commercial production of maize. So it was clear that seed production was more profitable than commercial production.

The data reveal that physical returns per acre for maize seed production was worked out to 30.26 quintals, whereas in case of commercial production the same was 26.24 quintals per acre. This clearly indicates not much variation in the yield between the both but the price offering by the seed companies were almost double than commercial production.

The per quintal cost of production was Rs.832 and Rs.803.13 on seed and commercial production of maize, respectively. This indicates that per quintal cost of production was high for seed production farms, the plausible reasons might be due to higher labour costs. The estimated farm income measures also high in case of Seed as compared to commercial production of maize.

The study revealed that maize seed production was profitable than the commercial production. Cobb Douglas production function analysis revealed that the variables bullock labour, machine power, manures and irrigation in maize seed production, whereas fertilizers and plant protection chemicals in commercial production were found to be positively significant. The sum of production elasticities indicated increasing returns to scale in all sample farms i.e., seed and commercial maize farms. The co-efficient of multiple determinations are significant for seed and commercial maize farms explaining 81.12 and 91.29 per cent of variations, respectively in the gross returns by all input categories. The production function analysis indicated that maize seed production was comparatively better than commercial production.

Creation of awareness about seed production through concerned officials by conducting field demonstrations for increasing the yield and also demonstration of proper management practices of seed production through organization of field visits to successful farms may increase the adaptation of seed production in a larger extent by the farming community.
The present study was conducted in Guntur district under Nagarjuna Sagar project area of Krishna river basin of Andhra Pradesh with the major objectives to assess the vulnerability index of districts under Krishna river basin of Andhra Pradesh, to assess the impact of climate change on socio economic conditions of farmers, to analyze the adaptation strategies taken due to climate change and to examine the efficient Rice production systems in the study area. A total of sample 240 paddy growing farmers were selected randomly, 40 from each village. The important analytical tools employed in the study were the Principle Component Analysis, Ricardian Regression Model, Logistic Regression Model, Simple Tabular Analysis etc.

The study revealed that among the nine districts under Krishna river basin, Anantapur was highly vulnerable whereas Krishna district was least vulnerable.

The impact of climate change on area of crops showed that the climate variables such as long term daily minimum temperature average (LLT) and long term daily maximum temperature average (HLT) were important determinants of maize and long term daily maximum temperature average (HLT) and annual rainfall (RY) were important determinants of paddy crop where as proportion of irrigated area to total cropped area (PROIA) and long term daily maximum temperature average (HLT) were important variables influencing Groundnut.

In case of productivity the variables proportion of surface irrigated area from tanks and canals (PROSUR) and long term daily minimum temperature average (LLT) in paddy, long term daily minimum temperature average (LLT) and long term daily maximum temperature average (HLT) in maize and long term daily minimum temperature average (LLT) and long term rainfall average (RLT) in Groundnut were important variables influencing productivity of crops.
The socio economic study revealed that an average age of the farmers was 36 years and the education level was up to high school level. Most of the farmers invest their income on health ranging from Rs.10000-20000 per year. Most of the farmers lend their credit from banks and cooperative societies. The study also revealed that 59.17 % of farmers reported adapted and 40.83% of farmers reported not adapted to climate change. The major constraints for not adapting were lack of information, lack of money, shortage of labour, shortage of land and poor potential for irrigation.

Logit model results indicate the variables that influence adaptation capacity of farmers significantly were farm size, farming experience, access to credit and access to extension services.

Among the different Rice production technologies in the study area, the total cost of cultivation was high in SRI followed by machine transplanting, farmers practice and in direct sowing. The net returns and B-C ratio were highest in direct sowing followed by SRI, machine transplanting and farmers practice. Cost of production was highest in farmers practice followed by machine transplanting, SRI and direct sowing. The WUE was highest in SRI followed by direct sowing.
The present study was conducted in Warangal district of Andhra Pradesh with the major objective to estimate and compare the costs and returns for SRI, transplantation and direct seeding methods of paddy cultivation on different size groups, to evaluate the resource use pattern and their efficiencies, to calculate water productivity and to identify the problems if any faced by the farmers and to give suitable measures to boost up the yields and returns. A total of 90 sample paddy growing farmers were selected, 30 each for SRI, transplantation and direct seeding methods respectively by adopting purposive random sampling technique. The selected farmers were post classified into different size groups based on their size of holding. A pre tested schedule was used to collect data through survey method related to the rabi season of the agricultural year 2010-11. Both conventional and functional analytical tools like simple mean, averages, percentages, cost concepts, farm income measures, Cobb-Douglas production function etc., were used to arrive at valid conclusions.

The costs according to cost concepts revealed that maximum cost of cost A1 and cost B was incurred for the production of SRI paddy i.e., Rs.51900.41 and Rs.61258.78 respectively followed by transplantation (Rs.37432.45 and Rs.45651.71) and direct seeding (Rs.10823.16 and Rs.14647.02) and the total cost of cultivation (cost C) inclusive of variable and fixed costs was estimated to be Rs.68451.95, Rs.51036.23, and Rs.15722.26 for SRI, transplantation and direct seeded rabi paddy respectively. The net returns realized were estimated to be Rs.24054.71, Rs.12913.77 and Rs.4978.46 with respect to SRI, transplantation and direct seeded paddy with a benefit-cost ratio of 0.36, 0.24 and 0.32 respectively.

The gross income, net income, family labour income, farm business income and farm investment income were more in SRI accounting Rs.92506.67, Rs.24054.71, Rs.31247.88, Rs.41289.53 and Rs.34102.11 respectively on pooled farms of SRI cultivation followed by transplantation (Rs.63950.00, Rs.12913.77, Rs.18298.29, Rs.26517.55 and Rs.22071.70) and direct seeding (Rs.20700.72, Rs.4978.46, Rs.6053.70, Rs.9877.56 and Rs.8802.32).
The results of production function analysis indicated increasing returns to scale in SRI ($\sum b_i = 1.0821$) and decreasing returns to scale in transplanted farms ($\sum b_i = 0.8734$) and direct seeded farms ($\sum b_i = 0.8374$) realizing the operation of farms at sub-optimal condition in SRI and thus there is a need for reorganization of resources to increase the resource use efficiency and obtain higher returns in SRI cultivation.

The total water productivity was worked out to be 0.98, 0.44 and 0.57 kg/m$^3$ for SRI, transplantation and direct seeding methods of paddy cultivation respectively. These values reveal that water productivity was highest in SRI followed by direct seeding and transplantation.

The opinion survey of the farmers revealed lack of knowledge about scientific or recommended practices (100%), weed menace (96.67%) more labour requirement (93.33%), irrigation water management (86.67%) and availability of implements (86.67%) as major constraints for SRI cultivation, while the same for transplantation and direct seeded paddy farms were weed menace (62.16% and 80.00%), traditional belief (86.67% and 83.33%) and low yields (73.33% and 83.33%).

Creation of awareness about scientific or recommended practices through concerned officials by conducting field demonstrations to adopt SRI cultivation and direct seeding methods in scarce irrigation areas for increasing the yield and also demonstration of proper management practices of SRI technology through organization of field visits to successful SRI paddy farms may increase the adaptation of SRI method in a larger extent by the farming community.
AGRICULTURAL ECONOMICS

Author : RAMYA LAKSHMI, S.B.

Title of the thesis : CROP SHIFTS IN COASTAL REGION OF ANDHRA PRADESH - AN ECONOMIC ANALYSIS

Major Advisor : Dr. I. BHAVANI DEVI

Degree : M.Sc. (Ag.)

College : S.V. AGRICULTURAL COLLEGE, TIRUPATI

Accession Number : D 8941

The present study was undertaken to study the growth rates of area, production and productivity of major crops, direction of cropping pattern changes, factors influencing the cropping pattern changes in the selected districts of Coastal Andhra region.

The study was conducted in two districts of Coastal Andhra region namely Vizianagaram and Prakasam. Data required for the study was collected from various published and unpublished sources. The data covered a period of 28 years commencing from 1981-82 to 2008-09.

In Vizianagaram district, jowar, bajra, ragi, small millets, bengalgram, recorded significant negative area growth. On the other hand, crops like maize, redgram, blackgram, greengram, sugarcane and sesamum were found associated with positive significant growth of area. Area under paddy declined at an annual rate of 0.20 per cent but it was non-significant. Among the foodgrains, bengalgram recorded the highest growth rate of productivity (3.80 per cent). In Prakasam district, area growth rate was the highest for bengalgram followed by maize and sunflower. Productivity growth rate was the highest in bengalgram (3.10 per cent) followed by chillies (2.04 per cent).

In Vizianagaram district, groundnut which retained a relatively higher proportion of its area in period I was highly unstable in period II. Greengram was the next crop to groundnut in period I which exhibited retention levels of its own area, but in period II it had a zero degree of retention. In the case of mesta, the retention probability of its own area has increased to a little extent to 0.3288 in period II from 0.3154 in period I. Paddy one of the major crops in the district did not retain much of its area in the second period as observed in the period I. Horsegram and sesamum remained as the most unstable crops in both the periods. Other crops ability to retain their own area was very less in period I but was moderate in period II. In Prakasam district in period I, bengalgram and cotton were the only unstable crops, but in period II, Jowar, cotton, redgram and tobacco remained as unstable crops. Cotton in both the periods was unstable.
In Vizianagaram district area under paddy, greengram, groundnut, mesta, sugarcane and sesame were significantly influenced by their own lagged prices. Rainfall significantly influenced the area under blackgram and groundnut only. Gross irrigated area exerted non-significant influence on paddy and sugarcane acreage. In Prakasam district area under paddy, redgram, bengalgram, chilly and tobacco were positively influenced by their own lagged prices. Increase in gross irrigated area had a significant positive influence on the area under paddy.
The present study was intended to examine costs and returns, resource productivity and allocative efficiency in seed and non-seed cultivation of paddy. Multi stage purposive cum random sampling technique was adopted for the selection of district, mandals, villages and the farmers. The sample of 80 farmers consisting of seed and non-seed growers was selected at random from six villages. The primary data for the year 2009-2010 were collected through a pretested schedule by survey method. Both conventional and functional analysis were used to analyse the data and to arrive at valid conclusions.

The total human labour employment on paddy seed farms was 61.8 mandays per hectare as against 59.28 mandays on non-seed farms.

On an average the per hectare cost of cultivation in seed production (Rs. 42,855.19) was higher than that of commercial cultivation of paddy (Rs. 40,769.65).

Rental value of owned land was the highest cost component on seed and non-seed farms. Human labour, manures and fertilizers, tractor power and seed were major items of expenditure accounting for 51.59 per cent of the total costs.

The gross and net returns per hectare of seed and non-seed farms were Rs. 81,000 and Rs. 38,144.81, Rs. 67,000 and Rs. 26,230.35 respectively. The returns per rupee of investment were also higher on seed farms (Rs. 0.89) compared to non-seed farms (Rs. 0.64).

The regression analysis indicated that all the four variables viz., human labour, machine power, manures and fertilizers included in the model except manures on non-seed farms contributed to the increase in the yields on seed and non-seed farms.
In the era of globalization and economic liberalization, the farmer’s focus shifted towards market-led production and this called for revamping the agricultural production sector towards strengthening the requisite farm infrastructure, extensive use of machinery, cultivation of cash crops etc. But, natural calamities like floods, droughts besides acute pests and disease infestations, use of spurious inputs etc., are still playing a major havoc with the farmers, making them to end up in a debt trap.

Srikakulam district in Andhra Pradesh was selected purposively and the top two indebted mandals viz., Ponduru and Gara were selected. Two villages from each mandal were selected based on the extent of severity of indebtedness. Thus, two mandals and four villages were ultimately selected. Forty respondents from each category i.e., marginal (<1 ha), small (1-2 ha) and other (>2 ha) were selected by simple random sampling technique, thereby, making a total sample size of 120 respondents. To assess the impact of Agricultural Debt Waiver and Debt Relief Scheme on the equity position of the farming community, the above sample is bifurcated into categories viz., borrowers eligible (beneficiaries) under Agricultural Debt Waiver and Debt Relief Scheme and borrowers not eligible under Agricultural Debt Waiver and Debt Relief Scheme. As the number of beneficiaries under Agricultural Debt Waiver and Debt Relief Scheme were 50, thereby, an equal number of borrowers non eligible under the scheme were selected to assess the impact of the scheme on the repayment pattern. Primary data were collected through personal interview method with the help of pretested schedules from the respondents and data was tabulated and analyzed.

The detailed analysis revealed that, the share of borrowed capital was more compared to equity capital for all the crops across all the categories of farmers except for red gram (small farms), chillies (small farms), sunflower (marginal and other farms), green gram (other farms) and mango (small and other farms). The size of land holding was directly related to the magnitude of debt of the farmers. But, considering the debt with reference to per hectare, it varies inversely with the size of land holding.
Source-wise indebtedness revealed that, 31.85 per cent of total debt was owed to institutional agencies and 68.15 per cent to non-institutional agencies. Purpose-wise indebtedness revealed that, nearly 55 per cent of total debt incurred for unproductive purpose and 45 per cent for productive purposes. Social-group wise indebtedness revealed that, on an average, farmers belong to backward caste accounted for 77.21 per cent of total debt followed by other castes with 14.91 per cent and scheduled castes with 7.88 per cent.

The major reasons for indebtedness include adverse climatic conditions resulting in crop failure, rising cost of cultivation, rising family expenditure, fluctuations in market prices, lack of adequate irrigation facilities, inadequacy of institutional loan amount and high rate of interest on non-institutional loan amount. Both cost of cultivation and family expenditure were found to be positively influencing the indebtedness at significant level.

The number of willful defaulters has been significantly increased compared to preceding periods of Agricultural Debt Waiver and Debt Relief Scheme. The dependency on financial institutions has been greatly declined and the dependency on non-institutional sources has been increased at significant level with the advent of Agricultural Debt Waiver and Debt Relief Scheme.
The present study was undertaken to overview the benefit cost ratio, resource productivity and resource use efficiency in rice production and to analyse the effect of climatic parameters in rice production. The study was undertaken in the Chitwan district of Nepal, which was purposively selected for the study as rice is cultivated in considerable area in the district. A sample size of 90 farmers were chosen for the present study consisting of canal irrigated small farmers, bore well irrigated small farmers and rainfed marginal farmers i.e. 30 farmers for each group. Three villages were purposively selected based on the irrigation system they were following under the consultation of government officials.

Majority of the rice farmers in the study area were found to be small and marginal farmers. The rice varieties being cultivated were mostly the modern varieties and local landraces varieties. Rice production in the study was found to be more human labour intensive supported by the fact that human labour occupied the major proportion of labour cost. The spread over of cost of cultivation to variable and fixed costs revealed the fact that variable costs accounted more as compared to fixed costs. The farmers were found to be resource poor farmers (APP, 2009). Rice productivity was found to be less as compared to the cost incurred for rice production. The productivity ranged between 32-34 quintals per hectare.

The net returns was found to be higher for canal irrigated small farms followed by bore well irrigated small farms and rainfed marginal farms. The results of the benefit cost ratio indicated that rice production was beneficial under canal irrigated small farms condition. The bore well irrigated small farms and rainfed marginal farms were of subsistence in nature. The canal irrigated small farms were found out to be operating in constant returns to scale whereas the bore well irrigated small farms and rainfed marginal farms were operating in decreasing returns to scale. Human labour and FYM were found to used in excess in all the three categories of farms i.e., canal irrigated small farms, bore well irrigated small farms and rainfed marginal farms.

The climatic function analysis concluded that the climatic parameters i.e., actual rainfall, mean max. temperature and mean min. temperature explained 33.45 % variation
in the rice production. The yield of rice for the past 20 years was found to be of decreasing trend. The rainfall pattern was found more erratic and unpredictable. Similarly, the mean max. temperature was found to be constantly increasing and the mean min. temperature was found to be almost constant for the past 20 years.
AGRICULTURAL ECONOMICS

Author : SOWJANYA, G.V.

Title of the thesis : “ECONOMICS OF GROUNDNUT SEED PRODUCTION VERSUS COMMERCIAL PRODUCTION IN KURNOOL DISTRICT OF ANDHRA PRADESH”

Major Advisor : Dr. I. BHAVANI DEVI

Degree : M.Sc. (Ag.)

College : S.V. AGRICULTURAL COLLEGE, TIRUPATI

Accession Number : D 8983

The present study was intended to examine costs and returns, technical efficiency, marketing practices, price spread and constraints of production and marketing on seed and commercial groundnut farms.

Kurnool district was purposively selected for the present study as it ranks second in the area (373 thousand hectares) and third in the production (228 thousand tonnes) of groundnut in Andhra Pradesh. Out of 53 mandals in Kurnool district, four mandals namely Kurnool, Aluru, Kodumur and Kowthalam which stood first, second, third and fourth in terms of acreage under groundnut were selected purposively for the present study. Two top villages from each selected mandal were chosen to make total number of sample villages to 8. The selected villages were Ulchala and Basapuram from Kurnool mandal, Hathibelagal and Hulabeedu from Aluru mandal, Varkuru and Kallapari from Kodumur mandal and Melaganur and Sulekeri from Kowthalam mandal. All the farmers in selected villages were stratified into seed and commercial farmers of groundnut production.

List of farmers growing groundnut for seed and commercial purpose in the selected 8 villages was prepared separately for the two categories. From the lists so prepared 60 seed farmers and 60 commercial farmers were selected at random, thus making the total sample size to 120 groundnut farmers. The data were collected for the agricultural year 2008-09 through survey method. Both tabular and linear programming technique (DEA) were employed to analyse the set objectives. An opinion survey was conducted to identify the constraints in production and marketing of groundnut.

The area under rainfed groundnut, on seed and commercial farms was 3.26 hectares and 2.40 hectares respectively. The proportionate area allocated for rainfed groundnut cultivation appeared to be lesser on commercial farms compared to seed farms. Total human labour utilized was 100 (100.00 percent) and 82 (100.00 per cent) man days per hectare on seed and commercial groundnut farms. On an average, the total
cost of cultivation per hectare of rainfed groundnut crop was Rs. 34,638.86 on seed farms and Rs. 26,827 on commercial farms. Cost per quintal of groundnut was marginally high on seed farms at Rs. 2,388.89 compared to Rs. 2,384.63 on commercial farms. The seed and commercial farms realized a gross income of Rs. 48,701 and Rs. 36,412 per hectare respectively. The net income was high on seed farms (Rs. 14,062.14) compared to Rs. 9,585 per hectare on commercial farms.

The analysis of price spread in groundnut marketing revealed that the producer was getting higher share of consumer’s rupee in Channel I (78.28 per cent) than that of Channel II (67.97 per cent). Major problem putforth by both seed farmers and commercial groundnut farmers was labour shortage during the crop growth period. Non-availability of HYV seed was a problem as ventilated by 43.33 per cent of seed farmers and a phenomenal 70 per cent of commercial groundnut farmers.
AGRICULTURAL ECONOMICS

Author : SUMAN, A.

Title of the thesis : COMPARATIVE ANALYSIS OF COTTON PRODUCTION SYSTEMS INTEGRATED PEST MANAGEMENT (IPM) VS. NON-IPM IN WARANGAL DISTRICT OF ANDHRA PRADESH

Major Advisor : Dr. K.SUHASINI

Degree : M.Sc. (Ag.)

College : COLLEGE OF AGRICULTURE, RAJENDRANAGAR

Accession Number : D 8835

Andhra Pradesh is one of the leading states in cotton cultivation and occupied the third position in area and production after Maharashtra and Gujarat. In Andhra Pradesh cotton is grown in 11.34 lakh hectares with a production of 34.91 lakh bales and productivity of 523 kg/ha (CMIE, 2008) which is higher than national average of 467 kg/ha. The average yield of cotton in Andhra Pradesh is 644 kg/ha which occupied the third position after Tamilnadu and Gujarat. Warangal is one of the leading districts in Andhra Pradesh and stands second in area where cotton is grown in 1.6 lakh hectares and stands third in production with 4.75 lakh bales (CMIE). The average productivity of cotton in Warangal district is 505 kg/ha and ranked tenth as in Andhra Pradesh. India is the largest producer of pesticides in Asia and ranks 12th in the world for the use of pesticides. A majority of population in India is dependent subsequently on the use of pesticides which has reached to an irreversible level of expansion during post green revolution particularly this expansion in use of pesticides is tremendous. The Indian pesticides market worth of US$0.6 billion, (Hundal et al, 2006). Since cotton production is associated with heavy use of chemicals to control pests, sometimes with at least 50 percent of production costs are spent on pesticides. The pesticides usage besides affecting farmers’ health, this practice makes cotton a major polluter crop, makes pest management actually more difficult with pest resurgence and secondary pest attack, worsens the balance in the ecosystem and thus lowers yields and income.

Total cost of human labour for IPM farmers was Rs. 15126.72 per hectare as compared to Rs. 14617.72 per hectare for Non-IPM farmers. IPM cultivation of cotton is more labour intensive than Non-IPM cultivation. Similarly, the per hectare cost of manures in IPM cultivation was worked out to be Rs.8608.3 as compared to Rs.8303.3 of Non-IPM cultivation of cotton. The mean for medium income of IPM group was Rs.84596.61. The low income category constitutes 17 respondents with mean income of Rs.71153 per annum which was higher compared to Non-IPM mean income Rs.61207.83. It can be inferred that IPM practices might have a positive impact on annual income of low income group of farmers.
The Cobb-Douglas production function analysis in cotton production estimated co-efficient of determination ($R^2$) to be 0.58 and 0.57 in case of IPM and non-IPM farmers respectively. A critical analysis of results reveal that in case of Non-IPM farmers inputs like chemical fertilizers and bullock labour are also used in excess. In case of IPM farmers, the sum of elasticities was 2.03 ($\sum b_i > 1$) which indicated increasing returns to scale. This meant that if all the inputs were increased by one per cent, the yield of cotton would increases by 2.03 per cent. The elasticity of plant protection chemicals in non-IPM farmers was negative and significant indicating that any increase in the use of plant protection chemicals would result in a significant reduction in the net returns in non-IPM farmers. Gross returns were found out to be Rs. 132203.4 and Rs. 123788.1 for IPM and non-IPM farmers. The net returns was found higher for IPM farmers i.e., Rs. 87166.46 as compared to Rs. 80386.18 for non-IPM farmers. Higher B: C ratio was found for IPM farmers as compared to non-IPM farmers. The B: C ratio was found 1.93 for IPM and 1.85 for non-IPM farmers. Net gain per hectare were found Rs. 8574.05 by adoption of IPM technology. The resource productivity analysis revealed that the use inputs namely seed, fertilizer and land were found significant at 1% level of significance for IPM farmers. The resource use efficiency analysis revealed that the inputs namely seed, bio-pesticide, fertilizers, machine labour, hired labour and pesticides were found to be underutilized incase of IPM cotton farmers. Similarly, the inputs organic manure and bullock labour were being over used by the IPM farmers. The inputs namely seed and hired labour were found to be underutilized and the inputs organic manure, fertilizer, machine labour, bullock labour and pesticides were found to be over used in case of non-IPM farmers.

Regarding the IPM technology adoption, summer ploughing was adopted by 100% of the farmers. The adoption of Erecting pheromone traps, use of resistant varieties, collection and destruction of egg mass and larvae and erecting the bird perches were found to be 83.33%, 75%, 66.6% and 45% respectively. 80% of the farmers felt that there is decrease in pesticides spray when cotton is cultivated under IPM practices. Similarly, 73.33% of the farmers opined that IPM cultivation is labour saving for spraying activity. Employment generation was felt as an advantage of following IPM technology by 36.66% of the IPM farmers. The less occurrence of pest and the lower damage caused by the pest was regarded as a plus point of IPM cultivation by 26.67% of the IPM cultivators. 23.33% of the IPM farmers opined that there was reduction in the health hazards by adopting IPM cotton cultivation. Thus the study revealed that cotton cultivation is beneficial if done practicing IPM technology as compared to non-IPM technology. The minimal health hazards and high returns make IPM technology the best practice for cotton cultivation in the study area. The adoption of IPM technology needs to be promoted by the concerned authorities with due care and responsibility.
The present study was undertaken to study the costs, returns and resource use efficiency in the production of jaggery, and marketing aspects. The study covered two mandals and four villages with 80 farmers producing jaggery.

The sample farmers were stratified into small and large. Data pertained to the agricultural year 2009-10 were collected through survey method with the help of pretested schedules. Conventional and functional analyses were used to analyse the data and arrive at valid conclusions. The cost of jaggery production was Rs 165859.81, Rs 171801.86 and Rs 169617.63 per hectare of sugarcane crop on small, large and combined farms respectively, thus, exhibiting positive relationship with the size of the farm. The cost of producing a quintal of jaggery showed inverse relationship with the size of the holding as it was Rs 1688.14 and Rs 1598.75 on small and large farms respectively. The net income increased from Rs 50,180.15 on small farms to Rs 72132.34 on large farms. The results of allocative efficiency highlighted that there is scope for increasing the returns through reorganization of resources. The producer’s share in consumer’s rupee was 82.33 and 79.58 per cent in channel I and channel II in marketing of jaggery. The estimated remunerative prices were Rs 2001.78, Rs 1829.49 and Rs 1819 on small, large and pooled farms. The seasonal indices of jaggery in two prominent jaggery markets viz., Anakapalle and Vellore indicated that the prices of jaggery are moving in the opposite direction to that of market arrival in both the markets.
Rice (*Oryza sativa*) is one of the most important staple food crops in many Asian countries. More than 90% of rice is produced and consumed in Asian countries. In India it is grown in an area of 45.35 M ha with a production of 99.15 Mt and in Andhra Pradesh rice is grown in an area of 4.38 M ha with a production of 14.21 Mt. India made remarkable progress in increasing food grain production from 1950’s. During this period, it increased paddy production by 4.5 times and area 42%. This is a remarkable achievement, but for the last decade or so, the production levels are stagnant. The demand for rice is growing, while the cost of irrigation is rapidly increasing, and adequate area to grow rice is unavailable. Therefore, India is facing a major challenge to increase rice production, the main food grain.

Rice production need to increase dramatically in the next decade to meet the demands of growing population. This increase must be accomplished with less land per capita, smaller, and less reliable water supplies, less degradation of the environment, and less drain on the resources of small holder farmers, who constitute the majority of the world’s poor. Finding local solutions to food production is essential to eliminating hunger and providing insurance against rising food prices.

The System of Rice Intensification (SRI) is the best current example of options available to farmers and nations to promote community-led agricultural growth, while managing soil and water resources more sustainably and even enhancing their future productive capacity. SRI is a set of alternative crop management practices, developed in the 1980s in Madagascar to benefit farmers with small. SRI increases the productivity of resources used in rice cultivation, reducing requirements for water, seed, synthetic fertilizers, pesticides, herbicides and often labour especially tasks performed.

Absence of standing water provides a congenial environment for weeds to proliferate in SRI. Since the weeds grow more rapidly and abundantly in SRI due to intermittent wetting and drying, it is important to manage the weeds regularly. If proper weed control measures are not taken up then crop productivity decreases. The field capacity of the present available weeders viz Cono weeder, Mandava weeder, Single or...
double wheel weeder, Kollur weeder weeders are less, which involves drudgery while operating more time in puddle field because of, to and fro motion of the weeders. An operator has to travel more distance to carry out weeding operation in an acre by manual cono weeder which is labouries, time consuming and increase input cost.

Keeping all the factors in view, Acharya N.G. Ranga Agricultural University Farm Implements and Machinery scheme (ANGRAU FIM) develop amotorized weeder for weeding operation in paddy cultivation grown under SRI to reduce drudgery. Though the effective field capacity and field efficiency of the weeder is promising it has less working width accounting for less weeding efficiency and a provision to prevent the weeder from bogging down in soil is not provided. So an attempt was made to modify the existing power weeder at College of Agricultural Engineering Bapatla.

The effective field capacity of the power weeder was found to be 0.0349ha/h with field efficiency of 79.74%. In addition, the effective field capacity and field efficiency of the cono weeder was found to be 0.0145 ha/h and 73.03% respectively.

The weeding efficiency of the power weeder was observed to be 84.58% and the weeding efficiency of the cono weeder was 68.97%. The plant damage of the power weeder was found to be 3.61% and cono weeder it is 2.03%. The data regarding plant damage and cono weeder obtained from the experiments were subjected to T test. It was observed that there is a significance difference between two weeding methods i.e. Cono weeder and Power weeder with respect to weeding efficiency and Plant damage. Power weeder has a higher weeding efficiency than cono weeder, and cono weeder has less plant damage than the power weeder.

The cost of operation of the power weeder was observed to be Rs.1928/ha with a fuel consumption of 0.6L/h. The cost of operation of the cono weeder was found to be Rs. 1352/ha. Though the cost of operation of power weeder is more than the cono weeder, subjects experienced more drudgery and physical strain while operating cono weeder than power weeder.
AGRICULTURAL EXTENSION

Author : KESHAV KATTEL
Title of the thesis : “A SWOT ANALYSIS ON TEA CULTIVATION IN NEPAL.”
Major Advisor : Dr. R. VASANTHA
Degree : M.Sc. (Ag.)
College : COLLEGE OF AGRICULTURE, RAJENDRANAGAR
Accession Number : D 8829

The present study on was undertaken to come out with the indicators for better performance of tea growers in Nepal. An exploratory research design was adopted for the study and two different districts belonging to the terai and hilly region of Nepal were selected. Three VDC’s from each district were selected thus making a total of six. 15 respondents from each village were randomly selected for the study. Also, a total of 30 stakeholders working for the development of the tea sector were selected to get an expert view on the research problem.

Majority of the respondents were of the middle age group and educated up to high school level, low experience in tea cultivation and were semi-medium farmers. Fifty percent of the respondents had medium socio-economic status. Majority of them had low extension contact with the extension agencies. Majority of the respondents did not receive any training.

In case of market intelligence, majority of them had medium market intelligence. Majority of the respondents sold their products within 5 kms from the village, opined the marketing facilities as poor, transported their products in vehicles and sold directly to factories. Majority of the respondents indicated that though they felt that they had more than 5 available markets, the market are not regulated and do not have storage facilities.

A considerable percentage of respondents reported though wages of labour are fair their availability is difficult for tea cultivation and they are not timely available. Majority of the respondents expressed that the inputs are available beyond 10 kms from the village, they are not timely available and farmers have to wait for few days no they have storage facilities for receiving inputs.

Majority of the respondents had utilized loans from the lending agencies. Majority of the respondents had medium risk orientation, innovativeness and achievement motivation.
A large majority of the respondents had medium knowledge followed by low and high knowledge on recommended tea cultivation practices. Majority of the respondents were in the category of medium level of adoption of recommended tea cultivation practices followed low adoption and high level of adoption.

The important weaknesses perceived by the tea cultivators were increasing pests and disease problems, high initial investments, shortage of labour for large scale tea cultivation, long gestation period required (5-7 years), poor quality of inputs, higher input costs, high costs of cultivation, lack of farm infrastructure, low yields than neighbouring Indian regions and very low shelf life of green leaves.

The important opportunities in tea cultivation perceived by the tea cultivators were congenial climate for tea cultivation, availability of markets in the vicinity in Terai region, scope for higher yields as the bushes grow old, new processing units under construction in Ilam district for processing of increasing volume of green leaves, small scale cottage industries slowly coming up at village level for tea processing, increasing number of cooperative societies and farmer organizations, cheaper than Indian tea so more scope for exports, scope for organic and other speciality teas such as green tea as consumer awareness is growing, possibility of procuring inputs from the Indian border and supervision and guidance available from local tea consultants.

The important threats in tea cultivation perceived by the tea cultivators were inadequate government support in terms of providing subsidies/loans/special concessions/privileges for tea growers, frequent price slashes due to changes in export policies or unregulated domestic markets, ineffective Extension and Research on tea by NTCDB, migration of labour to cities and towns leading to shortage, green leaves to be sold only in domestic market due to ban on Indian traders, lack of proper approach roads from farm gate to markets, frequent transport strikes causing huge losses, malpractices by middleman leading to low prices for farmers and high prices in market, lack of market information services and dependency on technicians across the border.
AGRICULTURAL EXTENSION

Author : LAKPATHI, CH.

Title of the thesis : “SWOT ANALYSIS OF MAIZE SEED PRODUCTION IN KARIMNAGAR DISTRICT OF ANDHRA PRADESH”

Major Advisor : Dr. I. SREENIVASA RAO

Degree : M.Sc. (Ag.)

College : COLLEGE OF AGRICULTURE, RAJENDRANAGAR

Accession Number : D 8830

An exploratory research design was adopted for the study. Karimnagar district of Andhra Pradesh was purposively selected for the study as it stands first in Telangana Zone of Andhra Pradesh in area and maize seed production. A total of five mandals were selected purposively based on acreage and from each mandal four villages were selected randomly making a total of 20 villages. From each village five maize seed producing farmers were selected randomly, thus making a total of 100 respondents. A pre-tested interview schedule with measurement devices of all the variables was used for the collection of raw data. The data thus collected were coded and analysed with the help of appropriate statistical tests.

Majority of the maize seed producers were literates and the sample dominated by the respondents(30%) who had completed middle school education. Majority(40%) of maize seed producer had small farm size.

Majority of the respondents were under the category of medium with regard to farming experience(55%), annual income(67%), extension contact(70%), risk orientation(57%) and majority(62%) were under the category of high with regard to innovativeness.

Majority(56%) of the respondents perceived the marketing facilities as poor and majority(56%) going to 5-10 Kms to market for buying.

Majority(55%) of the respondents reported the difficulty in the availability of labour and also majority(51%) of them perceived the labour wages as high. Majority of the respondents were satisfied with the availability of inputs and a majority of them have to go to a distance of more than 5 Kms for purchase of inputs in maize seed production. Majority of the maize seed growers had undergone training once.

A large majority of the respondents(68%) had high knowledge with regard to recommended package of practices of maize seed production technology.
A majority of the respondents (45%) were in the category of medium level of adoption of recommended package of practices of maize seed production technology.

The first ten strengths perceived by the maize seed growers in maize seed production were red soils and sandy soils best suited for maize seed production, awareness about detasseling, organic manure improve soil fertility and water holding capacity, no drainage problem, effective weed management, increased hybrid vigour, recommended harvest indices are beneficial, availability of plant protection chemicals, nearer marketing facility, enough sun shine.

The first ten weaknesses perceived by the maize seed growers were: less organic matter and less Zn in soil, shortage of labour, obstruction to irrigation due to discontinuous power supply, detasseling is a time consuming process, lack of awareness about optimum spacing, improper post harvest handling, tendency to harvest the crop, high cost of plant protection chemicals, non adoption of application of recommended dose of fertilizers, frequent repairs to motors due to power fluctuations.

The first ten opportunities perceived by the maize seed growers were: favourable climatic conditions, existence of village tanks and bore wells, FYM and compost is available at cheaper rate, easy to understand and can be practiced by anyone, availability of market information about prices and demand, large area for drying, ease of procuring plant protection chemicals around the mandal, south-west monsoon, for spacing no need of skilled labour, supervision and guidance available from the department and private companies.

The first ten threats perceived by the maize seed growers were: unseasonal sudden rains at flowering and grain filling stage, soil pollution due to fertilizer application, improper harvest leads to poor yield, spreading of pests and diseases, quality and health of cob during demand period, malpractices by the middlemen, improper detasseling leads to 5-15 per cent reduction in the yield, indiscriminate use chemicals may lead to pest resurgence, depletion in water table, heavy rains and wind storms.
AGRICULTURAL EXTENSION

Author: PRASHANTH, P.

Title of the thesis: “A STUDY ON ADOPTION OF ORGANIC FARMING IN COTTON IN KARIMNAGAR DISTRICT OF ANDHRA PRADESH”

Major Advisor: Dr. M. JAGAN MOHAN REDDY

Degree: M.Sc. (Ag.)

College: COLLEGE OF AGRICULTURE, RAJENDRANAGAR

Accession Number: D 8828

The present study had been initiated focusing on the adoption of organic farming in the cotton farming community.

Ex-post facto research design was adopted in the present investigation. Karimnagar district of Telangana region of Andhra Pradesh state was randomly selected for the study. The study was conducted in 6 villages selected from 2 mandals of Karimnagar district, which included 60 organic and 60 conventional cotton farmers at the rate of 10 organic and 10 conventional cotton farmers from each of the selected village”. A sample of 120 cotton farmers were selected for the study.

The analysis of profile characteristics of organic cotton respondents indicates that majority of them had primary school education and majority of them fell under medium category in terms of Age, farming experience, annual income, herd size, training received, decision making behavior and extension contact where as majority of them had small farm size and majority had high organic inputs utilization pattern.

In case of conventional cotton farmers majority of them has primary school education, and fell under medium category in terms of age, farming experience and extension contact and had low level of organic inputs utilization pattern and training, where as majority of them had large farm size, high annual income and small herd size.

Majority of the organic cotton farmers had high level of knowledge and high extent of adoption of organic cotton practices. Whereas conventional cotton farmers had low level of knowledge and low extent of adoption of organic cotton practices.

With regard to the knowledge level on selected organic practices conversion and certification requirements of organic cotton were ranked first and the practices of plant protection was ranked least by the organic cotton farmers. Whereas the conventional cotton farmers ranked the practices of land preparation, biomass development, sowing and weed management as first and the practices of certification and conversion requirements was ranked least.
In case of extent of adoption of selected organic cotton practices, the organic cotton farmers ranked first the practices of conversion and certification requirements and the least ranked practices are harvesting and post harvest management of the cotton produce. Whereas the conventional cotton farmers rated the practices land preparation, bio mass development and weed management as highest and the least rated practices are certification and conversion requirements.

Correlation analysis between organic cotton respondents and profile characteristics revealed that the independent variables viz., education, annual income, herd size, organic inputs utilization pattern, training received, decision making behavior and extension contact were found positively and significantly related with the level of knowledge about the organic cotton practices.

Correlation analysis between conventional cotton respondents and profile characteristics revealed that the independent variables viz., annual income, training received and decision making behaviour were found positively and significantly related with the level of knowledge about the organic cotton practices.

Correlation analysis between organic cotton respondents and profile characteristics revealed that independent variables viz., education, herd size, organic inputs utilization pattern, training received, decision making behavior and extension contact were found positively and significantly related with the extent of adoption about the organic cotton practices whereas farm size was negatively and significantly related.

Correlation analysis between conventional cotton respondents and profile characteristics also revealed that the independent variables viz., training received, decision making behaviour and extension contact were found significantly related with the extent of adoption about the organic cotton practices.

A great majority (85.70%) of the organic cotton farmers perceived the problem of lack of community approach for organic cotton cultivation, 85.00 per cent of farmers faced the constraint of small herd size, 78.00 per cent of farmers faced constraint of weak marketing system on organic cotton trade, Complex and costly certification process for organic cotton farming (76.35%).

A great majority (82.76%) of the conventional cotton farmers perceived the problem of complex and costly certification process for organic cotton cultivation, 80.00 per cent of farmers perceived labour intensive, lack of specific package of practices(79.00%), low yields and not suitable for irrigated conditions(78.00%).

The major suggestions offered by organic cotton respondents to overcome the listed problems were more financial credit may be lended to the organic cotton farmers with reasonable interest followed organic inputs should be available in time for effective management of pest population and sufficient number of training programmes should be organised on rouging, weed control, post harvest handling etc. and other market related aspects to build the confidence of farmers on organic farming in cotton crop.
Few success stories were also studied from organic cotton growers. A strategy has been developed keeping in view of the results obtained in the study and discussions held with the stakeholders of the study.
Agricultural Extension

Author: PYNBIAONGLANG KHARUMNUID

Title of the thesis: A STUDY ON PERCEPTION AND ADAPTATION OF POTATO GROWERS TO CLIMATE CHANGE IN EAST KHASI HILLS DISTRICT OF MEGHALAYA

Major Advisor: Dr. I. SREENIVASA RAO

Degree: M.Sc. (Ag.)

College: COLLEGE OF AGRICULTURE, RAJENDRANAGAR

Accession Number: D 8831

Ex-post facto research design was followed for the study. The investigation was carried out in East Khasi Hills district of Meghalaya where potato is predominantly grown. Samples of 120 potato growers from twelve villages of two blocks in East Khasi Hills district were selected randomly. The data were collected by a personal interview method through structured interview schedule and analyzed employing suitable statistical methods.

The profile analysis of potato growers indicated that majority of the respondents were female, illiterate, had large family size, marginal farmers, medium farm income, very low non-farm income, medium farming experience, medium farmer-to-farmer information exchange, medium knowledge about local agro-climate, low level of credit and subsidy orientation, medium Information seeking, medium preparedness for adaptation and low resistance to change.

The findings with regard to perception of potato growers towards climate change indicated that majority of the respondents had medium perception towards climate change, majority of the respondents perceived that annual rainfall had been decreased, majority of the respondents perceived that monsoon rainfall (June to September) had been increased, majority of the respondents in East Khasi Hills perceived that temperature had been increased, majority of the respondents perceived that occurrence of drought had been increased, majority of respondents had high level of perception towards physical effects, biological effects and economic effects whereas their perception towards chemical effects is very low.

The findings with regard to adaptation of potato growers to climate change indicated that majority of the respondents had medium adaptation to climate change. It was also found out that there were twelve (12) adaptation practices which were followed by majority of the potato growers, namely, use of improved high yielding and resistant varieties, bun and nur method of land preparation, planting pit method, use of well decomposed FYM in summer crop cultivation, use of grasses/stubbles in autumn potato
crop, early planting, minimum use of chemicals, crop diversification, rearing of livestock, off-farm diversification, terracing and earthing up (traditional way).

Correlation analysis of independent variables with perception of potato growers towards climate change revealed that there was a positive and significant relationship between independent variables, namely, education, farming experience, knowledge about local agro-climate, preparedness, size of household, farm income, farmer to farmer information exchange, credit and subsidy orientation and information seeking behaviour and perception. In the case of the relationship between independent variables and adaptation, there was a positive and significant relationship between independent variables, namely, farming experience, knowledge about local agro-climate, preparedness for adaptation, size of household, farm income, farmer to farmer information exchange, credit and subsidy orientation and information seeking behaviour and adaptation of farmers to climate change. The relationship between perception of farmers towards climate change and their adaptation was a positive and significant relationship.

Lack of quality seeds, non availability and high cost of production inputs, high incidence of disease, price fluctuation in the market, higher cost of cultivation using scientific methods, less technical knowledge of potato cultivation, lack of information about weather and climate, lack of efficient transport facility, lack of efficient marketing facility at village level, non-availability of credit and subsidy facilities, etc. were the major problems encountered by the cotton farmers.

The major suggestions offered by the potato growers to overcome the listed problems were the provision of better marketing facilities in the locality or its nearby areas, timely available of quality seeds at subsidized price, training on scientific methods and adaptation options, fixing of minimum support price, arrangement for availability of credit and subsidy, availability of weather and climate information up to the farmers’ village, implementation of weather related insurance scheme, etc.
EXTENSION EDUCATION

Author : BALAJI NAIK, K.
Title of the thesis : DISSEMINATION OF CROP TECHNOLOGIES BY KRISHI VIGYAN KENDRA TRAINED FARMERS OF ANANTAPUR DISTRICT OF ANDHRA PRADESH
Major Advisor : Dr. T.LAKSHMI
Degree : M.Sc. (Ag.)
College : S.V. AGRICULTURAL COLLEGE, TIRUPATI
Accession Number : D 8962

The study was conducted to analyze the Krishi Vigyan Kendra trained farmers in dissemination of groundnut and paddy crop technologies. Technologies acquired by them, transfer of technologies to untrained farmers, modes of transfer of technologies and compare crop productivity levels of trained and untrained farmers. Problems in practicing the dissemination of crop technologies and the suggestions to overcome the problems as perceived by groundnut and paddy trained farmers were also elicited.

Exploratory research design was followed for the study. The investigation was carried out in four adopted villages of Andhra Pradesh covering three adopted mandals of Reddipalli Krishi Vigyan Kendra, Anantapur district. From each of the selected villages 15 trained and 15 untrained farmers were selected randomly for Paddy and Groundnut crop respectively. Thus, a total of 60 trained and 60 untrained farmers constitute the sample of the study. The data were collected by personal interview method through structured interview schedule and analyzed by employing suitable statistical methods.

Majority of the trained farmers had medium acquisition followed by low acquisition and high acquisition on groundnut crop technologies. Majority of the trained farmers had medium acquisition followed by high acquisition and low acquisition on paddy crop technologies.

Majority of the trained farmers had transferred the technologies acquired on groundnut crop to some extent followed by maximum extent and least extent. Majority of the trained farmers had transferred the technologies acquired on paddy crop to some extent followed by least extent and maximum extent.

To transfer of the groundnut crop technologies by trained farmers regarding advantage of water management and fertilizer recommendation used Farm visits and also formal meeting were used. Informal meeting and also charcha mandals. Further, majority of the trained farmers had used demonstration in the transfer of technology like seed dormancy.
Further, one-fourth of the trained farmers used group discussion method for the harvesting. With regard to various modes used for groundnut and paddy crop technologies informal meeting, charcha mandal, farm visit, demonstration and group discussion were more reliable than formal meetings.

During kharif 2008 and 2009 there was an increase in crop productivity levels in groundnut and paddy crop was obtained by trained farmers when compared to that of untrained farmers. During rabi 2008 and 2009 there was an increase in productivity levels in groundnut and paddy crop was obtained by trained farmers when compared to that of untrained farmers.

Problems encountered by trained farmers from untrained farmers in dissemination of technologies viz. dependence on input dealers by untrained farmers instead of trained farmers followed by illiteracy among untrained farmers, low land holding by untrained farmers, socio-cultural differences, lack of comprehensive skills by the untrained farmers, Non/inadequate availability of critical resources, lack of interest by the untrained farmers and personal ego among the untrained farmers.

The trained farmers gave the following suggestions to overcome the problems viz. to depend on trained farmers for scientific technologies instead of input dealers, involvement in extension activities by the untrained farmers, creating awareness among the untrained farmers, availability of critical inputs in time to trained farmers, conducting adult education programme, co-operative farming and participation of untrained farmers in charcha mandals and FFS.
EXTENSION EDUCATION

Author : BALAKRISHNAN, ARATHY.

Title of the thesis : CONSTRAINT ANALYSIS OF RICE FARMERS OF THRISSUR DISTRICT OF KERALA

Major Advisor : Dr. S.V.PRASAD

Degree : M.Sc. (Ag.)

College : S.V. AGRICULTURAL COLLEGE, TIRUPATI

Accession Number : D 8961

Rice has shaped the cultures, diets and economies of thousands of millions of people in the world. India occupies first position in the area (44.6m ha) which is the highest area occupied by a single crop in the million-hectare plus countries in world during 2008 (USDA report). In Kerala, harvested area of rough rice in 2007 was 2,29,000ha and rough rice production stood at 8,19,000 tonnes.

Kerala was food deficient since its formation in the 1956 till recent times. The gap between production and requirement of the rice has been showing an increasing trend during the past decades. The deficiency was about 50 per cent in the 1960s and it is at an alarming level of 85 per cent in 2007-08. This is because of lot of constraints being faced by the rice farmers.

Hence the study to analyze the constraints faced by the farmers in rice production in was undertaken. The investigation was carried out in two Taluks of Thrissur district of Kerala which were purposively selected, where rice is intensively grown. Ex-post-facto research design was adopted for the study. A sample of 120 farmers was randomly selected from six villages. The data were collected by personal interview method and analyzed by employing suitable statistical methods. Fourteen independent variables were subjected to statistical analysis for the purpose of categorization of the respondents and for studying their relationship with dependent variable.

Majority of the rice farmers engaged in rice farming were old aged, with high school education, marginal farmers with medium farming experience, training undergone, credit orientation, social participation, mass media exposure, extension contact, economic motivation, scientific orientation, management orientation, innovativeness and risk orientation. Xi

Correlation analysis revealed that there was a negative and significant relationship between education, farm size, training undergone, credit orientation, social participation, extension contact, scientific orientation, management orientation and innovativeness of rice farmers with the constraints faced by them in rice farming. However, age, farming
experience, mass media exposure, economic motivation and risk orientation had non significant relationship with the dependent variable constraints of rice farming.

Constraints expressed by rice farmers in rice production belonged to ten categories viz; Improper pesticides and weedicides as major crop production constraint high cost of inputs as major input constraint, scarcity of labour during peak periods as major labour constraint, occurrence of summer showers during harvest as major bio physical constraint, unavailability of suitable farm machinery as major farm machinery constraint, lack of proper storage facilities as major post harvest constraint, high rate of interest by the middle men as major financial constraint, fewer efforts of extension personnel as major extension constraint, involvement of middlemen as major marketing constraint and price gap between parboiled rice and rice grain major social constraint.

Training of extension personnel about the latest plant protection chemicals and weedicides, government subsidy to the farmers, implementation of contract labour schemes by Panchayat and local bodies, development of short duration rice varieties not to coincide with the summer showers, development of suitable farm implements, equipment and machinery for the operations like transplanting, weeding, harvesting etc, creation of proper storage facilities at Panchayat or Taluk levels, farmers should be given loans at very lower rates of interests through new schemes and programmes, improving the efforts of extension agencies and personnel, bringing reforms in the agricultural extension system by restructured technology dissemination system, involvement of middlemen should be avoided by the formation of cooperatives and farmers groups in marketing, the extension personnel should encourage the younger generations by making them to know the potential of agriculture were the major strategies proposed with respect to the ten categories of constraints respectively.
EXTENSION EDUCATION

Author : BHAVYA MANJARI, M.

Title of the thesis : ROLE OF FARMERS IN SUPPLY CHAIN MANAGEMENT OF HORTICULTURAL PRODUCTS IN ANDHRA PRADESH

Major Advisor : Dr. M. SURYA MANI

Degree : Ph. D.

College : COLLEGE OF AGRICULTURE, RAJENDRANAGAR

Accession Number : D 8810

India ranks first in the world in the combined production of fruits and vegetables. It has been often noticed that the Indian farmer does not fully realize value for his inputs such as labor. One of the important factors responsible for this has been that the lion’s share goes to pre-harvest contractors, middlemen, transporters, wholesalers and retailers who are all involved in the channel from farm to consumer. In order to raise the farmer’s income, two important aspects that need attention are: (1) creation of an integrated and assured competitive domestic market and (2) improvement in communication, transport, storage, distribution and other services. In this context, Supply Chain Management (SCM) plays an important role in enhancing the shelf-life of the predominantly perishable commodities, and in producing a diversified range of value-added products and it also aids the economy as it generates employment as well as foreign exchange. Farmers are the backbone for the agriculture and he plays many roles in the crop production from the point of soil preparation to selling of the produce to the consumers.

The study was conducted to study the role of farmers in supply chain management of horticultural products in AP, to study personal, socio-economic and psychological characteristics of farmers and consumers, identify different existing SCM models, specific practices followed by farmers through SCM, eliciting farmer role in SCM of horticultural products, level of satisfaction towards SCM of horticultural products and problems of farmers and their suggestion to develop strategies for effective SCM.

An exploratory research design was adopted to carry out the study. The study was conducted in Andhra Pradesh covering all the three regions i.e., Telangana, Coastal Andhra and Rayalaseema in three districts namely Ranga Reddy, East Godavari and Cudapah. One mandal from each district was selected purposively having highest number of SCM models. The mandals selected were Kakinada from East Godavari, Cudapah from Cudapah and Bala nagar from Ranga Reddy district. A total of 150 farmers i.e., 40 banana growing farmers, 30 onion cultivating farmers, 40 tomato cultivating farmers and 40 mango orchard farmers were selected for the study. From each district 20 consumers were selected for study. A total of 60 consumers were selected for the study. Two
vegetables and two fruits and three retail outlets (Reliance fresh, Food world and More super market) and one rythu bazaar were selected for the study. Keeping in view of the objectives of the study, a semi structured interview schedule was prepared.

With regard to socio-economic profile of the sample farmers, majority belong to middle age, were educated from middle school to high school level, undergone two to three training programmes, had large families and were large scale farmers with medium level of farming experience. Majority of farmers distributed (48.67%) equally into medium and low income groups. The findings revealed that the majority of the farmers had medium contact with officials, with low exposure to mass media and having medium economic and marketing orientation. Further more, majority of farmers fell under medium category of achievement motivation, scientific orientation and risk orientation.

Regarding consumer profile, majority of them belong to middle age, with college education and high school education, were teachers and self employment had nuclear families. Majority of consumers also belong to upper middle class followed by middle income group and had nuclear family. Regarding shopping practices of consumers’ majority of them used 7-14 pre purchasing practices followed by 9-18 purchasing practices and 7-14 post purchasing practices while shopping. Majority of the total respondents were motivated by different factors like quality, good will of the shop, comfort, financial condition, necessity, brand/ trade mark, luxury, and prestige.

Under the study SCM models identified for the study purpose are Reliance Fresh, More Super market, Food World Super market and Rhythu Bazaar. Majorly marketing channel for these models is Farmer → Vendor → Collection center → Retail outlet → Consumer. Supply chain process of each model starts from the selection of farmer to the selling of the produce to the consumers. The findings revealed that majority of the total sample farmers followed SCM practices were three ploughings for field preparation with soil testing, control measures for pests and diseases and use of fertilizers, recommended seed rate, time of sowing, no. of . Irrigations, correct time of weeding and use of weedicides. Majority of the farmers had medium level participation in planning and procurement of material through reliance fresh, more super market and food world. High participation in production management and no participation in credit arrangement, post harvest management, processing and marketing through SCM models.

It could be observed that majority of the total sample farmers had medium level satisfaction towards Supply Chain management (SCM) of horticultural products. Majority of the consumers had high level of satisfaction towards SCM of horticultural products. Most of the respondents had problem of high velocity of wind i.e., cyclones during crop period followed by labor shortage and high wages, high cost of pesticides and other inputs. All the respondents expressed that lack of market information and lack of price information followed by non availability of other marketing channels, rejection of produce at initial stage as the major marketing constraints. A large of the sample farmers felt that guidance by experts for the problems faced by them followed by subsidies provided by the govt. for pesticides and other inputs, timely supply of inputs in the market at reasonable cost as suggested for production problems. The majority of the respondents suggested frequent extension contact by Horticultural officers for giving market and price information, followed by providing other marketing channels for
produce. As it is evident from the study, farmers adopted SCM practices which will improve the quality of the produce than the farmer practices but these practices are costly and farmers were unable to adopt some of those practices. So the extension officials and SCM Models/ managers along with public private partnership should develop low cost technologies and low cost suitable practices for farmers.

As expressed by the respondents of the study, the SCM models and private organizations should make efforts to support the movement in terms of assistance, input supply, advisory services and information support etc in order to increase the level of participation of small, marginal farmers to have better price in the open market. The present study suggested training programs need to be organized for all the stakeholders to create awareness about the pros and cons of SCM. FTCs, KVKs and DAATTs in the district should therefore undertake need based, location specific training programs to improve their knowledge and skills in Supply Chain Management.

Monitoring and evaluation can serve as one of the most effective measure for increasing participation through bringing together the perspective of both the local farmer and implementing officials. There is a need to establish Central Processing Centers (where sorting, grading and packing take place) at village level that combines income generation and improved livelihood of farmers. Encourage SHGs and RMGs to take up the participation in SCM models at village level which will turn creates employment opportunities to them. Establish cold storage structures for the village farmers at village level which will reduce the loss of produce at farm level.

The present study was confined to three districts and only four fruit and vegetables were taken for the study. So, further studies should take other horticultural or other agricultural product and their Supply Chain process. Explorative research design has been adopted in the present study in order to understand the participation of farmer in Supply Chain Management and potentials and constraints of farmers through SCM. These approaches could be tested by experimental studies in order to know the exact impact. The devices of measurement developed for the study appear to be convenient and appropriate. However, they need to be tried on large samples and to be cross validated with other similar measurements. The present study was limited to study of existing SCM in Andhra Pradesh. Further study could also take into consideration the SCM implicit in other states.
India is an Agricultural based country. Agro inputs are playing a major role in farm productivity. Among all the agencies input dealers are larger in number and spread even in interior areas of the country. Farmers themselves approach the input dealers for their requirements i.e. inputs, credit etc. Nothing is more urgent than ensuring that farmers have access to the inputs, if they need to increase farm productivity. Thus input dealers have a major role to play to make this possible.

Keeping the above in view, the research study was designed to assess the communication behaviour of input dealers in Guntur district of Andhra Pradesh. An ex-post facto research design was followed to conduct the study with a total of 60 respondents selected from two mandals. The data were collected through pre-tested interview schedule, which was subjected for statistical analysis and interpreted.

Detailed analysis of profile characteristics of input dealers indicated that majority of the respondents were middle aged with secondary education and were landless with business as their main occupation. Majority of the respondents had annual income above 5 lakhs with business experience of 11-30 years, farming experience up to 15 years followed by 31-60 days of training received along with medium economic orientation and medium innovativeness.

Majority of the respondents had medium level of information input, information processing, information output and communication behaviour.

Nine out of eleven independent variables such as education, business experience, occupation, farming experience, annual income, social participation, training received, economic orientation and innovativeness of input dealers showed significant relationship with all the components of communication behaviour viz., information input behaviour, information processing behaviour and information output behaviour.

The most important problems reported by the input dealers were lack of sufficient knowledge about farm inputs, lack of computer knowledge to diagnose the crop diseases,
less exposure to mass media, less encouragement from agricultural officers, lack of sufficient field experience, less risk bearing ability, less participation in social functions and lack of business experience for storage and transformation of information.

Suggestions given by the input dealers to overcome the problems were training programmes should be conducted regarding new farm inputs and diagnosis of the diseases, more number of training programmes should be conducted to impart computer knowledge, agricultural officers and scientists should maintain continuous contact with the input dealers, conducting frequent meetings and group discussions among input dealers and also with farmers, input dealers should be given sufficient information material about new farm information for updating their knowledge, agricultural officials should conduct more field visits for input dealers.

Strategy was given for the effective communication behaviour of input dealers as provide required knowledge and skill regarding new farm inputs, diagnosis of the disease and about computers through more number of training programmes, measures to improve the contact with agricultural officers and scientists to conduct frequent meetings and group discussions, conducting more number of field visits and vocational trainings, maintenance of demonstration units, providing farm information in the form of in the form of low cost audio and video cassettes, CDs and DVDs, using interaction multimedia modules and ICT tools like mobiles and touch screen information centres.

The attitude of farmers towards input dealers indicated that majority of the farmers had moderately favourable attitude towards input dealers.
Cotton popularly known as ‘White Gold’ is an important premier commercial crop of India. Bt cotton was the first and only genetically modified crop introduced for commercial cultivation in India during 2002 to manage the bollworms in cotton which were causing severe distress for cotton farmers. In Andhra Pradesh cotton was cultivated in an area of 14.83 lakh hectares for the year 2009-10 with a production of 52 lakh bales and productivity of 596 kilograms per hectare. Out of the total cultivated area of 14.83 lakh hectares nearly 84.49 per cent of the area was under Bt cotton cultivation. The tremendous increase in adoption of Bt cotton by the Andhra Pradesh farmers from 0.80 per cent in 2002 , to 84.49 per cent in 2009 has created a landmark victory in adoption of first genetically modified Bt cotton crop.

However even after introduction of Bt cotton in Andhra Pradesh, the productivity has jumped from a meager 418 kg/ha in 2002-03 to touch 596 kg/ha during 2009-10. Where as in China average cotton lint yield was 1265 kg/ha. So there is a need for overcoming the gap between the potential yield and realized yield. For getting potential yield, the Bt cotton farmers should possess accurate knowledge, proper skills to adopt Bt cotton cultivation practices and also pros and cons of Bt cotton. Hence the present study entitled “An analytical study on Bt cotton cultivation in Andhra Pradesh” was undertaken to study the profile characteristics, attitude, knowledge, adoption levels of Bt cotton farmers, cost of cultivation of Bt cotton and non Bt cotton, SWOT analysis of Bt cotton cultivation practices, relationship between dependent and independent variables and finally to give the appropriate strategies for sustainability of Bt cotton cultivation in Andhra Pradesh. An ex-post-facto research design coupled with explorative research was adopted for the study. A total of 18 villages were selected at random from 6 mandals and 180 respondents were selected from the 18 villages based on proportionate stratified random sampling method. A pre-tested interview schedule with measurement devices of all variables was used for collection of raw data. The data thus collected was coded and analysed with the help of appropriate statistical tests.

The following were the salient findings emerged out of the study
Majority of the respondents were middle to young aged, illiteracy was still dominating feature, 3 to 8 years of experience in Bt cotton cultivation, un trained, having less than two hectares of land holding, medium in social contact, extension contact, depends on friends, input dealers and television for getting information regarding Bt cotton cultivation and growing of Bt cotton under rain fed situation was the dominating feature.

Majority of the respondents had medium level of assets and annual income. Only fifty per cent of the respondents acquiring credit from public sources and fifty five per cent of the acquired credit was utilizing for non agricultural purpose. Coming to psychological characteristics, majority of the respondents were under medium level of risk orientation, economic motivation, scientific orientation and management orientation.

The attitude scale was constructed with 22 statements by using summated rating scale developed by Likert. Majority of the respondents were having favourable attitude towards Bt cotton cultivation. Majority of the respondents have greater satisfaction with the performance Bt cotton in terms of yield, bollworms management, net income. But they opined that it is not a panacea for all ills of cotton. The study also reveals that majority of the respondents had medium to high level of knowledge with respect to Bt cotton cultivation aspects. Majority of the farmers had knowledge about purpose of development of Bt cotton, days of protection of Bt cotton toxin against bollworms. Respondents had low level of knowledge on stem application technique, biofertilizers and economic threshold levels. Majority of the respondents were in medium level of adoption of recommended Bt cotton cultivation practices. Technologies like maintenance of refuge crop, irrigation at critical stages, application of biofertilizers and use of stem application technique were not adopted by majority of the respondents.

Regarding to economics of Bt cotton cultivation, total cost of cultivation per hectare worked out to Rs46809 with Bt cotton and Rs 52925 with Non-Bt cotton. The net returns and benefit-cost ratio were highest in Bt cotton with Rs35591 and 0.76 respectively. While in the case of non Bt cotton net return was Rs 13315 and benefit coat ratio was0.25.

Correlation analysis revealed that age, education, experience in Bt cotton cultivation, training, land holding, social contact, source of information, irrigation facility, assets possession, annual income, risk orientation, economic motivation, scientific orientation and management orientation were found to be positive and significant relationship with the attitude of Bt cotton farmers. Regression analysis revealed that all the selected independent variables put together explained 69.43 per cent of variation in the attitude of farmers towards Bt cotton cultivation.

The variables education, experience in Bt cotton cultivation, training, land holding, social contact, source of information, irrigation facility, annual income, economic motivation, scientific orientation and management orientation exhibited positive and significant relationship with knowledge of the respondents.72.78 per cent of variation was explained by all the variables put together. Correlation analysis revealed
that age, education, experience in Bt cotton cultivation, training, land holding, social contact, source of information, irrigation facility, assets possession, annual income, risk orientation, economic motivation, scientific orientation and management orientation were found to be positive and significant relationship with the adoption level of the respondents. Regression analysis revealed that all the selected independent variables put together explained 70.07 per cent of variation in the adoption of farmers towards Bt cotton cultivation.

The major strengths of Bt cotton cultivation as expressed by the Bt cotton growers were higher yields, higher net income and reduction in the total number of pesticide sprays. Regarding major weakness as perceived by the Bt cotton growers were higher incidence sucking pests, diseases and micronutrient deficiencies, Bt cotton potential is low under rain fed condition and high escalating labour costs. Strengthening public and private partnership in agriculture, scope for the Bt cotton farmers to repay long pending debts and facilitates to improve the efficiency of insecticides due to dual protection of Bt and insecticides were the top three opportunities of Bt cotton cultivation as perceived by the farmers. In threats of Bt cotton cultivation farmers had given first rank for frequent droughts and floods, international policies and marketing fluctuations and environmentalists protests against Bt cotton.

In the strengths of Bt cotton cultivation, extension functionaries had given first rank for reduction in the total number of pesticide sprays followed by higher yields and good quality of cotton lint from Bt cotton. Higher incidence sucking pests, diseases and micronutrient deficiencies, Bt cotton potential is low under rain fed condition and present Bt cotton technology is available in hybrids only not in varieties were perceived as the important weakness in Bt cotton cultivation by the extension functionaries. In opportunities of Bt cotton cultivation facilitates to improve the efficiencies of insecticides due to dual protection of Bt and insecticides, scope to introduce Bt genes into local varieties and scope for improving cotton breeding programme were perceived by the extension functionaries. Frequent droughts and floods, non maintenance of refuge crop will pose the danger of development of resistance in bollworm and international policies and market fluctuations.

Finally a hypothetical strategy was developed for sustainability of Bt cotton cultivation based on the SWOT Perceptions and other results derived from the study. Based on the above findings several implications for future research had been drawn. The suggestions offered through the study, if followed, there would be possibility of improving of higher Bt cotton production and thereby socio-economic conditions of Bt cotton farmers.
The study was conducted to analyse the impact of groundnut production technologies, to study their the selected profile characteristics of groundnut farmers, to analyze the impact indicators under different combinations of technologies as followed by the groundnut farmers, to study the relationship between the profile characteristics and the impact of groundnut production technologies on groundnut farmers, to elicit the problems in practicing the production technologies of groundnut and the suggestions to overcome the problems as perceived by groundnut farmers.

Ex-post-facto research design was followed for the study. The investigation was carried out in 12 villages of Andhra Pradesh covering four mandals from Chittoor district of Rayalaseema region. From each village 10 groundnut farmers were selected randomly, thus making a total sample of 120 groundnut farmers as the respondents for the study. The data were collected by personal interview method through structured interview schedule and analyzed by employing suitable statistical methods.

Majority of the groundnut farmers were middle aged with middle school education, had small farm size, had medium farming experience, had medium extension contact and medium mass media exposure. Majority of the respondents had medium achievement motivation, scientific orientation, management orientation and innovativeness.

Half of the groundnut farmers perceived the impact of groundnut production technologies as medium followed by high and low impact of groundnut production technologies. Among all the thirty selected technologies optimum time of sowing was ranked first in terms of its highest impact percentage followed by Chemical control for pests and diseases, varieties, crop rotation, seed treatment, weed management Neem seed kernal extract, fertilizer management, summer ploughing, water management, gypsum application, optimum seed rate etc. in their respective rank order.
The groundnut farmers were categorized on the basis of their net income and the category-wise impact of groundnut production technologies as perceived by the groundnut farmers indicated that the impact percentage was decreased from 67.33 percent to 30.40 percent from high income category to low income category.

Among the thirty groundnut production technologies under category I, twenty seven technologies were adopted and three were not adopted. Under category II twenty four technologies were adopted and six were not adopted. Under category III twenty three technologies were adopted and seven were not adopted. Under category IV twenty two technologies were adopted and eight were not adopted. Under category V seventeen technologies were adopted and thirteen were not adopted.

The technologies optimum time of sowing, seed treatment, crop rotation, chemical control of pests and diseases were found to be more significant in all the categories. In comparison between category I to category V clearly indicates the technologies gypsum application, borax, ferrous sulphate, weed management post emergence and summer ploughing were contributing significantly in increasing the net income from Rs.4000 of category V to Rs.16000 and above category I. Hence these vital technologies need to be emphasized by the extension functionaries for its adoption.

Correlation analysis revealed that, education, farming experience, extension contact, mass media exposure, achievement motivation, management orientation, scientific orientation and innovativeness were found to be positively significant. Age and farm size were found to be negatively significant. Actual net profit and actual productivity were found to be positively significant and actual cost of cultivation was found to be negatively significant with perceived impact of groundnut production technologies.

Non availability of improved seed, lack of remunerative price, and high cost of seed were the major problems expressed by the groundnut farmers ranked first, second and third respectively. More cost of labour at harvest, pests and diseases, Less credit facilities, Insufficient extension activities, Non availability of inputs in time, Lack of crop insurance and so on were the other problems perceived by the groundnut farmers as per the rank order from four to fifteen.

Majority of the groundnut farmers suggested provision of improved seed at correct time, Provision of remunerative price, provision of improved seed at subsidized rates were the major suggestions expressed by the groundnut farmers ranked first, second and third respectively. Development of farm machinery especially for harvesting, training on identification and control of pests and diseases and pest forecasting measures, provision of proper institutional finance and crop insurance, extension activities and training, timely supply of inputs, gypsum availability, supply of manures and organic fertilizers, development of cost effective technologies and development of processing and value addition units were the other suggestions given by the groundnut farmers as per the rank order from four to twelve respectively.
Farmers are more desirous and anxious to get quick, exact and authentic information in the changing scenario of agriculture at local and at global levels. Dissemination of the required and recent agricultural information to the farmers in scattered villages at the variegated geographical situation in India is very difficult task. Transfer of technology to farmers is not a one time exercise because new farm technology is being constantly evolved. A continuous flow of technologies in an appropriate manner is vital to provide quick benefit of this development to the farmers.

There has been a technological explosion in the field of agriculture. This demands that the farmer has to know all aspects of technology prior to its adoption. Interactive Multimedia Module (IMMM) has potential to reach the unreached.

Interactive multimedia is a sub field of computer science which extends the hypertext concept of non-linear and non-sequential links of textual material that may be digitally encoded for storage and retrieval through computer based systems, including images, sound, graphics, moving video, animation, text and photographic quality stills. Using the multimedia data types such as video, graphics, images or animation any participant can introduce illustrative material into the meeting to facilitate better communication. It informs, educates, persuades and entertains with dazzling pictures and animations, engaging sounds, compelling video clips and raw textual information.

Experimental research design was followed in the present investigation. The study was conducted in Guntur and Adilabad districts of Andhra Pradesh. The sample of the study comprised a total of 180 cotton growing farmers. A comprehensive interview schedule and Interactive multimedia module covering all the facets of IPM in cotton was developed. The collected data was coded, tabulated and analyzed statistically and the results were interpreted accordingly.

The findings of the study revealed that majority of the cotton farmers belonged to middle age category followed by young and old age categories.
It was revealed from the study that majority of the cotton farmers were educated up to high school level followed by middle school, college and above, primary school, functionally literate and illiterate categories. It was found from the study that most of the cotton farmers were small farmers followed by marginal farmers and big farmers. Majority of the cotton farmers had 11-20 years experience followed by above 21 years and up to 10 years experience. It was indicated that majority of cotton farmers had medium information seeking behaviour followed by high and low information seeking behavior most of the cotton farmers were having medium extension contact followed by low and high extension contact. Majority of the cotton farmers were having medium mass media exposure followed by high and low levels of mass media exposure. It was identified that majority of the cotton farmers had medium innovativeness followed by low and high levels of innovativeness. It was indicated that majority of the respondents had medium scientific orientation followed by low and high of scientific orientation. It was found that most of the respondents had low level of knowledge followed by medium level and high level before the exposure of IMM to the respondents. But after the exposure of IMM to the respondents, their was drastic increase in their knowledge level, high knowledge level of cotton farmers followed by medium level and low level. The difference between knowledge level of pre and post exposure of IMM revealed that most of the respondents belong to high level followed by medium and low level. Education, area under cotton cultivation, experience in cotton cultivation, information seeking behavior, extension contact, mass media exposure, innovativeness and scientific orientation were found to be positively significant while age was found to be negatively significant. Extension contact and mass media exposure were the major variables to explain the knowledge gain of cotton farmers. From the study it was revealed that the overall perception of the IMM the respondents were highly satisfied followed by satisfied and a minimal of respondents were not satisfied.

It was manifested from the findings that majority of the cotton farmers were highly satisfied with adequacy of information followed by motivation to learn subject matter, provides complete knowledge, motivate to adopt the message in farm, message is understandable, practical usage of message, use of simple words and sentences, readability of text matter, colour combination of text, clarity of voice, quality of illustration, text Vs video clipping balance/synchronization of voice, duration of the video, understandability of video clipping, attractiveness of video clippings, naturality of the module and pleasant background music. The suggestions as indicated by the respondents for improvement were to increase the sound & clarity and to decrease the volume of the background music.

It was indicated that most of the respondents felt that village knowledge/resource centre followed by mobile phone, panchyat office, farmers society/association and community hall information kiosks, A.O office, K.V.K premises, village libraries (Grandhalayam), input dealers, research stations, information centres in agricultural colleges/polytechnics, F.T.C., home, JDA office, ADA office and at DAATTC were the places to install the IMM for promotion.
Most of the cotton farmers suggested for the need of operator to operate the computer and interactive CD or pen drive or memory card as most of the respondents might be unfamiliar with computers and felt that they need training for operation of IMM. They also suggested that to develop IMM for crops like paddy, chilies, coconut, ragi and vegetables.
EXTENSION EDUCATION

Author : PREETHI MANUKONDA

Title of the thesis : EMPOWERMENT SUSTENANCE AMONG WOMEN SELF HELP GROUPS THROUGH MICRO FINANCE ACTIVITIES – A CRITICAL ANALYSIS

Major Advisor : Dr. B. JAMUNA RANI

Degree : Ph. D.

College : COLLEGE OF AGRICULTURE, RAJENDRANAGAR

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The empowerment of women, improvement of their status and economic roles need to be integrated into economic development programmes, as the development of any country is inseparably linked with the status and development of women. Experiences from world over have shown that provision of credit, promotion of enterprise creation and income generating activities among women, especially in groups would transform them from ‘being alive’ to ‘living with dignity’. Micro-Finance as a tool of poverty alleviation and women empowerment has gained acceptance in development for both consumption and production purposes. It is also an accepted fact that the success of SHGs as a development tool depends on the availability of micro finance. Empowerment sustenance is identified as a major factor for the active performance of a self help group. Hence, the present study was designed to study the Empowerment Sustenance of women self help groups through micro finance activities, in three regions of Andhra Pradesh.

Ex-post facto research design was used for conducting the study. The three regions of Andhra Pradesh namely Telangana, Rayalaseema and Andhra have been selected for the study. One district from each region namely Nalgonda, Chittoor and East Godavari were selected purposively for having highest number of SHGs in operation. Four mandals from each district with highest longevity and two villages from each mandal were selected randomly. 10 women from each village making a total of 240 women were selected by simple random sampling method.

The empowerment sustenance was measured by developing an index called Empowerment Sustenance Index (ESI) which was operationalized as fourteen indicators of ESI namely Group Approach, Group motivation and participation, Interpersonal Relationships, Access to Development Programmes, Power in local polity, Participation in MFIs, External resource mobilisation, Change in Gender Dynamics, Thrift and Credit activities, Group leadership and Achievement levels of SHG were identified to measure ESI. Moreover, nineteen independent variables were chosen for the study that influenced both the dependent variables viz. empowerment and empowerment sustenance.
The following findings emerged from the present investigation.

Distribution of respondents based on personal, social, economic, psychological, situational and group related characteristics showed that majority of the respondents belonged to the high category with regard to market facilities, achievement motivation and supportive environment for measurement of empowerment and empowerment sustenance among SHG women. Except for the variables group loafing and financial assistance obtained where majority fell under low category, for the rest of the variables majority of them were found to be in medium category.

Out of the fourteen indicators of Empowerment Sustenance Index majority of the respondents were in the higher category for Group motivation and participation, interpersonal relationships, economic independence, Change in gender dynamics, Thrift and credit activities of SHGs and Achievement levels of SHGs. For indicators like Access to development programmes, Power in local polity and External Resource mobilisation in SHGs the majority of respondents were in low category and for the rest of indicators they were in medium category.

The empowerment of SHG women was measured in two dimensions namely process and product empowerment. Except for desire to control dimension of process empowerment where majority of respondents fell in high category, in all the other dimensions, majority of respondents were found to be in medium category. With regard to product empowerment, except for the dimension, managerial competencies, where majority of respondents fell in medium category, in all the other dimensions majority of respondents were found to be in high category.

Simple correlation analysis of independent variables with empowerment of SHG women revealed that age, education, family size, occupation, family income, community participation, market facilities, risk orientation and supportive environment were positively significant to empowerment while caste, family type and group loafing were found to be negatively significant to empowerment.

The results of regression analysis inferred that family size, family type, occupation, family income, risk orientation and team spirit were found to be significant at 0.01 percent level of probability with empowerment of SHG women while, working age of the group and group loafing were found to be negatively significant.

With regard to empowerment sustenance, simple correlation analysis of independent variables revealed that education, family size, occupation, community participation, family income, market facilities, risk orientation, supportive environment and team spirit were found be positively significant while caste, group loafing and family type were found to be negatively significant.

Multi linear regression analysis showed that family size, occupation, participation in community activities, family income, indebtedness, achievement motivation, supportive environment and team spirit were positively significant at 0.01 level, while family type and group loafing were negatively significant to empowerment sustenance of SHG women. Step down regression analysis of independent variables with empowerment of SHG women indicated that 69.49 per cent variation was explained by eight variables
alone viz. age, caste, occupation, participation in group activities, family income, achievement motivation, risk orientation and group loafing.

Significant variation in empowerment among selected SHG groups was found with F value being 4.13 indicating significant variation in empowerment between the groups, in three districts.

Step down regression analysis of empowerment sustenance with independent variables indicated that 63.02 percent variation was explained by seven variables alone viz., education, occupation, participation in group activities, family income, achievement motivation, working age of the group and financial assistance obtained.

A significant variation in empowerment sustenance was found between selected SHG groups with F value showing 11.43, indicating considerable variation with in the groups in three districts.

The major problems expressed by SHG women were lack of adequate credit, lack of education, training and managerial skills, long durations of loan processing and high costs of production. The major suggestions given by SHG women include provision of adequate credit at low interest rates, training by competent trainers, fabrication of programmes for education and provision of sales outlets at mandal level.

A strategy for making the SHG women self reliant was suggested based on the findings of the study.
Agriculture continues to be the primary occupation and way of life for more than half of Indian population even today making single largest contribution to the GDP accounting for 15.70 per cent of the total. Sustainable prosperity of the farmers and the agricultural labourers holds the key for improving the overall human resource development scenario in the country. Though India has achieved self sufficiency in food grain production, we cannot complacent with the increasing population. There is a need to increase production and productivity of agriculture. Hence the Indian farmers need to be updated with the latest knowledge about new techniques of farming, new cultivars, farm machinery, market and trade situation etc.

The extension personnel of the department of agriculture disseminated the technologies and messages to the farmers through various extension methods. But these approaches have not been able to reach majority of the farmers spread across the country as the ratio between farmer and extension worker is 1000:1. This gap remains a challenge for extension system even today. To reach 110 million farmers spread over more than 500 districts is an uphill task. Farmers’ needs are much more diversified and the knowledge required to address them is beyond the capacity of the grass root level extension functionaries. In this context, Information and Communication Technologies (ICTs) plays an important role in reaching the unreached, supplement and reinforce the extension efforts.

The present study is designed to analyze the extent of use of Information and Communication Technologies in selected crops by the farmers of Guntur district of Andhra Pradesh. The selected crops include paddy, cotton and chilli. Ex-post facto research study was followed. Guntur district of Andhra Pradesh was selected purposively. One mandal for each crop with highest area of cultivation was selected for the study. Thus a total of three mandals viz., Bapatla for paddy, Amaravathi for cotton and Veldurthy for chillies were selected for the study. Four villages from each mandal were
selected randomly with a total twelve villages. For each crop forty farmers were selected by following proportionate random sampling constituting the total sample size to 120.

Data were collected through Interview schedule, which was subjected for statistical analysis and interpretation. Findings emerged out of the study are presented as below.

Detailed analysis of profile characteristics of farmers indicated that majority of the respondents were middle aged with primary schooling education and were having small land holdings with medium farming experience. Majority of the respondents had medium information seeking behaviour, socio-politico participation, extension contact, medium in economic status, scientific orientation and achievement motivation.

The findings of the study indicated that all ICT tools were not used by the farmers. Only Radio, Television and mobile were used to some extent. Majority of the farmers (65.83%) belonged to medium category of extent of use of ICTs.,

A little less than three fourth (71.67%) of the respondents had moderately favourable attitude towards ICTs use.

Eight out of eleven independent variables viz., education, farming experience, information seeking behaviour, extension contact, economic status, achievement motivation, scientific orientation and innovativeness were positively correlated with extent of use of ICTs and attitude towards ICTs use. The association was found significant at 1 per cent level of probability and the remaining variables age, land holding and socio-politico participation showed non-significant relation with extent of use of ICTs and attitude towards ICTs use.

The eleven independent variables with the extent of use of ICTs by the farmers taken on Multiple Linear Regression Analysis gave the R² (Co-efficient of multiple determination) value of 0.8943. It indicates that the independent variables put together contribute 89.43 per cent of the total variation in the extent of use of ICTs by the farmers, leaving the rest to extraneous factors. The independent variables viz., education, farming experience, extension contact, economic status of the respondents had contributed significantly at 0.01 level of probability towards the variation in the extent of use of ICTs.

The eleven independent variables with attitude of farmers towards ICTs use taken on Multiple Linear Regression Analysis gave the R² (Co-efficient of multiple determination) value of 0.8687, which indicates that the independent variables put together contributed up to 86.87 per cent of the total variation in explaining the attitude towards ICTs use by the farmers, leaving the rest to extraneous factors. The independent variables viz., education, farming experience, land holding, economic status of the respondents had contributed significantly at 0.01 level of probability towards the variation in the attitude towards ICTs use.
The most important constraints reported by the farmers in utilization of the ICT tools were lack of awareness of all the ICT tools within the community, failure to broadcast/telecast timely information, do not repeat the important programmes followed by irrelevancy of the programmes to the farmers, timings of broadcast/telecast are not suitable to the farmers, the information broadcasted/telecasted was not complete and brief, the recommendations given were not authentic and applicable to all the farmers in that area, lack of training and getting complete information is very cumbersome.

Suggestions given by the farmers to overcome the problems were create awareness on the ICT tools within the community by conducting awareness programmes and campaigns, provide timely information followed by change the timings of the farm broadcast/telecast to evening, use simple, clear and understandable words, repeat the highlights of the programme, conduct live in phone programme with progressive farmers and scientists, localized recommendations should be given, training should be given, increase the availability of kiosks at village level and complete information should be provided by the call centres.
Extension has been traditionally funded, managed, and delivered by the public sector all over the world. The public sector monopoly came under increasing threat in the 1980s as many professionals started questioning the desirability of this situation on economic and efficiency grounds. Increasing restraints on government finances and emergence of new extension arrangements offered by the private and voluntary sectors have accelerated the process of limiting the role of government in extension. Decentralization, cost sharing, cost recovery, withdrawal from selected services, and contracting are some of the options exercised by various governments in privatizing extension services. There is a need to sensitize the total extension system.

Hence, the present study “Privatization of Agricultural Extension Services in Guntur District of Andhra Pradesh” executed by selecting the Cotton, Chilli and Paddy crops using descriptive research design. Guntur district of Andhra Pradesh was selected purposively. Six mandals from the district namely Amaravathi and Thadikonda mandals were selected for Cotton, Veldhurthy and Gurazala were selected for Chillies and Bapatla and Nekarikallu mandals for Paddy were selected purposively as these crops occupy highest area under cultivation. Two villages from each of the selected mandal were selected randomly covering to a total of twelve villages. For each crop, forty farmers were selected by following proportionate random sampling constituting the total sample size to one hundred and twenty (n=120).

Data was collected through Interview schedule, which was subjected for statistical analysis and interpretation. Findings emerged out of the study were presented as below.

The findings of the study revealed that majority of the Cotton and Chilli farmers preferred privatization of agricultural extension services in the areas of input supply followed by advisory services and hire services. Majority of the Paddy farmers preferred privatization of extension services in input supply. Majority of the respondents preferred privatization in input supply such as supply of seeds, fertilizers, fungicides and pesticides. Among advisory services private agencies were preferred for providing
information related to market intelligence, integrated pest management, integrated disease management and soil testing and analysis. Among hire services, private agencies were preferred in supply of farm implements for preparatory cultivation, labour management, storage godowns and ginning.

Majority of the respondents had favourable attitude towards privatization of agricultural extension services followed by least favourable and most favourable attitude categories.

In all the three crops, Cotton, Chilli and Paddy, government agencies were preferred in providing advisory services in the areas of cropping pattern, seed usage and treatment, insecticides and disease related information, seed supply and training and demonstrations. Private agencies with government assistance were preferred in providing advisory services in the areas of soil testing and analysis, market intelligence, rodent control, input services such as seed supply, hire services pertaining to farm implements for preparatory cultivation and implements for intercultural operations. They preferred to have the role of private agencies without government assistance in the areas of integrated pest management and disease management, supply of fungicides, insecticides/pesticides, fertilizers and seed treatment chemicals.

In all the three crops for advisory services, majority of the respondent’s preferred cost-sharing approach by village extension contract system. For input supply and hire services, they preferred extension contract system. Mode of payment may be in the form of cash or kind based on their convenience and based on the services provided either per visit or per crop or per season.

Important problems elicited are poor socio-economic status of farmer, competition among private agencies, possibility for increase in cost of production, spurious and adulterated products, lack of demand for many services, problematic land holding, possibility of withdrawing input subsidies and illiteracy of people and lack of government certification agencies to screen the professionals and agricultural inputs. Important suggestions given by the respondents are; charges should be reasonable, cost of production should be reasonable, reputed private agencies should be encouraged, government should screen the professionals, farmers should be educated, certification of products by government agencies, no adulteration of chemicals with government checkups, importance of various services should be known to farmers and proper information and communication technologies should be made available at village level.
The agriculture services in the country now in the process of reorientation of their development strategies towards supporting farmer empowerment. One method of empowering farmers and their capacity building is through Farmers Field School [FFS]. FFS is a participatory approach to adult education adopted by Indian government since 1990 towards the achievement of ecologically sound, profitable and socially sustainable small scale farming. Participatory extension approaches such as farmer to farmer extension and FFS encourage farmers to utilize their resources, own knowledge, skills while integrating new expertise, enhance farmers position as manager of their own land and resources. FFS empowered to build up their self-confidence and self-reliance. This implies the need to decentralize expertise to the field level by educating local people to analyze field situations and to make appropriate management decisions. Thus, the Field School was a school without walls that taught basic agro-ecology and management skills. From 2004 onwards, the state governments modified the existing extension approach from demonstration to FFS so as to enable farmers to evaluate technologies by themselves and have taken steps to institutionalize the IPM-FFS model for cotton and other crops in their mainstream extension.

The study entitled “Empowerment of Farmers Through Farmer Field School in A.P” was mainly intended to find out the empowerment in terms of Attitude, Knowledge, Skills, Adoption, Agro ecosystem management and Decision making ability of cotton integrated crop management practices by farmers after FFS programme. An attempt is also made to study the agro ecosystem management and utilization of ITKs farmers while practicing cotton FFS. The findings of the study would help for further refinement of FFS programme for reaching more number of farmers with adoptable low cost technologies in Cotton.

An ex-post-facto research design was adopted for the study. 180 FFS farmers (30 from one FFS) and 18 Extension officers (6 from each district) selected purposively and 180 Non FFS farmers (30 from each village) were selected randomly for the study. Thus, a total of 360 farmers (180 FFS farmers and 180 Non FFS farmers) and 18 Extension officers from three districts of A.P formed the sample of the study. A pre-
tested interview schedule with measurement devices of all variables was used for
collection of raw data. The data thus collected was coded and analysed with the help of
appropriate statistical tests.

Majority of FFS farmers belonged to middle aged, high school education, had 3-
13 years of experience in farming, small farmers, medium level of mass media exposure,
medium extension contact, medium group orientation, medium market intelligence,
medium level of risk orientation, medium innovativeness and medium level of
management orientation. In case of Non FFS farmers, majority belonged to middle age
primary school education, had 3-13 years of experience in farming, small farmers, medium
level of mass media exposure, medium extension contact, medium group
orientation, medium market intelligence, medium level of risk orientation, medium
innovativeness and medium level of management orientation.

Majority of the FFS respondents were having favourable attitude and opined that
FFS is an innovative school of learning for farmers at field level and promote eco-
friendly technologies. Majority of respondents had medium knowledge about Cotton
ICM practices and they could diagnose nutritional deficiencies and sucking pest damage.
Majority of respondents belonged to medium skills learnt category, Adoption, Agro
ecosystem management and Decision making ability towards Cotton ICM practices.
Further the Z-test results confirmed that the FFS farmers had significant improvement in
Cotton ICM aspects over Non FFS farmers.

Correlation analysis revealed that Education, Mass media exposure, Market
intelligence, Risk orientation, Innovativeness and management orientation were
positively significant whereas Age and Experience in farming were found be negatively
significant with Attitude level of FFS farmers on Cotton ICM practices. All the 11
independent variables put together explained for about 76.66 percent variation in the
attitude of FFS farmers and 48.33 percent in Non FFS farmers on Cotton FFS
programme. In case of Knowledge of FFS farmers, Education, Mass media exposure and
Innovativeness were positively significant whereas Age and Experience in farming were
found be negatively significant with Knowledge level of FFS farmers on Cotton ICM
practices. Whereas in Non FFS farmers all the variables were non-significant. All the 11
independent variables put together explained for about 80.00 percent variation in the
Knowledge of FFS farmers and 44.33 percent in Non FFS farmers on Cotton FFS
programme.

Education, Mass media exposure and Innovativeness were significant with Skill
of FFS farmers on Cotton ICM practices, whereas all the variables were found to be non-
significant with skills of non FFS farmers. All the 11 independent variables put together
explained for about 77.00 percent variation in the Skill of FFS farmers and 42.00
percent in Non FFS farmers about Cotton FFS programme.

Education, Mass media exposure and Innovativeness were positively significant
whereas Age and Experience in farming were found be negatively significant with
Knowledge level of FFS farmers on Cotton ICM practices. Whereas incase of non FFS
farmers age, education and experience were found to be positively significant relationship
with Adoption of Cotton ICM practices. All the 11 independent variables put together
explained for about 74.00 percent variation in the Adoption of FFS farmers and 46.66 percent in Non FFS farmers about Cotton FFS programme.

Education, Mass media exposure and Innovativeness were positively significant whereas Age and Experience in farming were found be negatively significant with agro ecosystem management of FFS farmers on Cotton ICM practices. Whereas in case of non FFS farmers all the variables were found to be non-significant relationship with agro ecosystem management of Cotton ICM practices. All the 11 independent variables put together explained for about 55.33 percent variation in the Agro ecosystem management of FFS farmers and 37.33 percent in Non FFS farmers about Cotton FFS programme.

Relationship between selected profile characteristics of the FFS and Non FFS farmers and their Decision towards Cotton FFS shows that Education, Innovativeness were positively significant whereas Age and Experience in farming were found be negatively significant with decision of FFS farmers on Cotton ICM practices. Whereas in case of non FFS farmers, Education and management orientation were found to be positively significant relationship with decision of Cotton ICM practices. All the 11 independent variables put together explained for about 70.33 percent variation in the decision of FFS farmers and 43.00 percent in Non FFS farmers about Cotton FFS programme.

Except Neem based products no other ITKS were used in FFS programme. But in case of non FFS farmers, ITKs like Putting light in Pot acts as light trap in Cotton crop, Apply Inguva 30g/plant and then irrigate to reduce wilt incidence, Puttamannu 50g+ Cow urine 50ml+Cow dung 50g used for treatment [acts as anti-biotic and improves germination percentage].

Finally a hypothetical strategy was developed for successful implementation of FFS programme based on farmers and officials suggestions and results derived from the study. Based on the above findings, several implications for future research were drawn. The suggestions offered through the study, if followed, there would be a great benefit to farming community through FFS programme.

EXTENSION EDUCATION

Author: PRABHUGOUDA KAMARADDI
A study on entrepreneurial behaviour of Pomegranate growers in Koppal district of Karnataka was carried out during 2011. Respondents from each village in the district had been randomly selected by using proportionate sampling procedure, thus making a total of 120 respondents and data was collected by personal interview method.

The detailed analysis of profile of Pomegranate growers indicated that majority of the respondents were middle aged, having Primary school education, medium land holding, medium in social participation, mass media exposure, training exposure, scientific orientation, credit orientation, and market orientation.

The study revealed that majority of the Pomegranate growers had medium entrepreneurial behaviour.

Among Sub-components of the Entrepreneurial behaviour, it was found that majority of the respondents had medium self confidence, decision making ability, information seeking behaviour, risk taking ability, innovativeness, achievement motivation, ability to coordinate farm activities, management orientation, cosmopoliteness and economic motivation.

The correlation analysis revealed that education, land holding, social participation, mass media exposure, experience in Pomegranate cultivation; training exposure, scientific orientation, credit orientation and market orientation were positively and significantly correlated with entrepreneurial behaviour of Pomegranate growers and age was negatively significant with entrepreneurial behaviour of Pomegranate growers. All the independent variables taken together explained to the extent of 83.40 per cent to the total variance in the

The Multiple Linear Regression analysis indicated that all the ten subcomponents of entrepreneurial behaviour put together explained 99.80 per cent variance of the entrepreneurial behaviour. The most important sub-components in order of their importance were, innovativeness, management orientation, information seeking behaviour, economic motivation, risk taking ability, cosmopoliteness, achievement motivation, decision making ability, self confidence and ability to coordinate farm activities.
The average annual family income of respondents after Pomegranate cultivation was raised around fourteen times as compared to before its cultivation. Majority of farmers created the farm assets, household assets and purchased the land out of their earnings from Pomegranate cultivation. Majority had responded that their social recognition, social interaction, contact with AHO/ADH, social participation, increased remarkably and few responded that their political participation also increased. Nearly half of the Pomegranate growers were giving better education for their children with the benefits earned.

Main constraints faced by the Pomegranate growers include, bacterial blight, difficult to identify disease free planting material, non-availability of labour for harvesting, high cost of plant protection chemicals and fertilizers, lack of knowledge about value added products of Pomegranate, requirement of more investment, low rate of subsidy, lack of horticultural training programmes, inadequate transport facilities and inadequate marketing facilities.

Important suggestions were, disease free planting material should be supplied by the Horticulture department or by Horticultural University, the costs of the fertilizers and plant protection chemicals should be reduced by more subsidizing them. Trainings should be given by State Department of Horticulture and Horticulture University regarding all aspects of Package of Practices and post-harvest handling of the produce, processing unit (plant) should be started in the area, marketing and transport facilities should be improved, and under MGNREGA, employment should be provided to MGNREGA beneficiaries, only during off-season.
An experiment entitled “Isolation and screening of Plant Growth Promoting Rhizobacteria” was conducted at Department of Agricultural Microbiology and Bioenergy, College of Agriculture, Rajendranagar, Hyderabad for characterization of efficient PGPR isolates with multiple beneficial activities. In search of efficient PGPR isolates with multiple activities, a total of 64 bacterial isolates belonging to Bacillus (20), Pseudomonas (20), Azotobacter (12) and Rhizobium (12) were isolated from different rhizospheric soils of groundnut and sorghum in Mahaboobnagar district. These test isolates were biochemically characterized and screened in vitro for their plant growth promotion properties like phosphate solubilization, production of indoleacetic acid (IAA), hydrogen cyanide (HCN) production, siderophore production and antagonistic activity. Twenty selected isolates with respect to multifunctional properties were also studied for the molecular diversity by PCR-RAPD technique.

The results revealed that all the isolates of Azotobacter and 91.5% of Rhizobium showed IAA production. Where as only 35% of Pseudomonas and 30% of Bacillus isolates showed IAA production. 50% of Pseudomonas, Rhizobium and Azotobacter isolates solubilized phosphate with highest solubilization zone of 16, 13 and 15 mm respectively. Where as 40% of Bacillus isolates solubilized phosphate with highest solubilization zone of 18 mm. Production of HCN was commonly detected in the isolates of Rhizobium (66.6%) followed by Pseudomonas (50%), Bacillus (45%) and Azotobacter (25%). Production of siderophores was detected in the isolates of Rhizobium (42%) followed by Pseudomonas (25%) and Bacillus (25%). None of the Azotobacter isolates showed siderophore production.

All the 64 plant growth promoting rhizobacterial isolates were examined for the potential to inhibit two fungal pathogens viz., Sclerotium rolfsii and Rhizoctonia solani under in vitro conditions. Out of 64 isolates, 29 isolates exhibited inhibition potential against one or the other phytopathogen, while the remaining 35 isolates did not show inhibitory activity against any of the pathogens tested. Out of 29 antagonistic isolates, 20 were inhibitory to Sclerotium rolfsii, 18 to Rhizoctonia solani, nine isolates showed inhibition potential against both Sclerotium rolfsii and Rhizoctonia solani. The molecular diversity of 20 selected plant growth promoting rhizobacterial isolates viz., Bacillus cereus, Pseudomonas fluorescens, Rhizobium spp. and Azotobacter spp. was studied by PCR-RAPD technique. The 20 plant growth promoting rhizobacterial isolates were selected based on their multifunctional PGPR traits i.e each isolate is
having best or good PGPR property among the 64 isolates and some isolates that having multiple PGPR traits also taken in to consideration.

From the present investigation, it can be inferred that PGPR due to their multiple beneficial activities increase the plant growth and soil fertility by direct and indirect means. Direct means through nutrient supply such biological nitrogen fixation, phosphate solubilization, production of plant growth promoting substances like IAA etc. Indirect means through biocontrol activity by production of siderophores and HCN. These are eco-friendly in nature and cost effective. So PGPR help in improving profitability in agriculture and improve livelihoods of small and marginal farmers.
Amaranth greens, are common leafy vegetables available throughout the tropics and in many warm temperate regions. It is remarkably rich in vitamin C, iron, calcium and folate. However, there is very little information on the use of biofertilizers and organic manures alone or in combination with chemical fertilizers on Amaranthus yield and quality. Thus this study is designed to evaluate the impact of biofertilizers on nutrient content and antioxidant activity of Amaranthus.

The experiment was conducted in complete randomized design with 12 treatments and three replications. Vermicompost, chemical fertilizers and biofertilizers were applied to the soil according to the treatments imposed. Amaranthus seeds were sown in poly bags with different treatments. The crop was harvested at 30 days (first picking), 45 days (second picking), 60 days (third picking) DAS. At each picking, yield was noted. Fresh leaf samples were used for estimation of vitamin C content and total carotene content. Dry powdered leaf samples were used for estimation of total antioxidant activity, total phenols and mineral content. The physico-chemical properties of soil and microbial population of soil was estimated before sowing and after harvesting of crop. The shelf life was assessed after harvesting at room temperature and refrigeration temperature.

There were significant differences in yield, vitamin C content, carotene content, minerals, phenols and antioxidant activity of Amaranthus. Among treatments significantly higher yield was recorded with the application of 50% RDF+NBF+PSBF. Total dry weight differed significantly among the treatments at all stages. Higher total dry weight was recorded with the application of 50% RDF+NBF+PSBF.

The quality parameters viz., vitamin C content, carotene content, minerals, phenols and antioxidant activity were significantly higher with the application of 50% RDF+NBF+PSBF.

The shelf life of Amaranthus was significantly better with the application of 50% RDF+NBF+PSBF and the lowest shelf life was recorded in 100% RDF. The results from
This study demonstrated that yield and quality parameters will be improved by combined application of chemical fertilizers and biofertilizers.
AGRICULTURAL MICROBIOLOGY

Author : REVATHI, K.
Title of the thesis AND
"IMPACT OF BIOFERTILIZERS ON NUTRIENT CONTENT AND ANTIOXIDANT ACTIVITY OF SPINACH BEET (Beta vulgaris)"

Major Advisor : Dr. S. SUMATHI
Degree : M.Sc. (Ag.)
College : COLLEGE OF AGRICULTURE, RAJENDRANAGAR
Accession Number : D 8845

A poly bag experiment was conducted at Department of Agricultural Microbiology and Bioenergy and Inter faculty Department of Biochemistry, College of Agriculture, Rajendranagar, Hyderabad during 2010-11. The experiment was laid out in completely randomized design with 3 replications and 12 treatment combinations. Recommended dose of chemical fertilizers (100% RDF, 50% RDF), vermicompost and biofertilizers (nitrogen biofertilizer (NBF): Azotobacter and phosphate solubilizing biofertilizer (PSBF): Bacillus) were applied to the soil according to the treatments imposed. All green variety of spinach beet seeds (20) were sown in poly bags and watered regularly. The crop was harvested at 30 (1st picking), 45 (2nd picking) and 60 (3rd picking) days after sowing. At each picking, yield was noted, and fresh leaf samples were used for estimation of vitamin C content and total carotene content. Dry powdered leaf samples were used for estimation of total antioxidant activity, total phenols and mineral content. The physico-chemical properties of soil and microbial population in the soil were estimated before sowing and after harvesting of the crop. The shelf life of the leaf samples was assessed both at refrigeration and ambient temperature in 150 gauge polythene covers.

The results revealed that the treatment receiving 50% RDF + NBF + PSBF recorded higher yield followed by 100% RDF, 50% RDF + NBF, 50% RDF + PSBF and vermicompost + 50% RDF. Dry weight was significantly higher on application with 50% RDF + NBF + PSBF which was on par with 100% RDF, 50% RDF + PSBF, 50% RDF + NBF and vermicompost with 50% RDF.

The application of 50% RDF + NBF + PSBF resulted in higher vitamin C content over the other treatments at 30, 45 and 60 days after sowing. Low vitamin C content was recorded with vermicompost + NBF application and with PSBF application. Total carotene content was significantly higher with application of 50% RDF + NBF + PSBF at 30, 45 and 60 DAS over all other treatments. Calcium content was found to be significantly higher with the application of 50% RDF + NBF + PSBF followed by vermicompost with biofertilizers alone or combined and with 50% RDF. The lowest
calcium levels were observed with only vermicompost treatment followed by 100% RDF. Iron content was found to be significantly higher with the application of 50% RDF + NBF + PSBF followed by vermicompost + 50% RDF and with two biofertilizers i.e., NBF and PSBF.

Among all treatments total antioxidants were increased significantly with 50% RDF + NBF + PSBF which was on par with vermicompost + 50% RDF treatment. There was significant difference among 30, 45 and 60 days after sowing in the total antioxidant content. Significantly maximum total phenolic content was recorded in 50% RDF + NBF + PSBF followed by vermicompost + NBF + PSBF, vermicompost + 50% RDF and vermicompost + NBF. The lowest phenolic content in spinach beet leaves was found with vermicompost treatment and all other treatments showed significantly higher total phenol content.

Shelf life was higher in the 50% RDF + NBF + PSBF treatment followed by vermicompost + NBF + PSBF, NBF + PSBF and vermicompost + 50% RDF both at refrigeration and room temperature in polythene cover.

The soil pH was decreased with application of organic fertilizers and biofertilizers and EC was increased. The organic carbon content, nitrogen, phosphorus and potassium levels in the soil increased with 50% RDF + NBF + PSBF combination. Significatly higher soil microbial population was recorded with 50% RDF + NBF + PSBF treatment. Azotobacter and Bacillus population were higher in the treatments with biofertilizers alone or in combination, and with vermicompost. Lowest soil microbial population was recorded in 100% RDF. 50% RDF with NBF and PSBF was found to be the best among the treatments used in the present study as it resulted in the higher yield, vitamin C, total carotene, nutrient contents and antioxidant activity.
Plant growth promoting rhizobacteria (PGPR) are beneficial bacteria that colonize plant roots and enhance plant growth by a wide variety of mechanisms. The use of PGPR is steadily increasing in agriculture and offers an attractive way to replace chemical fertilizers and pesticides. Keeping this in view an experiment was conducted at Department of Agricultural Microbiology and Bioenergy, College of Agriculture, Rajendranagar, Hyderabad for characterizing efficient PGPR isolates with multiple beneficial activities. Forty bacterial isolates were isolated from the Groundnut and Redgram crops and were identified as *Rhizobium* (10), *Pseudomonas* (15) and *Bacillus* (15) isolates. These isolates were screened in vitro for Plant growth promoting attributes like phosphate solubilization, production of Indole acetic acid (IAA), hydrogen cyanide (HCN) and are further studied for their antagonism against three soil borne pathogens viz., *Rhizoctonia solani*, *Sclerotium rolfsii* and *Fusarium solani*. These isolates are further tested for their compatibility with the commonly used agrochemicals, *i.e.* fungicides (Copper oxy chloride, Carbendazim, Thiram and Captan), insecticides (Phorate, Carbofuran, Imidachloprid and Chlorpyriphos) and herbicides (Alachlor, Butachlor, Pendimethalin and Oxy fluorofen).

Results revealed that all the *Rhizobium* isolates showed positive results for phosphate solubilization, production of IAA and HCN. The *Rhizobium* isolates, SBGR, KRR and AGR showed maximum antagonism against *Rhizoctonia solani*, *Sclerotium rolfsii* and *Fusarium solani* respectively. 70% of these isolates showed siderophore production. Many of these isolates showed compatibility with the commonly used agrochemicals, insecticides, but only two rhizobial isolates (DRR and SBGR) were compatible with all herbicides used in the present study.

80% of the *Pseudomonas* isolates except SFRP, AGP and MGP showed phosphate solubilization. 80% of the isolates showed IAA production. The *Pseudomonas* isolates, DGP, SBRP and SBGP exhibited maximum inhibition against *Rhizoctonia solani*, *Sclerotium rolfsii* and *Fusarium solani* respectively. While 80% of these isolates produced siderophores and 40% of the isolates produced HCN. Majority of the isolates showed compatibility with all the agrochemicals used in the present study.
Regarding *Bacillus* isolates, 33% of them solubilized phosphorus and produced IAA. The *Bacillus* isolate, ARB showed higher biocontrol activity against *Rhizoctonia solani*, *Sclerotium rolfsii* and *Fusarium solani*. 33% of the isolates expressed for siderophores and HCN production. All the *Bacillus* isolates showed their compatibility with all the fungicides except Thiram and Captan, insecticides and herbicides.

From the present investigation, it can be inferred that PGPR due to their multiple beneficial activities increase the plant growth and soil fertility by direct and indirect means. Direct means through nutrient supply such as biological nitrogen fixation, phosphate solubilization, production of plant growth promoting substances like IAA etc. Indirect means through biocontrol activity by production of siderophores and HCN. These PGPR are eco-friendly in nature and cost effective and therefore their use in crop production makes agriculture profitable and sustainable.
Agricultural Microbiology

Author: SUPRAJA, Y.

Title of the thesis: BIODIVERSITY OF FLUORESCENT PSEUDOMONADS FROM THE RHIZOSPHERE SOILS OF REDGRAM AND MAIZE CROPS

Major Advisor: Dr. R. SUBHASH REDDY

Degree: M.Sc. (Ag.)

College: COLLEGE OF AGRICULTURE, RAJENDRANAGAR

Accession Number: D 8847

In the present investigation, fluorescent pseudomonads were isolated from the rhizosphere of maize and redgram crop plants, since the microorganisms that grow in the rhizosphere provide defense for roots against the attack by plant pathogens. Thirty bacterial isolates were obtained from the 50 rhizosphere soil samples. Out of which, fifteen isolates were identified as fluorescent Pseudomonads based on their fluorescence nature under UV-light on Pseudomonas agar.

To test the antagonistic potential of isolated fluorescent pseudomonads they were screened against two common soil borne fungi viz., Fusarium moniliforme and Macrophomina phaseolina under in vitro conditions using dual culture plate technique. In this study, Pseudomonas (RPF-5, MPF-4, RPF-7, RPF-4, MPF-6 and MPF-2) isolates showed highest potential for antagonism against Fusarium moniliforme. Three Pseudomonas isolates (RPF-5, MPF-6 and RPF-8) were found as potential antagonists for Macrophomina phaseolina. The two isolates RPF-5 and MPF-6 had the capacity to inhibit the growth of two fungal pathogens.

Under field conditions, in addition to biocontrol agents, farmers use agrochemicals like fungicides, insecticides and herbicides etc. to control plant diseases, pests and weeds. Because of this, the potential antagonistic PF (fluorescent Pseudomonas) isolates were tested for their compatibility with the commonly used agrochemicals. All the agrochemicals were found to be compatible with the ten PF (RPF-1, RPF-2, RPF-3, RPF-4, RPF-5, RPF-7, RPF-8, MPF-2, MPF-4 and MPF-6) isolates.

To know the nature of the antagonistic property of PF isolates, tests were conducted for the production of siderophores and Hydrogen cyanide (HCN). They were also examined for the production of Indole acetic acid (IAA) and solubilization of phosphate. It was observed that all the isolates, which showed antagonism against fungal pathogens, were also found positive for IAA and siderophore production. All the isolates showed phosphate solubilization except RPF-7 and MPF-4. Only RPF-5 and RPF-8 were positive for HCN production.
In order to know the genetic similarity of isolated fluorescent Pseudomonads, RAPD analysis was carried out by using twenty operan series (OPL) primers. In this study, all the isolates were proved cent per cent polymorphic based on polymorphic bands formed and dendrogram analysis. At 61% similarity level 6 clusters were distinguished with 15 isolates of fluorescent Pseudomonas isolates by RAPD using twenty primers (OPL series). In that the best isolates RPF-5, RPF-8 and MPF-6 were assimilated in to different clusters. RPF-5 formed a separate major subgroup with 59 per cent similarity coefficient. RPF-5 was best isolate in the present study for production of IAA, siderophore, HCN and phosphate solubilization. It exhibited antagonistic activity against Fusarium moniliforme and Macrophomina phaseolina. Another best isolate, MPF-6 belongs to 2nd cluster could produce Indole acetic acid, siderophores and phosphate solubilization ability. RPF-8, isolate formed 5th cluster. It showed similar qualities like RPF-5. Eventhough these three isolates showed similar qualities but variability is higher among these three isolates. It means that the genotypic and phenotypic diversity of P. fluorescens could be based on the geographic origin and functional differences in the genome of the isolates. At 55 per cent similarity coefficient all the fifteen isolates are genetically related.
Ethanol is quantitatively and economically the world's premier biotechnological commodity. Ethanol can be produced from any fermentable carbohydrates by yeasts. A long term goal of the brewing industry is to identify yeast strains with increased tolerance to the stresses experienced during the brewing process. A combination of high temperature, ethanol and sugar tolerance is clearly desirable characteristics in fermentation processes. Until 1990s, classical tests based on morphology, biochemical and sexual reproduction characteristics were used for wine yeast identification. Such methods only allowed discrimination between species and they were laborious, time consuming and imprecise. In the last decade, the application of several molecular techniques has generated a large number of studies concerning ecology and biodiversity of indigenous \textit{Saccharomyces cerevisiae} strains.

The present investigation is carried out with the objective of isolating ethanologenic yeasts from different sources and location followed by screening for diversity on basis of alcohol production and functional characteristics using cultural and molecular methods. Twenty samples were obtained from different sources and pure isolates were identified as yeast cultures based on their morphological characters, cultural characters, carbohydrate assimilation profile and alcohol producing ability. All isolates had alcohol producing ability but maximum alcohol production was observed with standard yeast culture \textit{Saccharomyces cerevisiae} MTCC-172 (67.77 g l\(^{-1}\)) followed by isolate APY-4 (67.53 g l\(^{-1}\)) and AMY-2 (67.50 g l\(^{-1}\)) while isolate AMY-7 produced the least (30 g l\(^{-1}\)).

Twenty yeast isolates and standard yeast culture \textit{Saccharomyces cerevisiae} MTCC-172 were screened for ethanol tolerance, thermo tolerance, sugar tolerance and osmotolerance. It was found that isolates exhibited high diversity for tolerance and were grouped according to it. Based on these results it was observed that isolates APY-4, AMY-2, AMY-9 and standard culture \textit{Saccharomyces cerevisiae} - MTCC-172 were best among all isolates. These four pure cultures were tested for their alcohol producing ability at 40°C by inoculating them in fermentation medium containing 20% sugar. Four yeast cultures fermented sugar and produced alcohol at 40°C and 20% sugar
concentration. Isolate AMY-2 showed superior capacity for alcohol production and sugar conversion efficiency (SCE) while the standard culture *Saccharomyces cerevisiae* MTCC-172 exhibited better alcohol production and sugar conversion efficiency (SCE) at 40°C and 20% sugar concentration.

Genomic DNA of 21 pure cultures of *Saccharomyces cerevisiae* were analyzed by RAPD technique using fifteen different primers and a dendrogram was constructed. Only isolates AMY-7 and APY-2 formed separate single element groups in dendrogram. The dendrogram analysis was compared with analysis formed from assimilation profiles, cultural characteristics, morphological characteristics and functional characteristics (sugar conversion efficiency, thermostolerance, osmotolerance, ethanol tolerance and sugar tolerance) which revealed great biodiversity among the twenty one pure *Saccharomyces cerevisiae* cultures.

Based on the present study it is established that the important functional diversity found for ethanol tolerance, thermostolerance, sugar tolerance and osmotolerance indicate that the use of wider range of yeast isolates could be outlined and further developed for valorization. These results can be applied for optimization of alcohol production, brewery and baking industries as well in tropical countries such as India. Strain biodiversity represents a fundamental source of specific and also potential rare characteristics, which contributes to increase the economics of fermentation. This natural biodiversity represents an essential source for selection of strains possessing desirable characteristics. The use of molecular method like RAPD helps in elucidation of genetic diversity among the isolated yeast strains thereby establishing their evolutionary relationships. This will enable researchers in designing novel strains carrying all desirable characteristics.
The present study was conducted during summer 2011 on sandy clay loam soils of College farm, College of Agriculture, Acharya N. G. Ranga Agricultural University, Rajendranagar, Hyderabad. The treatments consisted of three hybrids (Vikas, Hanuman and XB-20plus) and four nitrogen levels (0, 40, 80 120 kg N ha$^{-1}$). The experiment was laid out in split plot design with hybrids as main factor and nitrogen levels as sub factors with three replications.

Plant height, tillers m$^{-2}$, leaf area and dry matter at 20, 40, 60 days after sowing and at harvest were recorded highest with hybrid Hanuman. Similarly, at 120 kg N ha$^{-1}$ plant height, tiller m$^{-2}$, leaf area and dry matter were found markedly higher compared to the rest of the doses.

The physiological studies have indicated the crop growth rate was highest between 40-60 DAS and highest for hybrid Hanuman and at 120 kg N ha$^{-1}$ among all the levels of nitrogen. Relative growth rate and net assimilation rate were found highest between 20-40 days after sowing.

Yield attributing character i.e. number of spikes m$^{-2}$, spike length, grain weight spike$^{-1}$ were registered highest with hybrid Hanuman. Test weight was found to be at par with all the three hybrids. All the above yield attributing parameters including test weight were found highest with 120 kg N ha$^{-1}$.

Grain and stover yield recorded highest with hybrid Hanuman over the other two hybrids and among the nitrogen levels application of 120 kg N ha$^{-1}$ recorded highest grain and stover yields.

The nitrogen and phosphorus uptake in grain and stover was highest with hybrid Hanuman. The potassium uptake in grain was significantly highest in hybrid Hanuman and all three hybrids were at par for potassium uptake in stover. Among the nitrogen levels, 120 kg N ha$^{-1}$ recorded significantly highest uptake of all the three nutrients in grain and stover.

Net returns and benefit-cost ratio were highest with hybrid Hanuman and among the nitrogen levels application of 120 kg N ha$^{-1}$ recorded highest values.

It can be concluded that among the three hybrids, hybrid Hanuman with 120 kg N ha$^{-1}$ is the best combination for obtaining higher yields and returns on sandy clay loam soils of Southern Telangana region of Andhra Pradesh.
A field experiment was conducted at S.V. Agricultural College Farm, Tirupati campus of Acharya N.G. Ranga Agricultural University, Andhra Pradesh, during rabi, 2010 to study the performance of pigeonpea genotypes under varied spacings in Southern Agro-climatic Zone of Andhra Pradesh.

The present experiment was laid-out in a randomized block design with factorial concept and replicated thrice. The treatments consisted of combination of four pigeonpea varieties viz., LRG-41, TRG-7, TRG-22 and ICPL-85063 and three spacings viz., 45 x 10 cm, 60 x 15 cm and 75 x 15 cm.

Plant height and dry matter production of pigeonpea was increased with increase in age of the crop up to maturity. Leaf area index (LAI) was increased up to 100 days after sowing and decreased at maturity.

Growth characters like plant height, LAI and dry matter production were higher with ICPL-85063. Plant height, dry matter production and LAI were higher at a spacing of 45 x 15 cm.

Number of pod bearing branches plant-1 and pods branch-1 was higher with ICPL-85063 followed by TRG-22, LRG-41 and TRG-7. Among the spacings, number of pod bearing branches plant-1 was higher with 75 x 15 cm, whereas number of pods branch-1 was higher with 45 x 15 cm spacing.

Interaction between varieties and spacings on number of pod bearing branches plant-1 and number of pods branch-1 revealed that more number of pods bearing branches plant-1 was recorded with ICPL-85063 at a spacing of 75 x 15 cm. More number of pods branch-1 was registered with ICPL-85063 at a spacing of 45 x 15 cm.

Pod length, number of seeds pod-1 and test weight were recorded higher with ICPL-85063. A spacing of 45 x 15 cm recorded maximum pod length, number of seeds pod-1 and test weight. Interaction between varieties and spacings on these characters revealed that maximum pod length, number of seeds pod-1 and test weight were with ICPL-85063 at a spacing of 45 x 15 cm.
Maximum seed yield (2060 kg ha\(^{-1}\)) and stalk yield (5789 kg ha\(^{-1}\)) was recorded with ICPL-85063, followed by TRG-22, LRG-41 and TRG-7. Among the spacings, maximum seed yield (1859 kg ha\(^{-1}\)) and stalk yield (5648 kg ha\(^{-1}\)) was recorded with 45x15 cm followed by 60 x 15 cm and 75 x 15 cm. Interaction between varieties and spacings on seed yield and stalk yield revealed that maximum seed yield (2411 kg ha\(^{-1}\)) and stalk yield (6456 kg ha\(^{-1}\)) was registered with ICPL-85063 at a spacing of 45 x 15 cm.

Harvest index was recorded higher with ICPL-85063. Harvest index did not vary significantly between spacings. Maximum gross returns (63,729 ` ha\(^{-1}\)), net returns (47,929 ` ha\(^{-1}\)) and B:C ratio were recorded with ICPL-85063 at a spacing of 45 x 15 cm and decreased with increase in spacing.

Maximum N, P and K uptake at harvest were recorded with ICPL-85063. Among the spacings, maximum N, P and K at harvest were with 45 x 15 cm. Results of this study revealed that pigeonpea variety ICPL-85063 at spacing of 45 x 15 cm can be profitably grown during rabi season on sandy loam soils in Southern Agro-climatic Zone of Andhra Pradesh.
A field experiment was conducted on sandy clay soils of the Agricultural College Farm, Bapatla, during rabi, 2008-09. The treatments consisted of three moisture conservation methods (L1-flat sowing, L2- broadbed-and-furrow (BBF) and L3- ridge-and-furrow (RF) systems) assigned to horizontal strips and four sprinkler irrigation systems (I0 - no irrigation, I1 - one sprinkler irrigation at branching, I2 - one Sprinkler irrigation at pod initiation and I3-two sprinkler irrigations each at branching and at pod initiation stages) as vertical strips arranged in a strip plot design and were replicated thrice.

The tallest plants and more number of branches per plant at 30 DAS were recorded with crop grown on broadbed-and-furrows system, over ridge-and- furrow and flat systems. Flat bed land configuration proved significantly inferior over other two land configurations in increasing growth parameters of chickpea. The maximum drymatter accumulated under broadbed-and-furrow system with two sprinkler irrigations was on a par with ridge-and-furrow system with one sprinkler irrigation.

Irrigation at branching and pod initiation stages (I3) resulted in higher plant height, drymatter and number of days to 50% flowering over one-time irrigation either at branching or pod initiation stages. However, the difference in drymatter production between one-time irrigation at branching and at pod initiation stages was not significant.

Chickpea sown on broadbed-and-furrow system recorded significantly higher number of pods per plant, test weight, seed yield and haulm yield over that of other two land configurations. However, the number of seeds per pod recorded with broadbed-and-furrow system was on a par with ridge-and-furrow system.

Application of two sprinkler irrigations each at branching and pod development stages resulted in significantly higher number of pods per plant, seeds per pod and ultimately yield over one-time irrigation at branching (I1) or at pod development (I2) and no irrigation (I0). Irrigation at branching (I1) found significantly superior to irrigation at pod development (I2) in increasing number of pods per plant, test weight and finally the seed and haulm yields. However, the number of
seeds per pod of chickpea recorded with one-time irrigation either at branching or at pod initiation stages was not significant.

The highest consumptive use of water recorded with broadbed-and-furrow system was on a par with that of ridge-and-furrow system. However, the water use efficiency recorded with BBF was significantly higher than that of the other two moisture conservation practices. Application of two irrigations resulted in significantly more consumptive use and moisture use rate than with one irrigation. A higher return per rupee invested was realized from BBF system with two irrigations (L2I3).

Overall, the results showed that sowing on broadbed-and-furrow system found suitable for higher productivity of chickpea over ridge-and-furrow and flat bed systems. Two sprinkler irrigations each at branching and at pod initiation stages were found optimum as evidenced by higher drymatter production and seed yield.
An experiment was carried out during Kharif 2010 at the Student’s Farm, College of Agriculture, Rajendranagar, Hyderabad on red sandy loam soils to study the effect of integrated nutrient management in *Pongamia* + castor agri-silvi system. The Farm is geographically situated at an altitude of 542.3 m above mean sea level at 17°19’N latitude and 78°28’E longitude and falls under the Southern Telangana Agro-climatic Zone of Andhra Pradesh. The experiment was laid out in a randomized block design with nine treatments namely T$_1$-Control, T$_2$-100% RDN –Inorganic, T$_3$-75% RDN-Inorganic + 25% RDN-FYM, T$_4$-75% RDN-Inorganic + 25% RDN-Neem cake, T$_5$-75% RDN-Inorganic + 12.5% RDN-FYM +12.5% RDN-Neem cake, T$_6$-75% RDN-Inorganic + 25% RDN-FYM + 12.5% RDN-Neem cake, T$_7$-50% RDN-Inorganic + 25% RDN-FYM, T$_8$-50% RDN-Inorganic + 25% RDN-Neem cake and T$_9$-50% RDN-Inorganic + 12.5% RDN-FYM +12.5% RDN-Neem cake and replicated thrice.

The morphological growth characters of castor such as plant height, dry matter production, leaf area and number of branches were maximum with the application of 75% RDN through urea + 12.5% RDN through FYM + 12.5% RDN through neem cake over the other treatments at all stages of the crop growth.

Yield and yield attributes were significantly influenced by the integrated nutrient management treatments. Spike length, number of capsules per spike and test weight of castor was significantly higher with 75% RDN through urea + 12.5% RDN through FYM + 12.5% RDN through neem cake over control and followed by 100% RDN through urea. Significantly higher number of spikes per plant was recorded in 75% RDN through urea + 12.5% RDN through FYM + 12.5% RDN through neem cake over 100% RDN through urea and control. Increase in the number of spikes per plant was attributed to use of FYM and neem cake. Among the treatments, significantly higher seed yield and stalk yield of castor was recorded in 75% RDN through urea + 12.5% RDN through FYM + 12.5% RDN through neem cake over all the other treatments and followed by 100% RDN through urea. Significantly higher harvest index was recorded in 75% RDN through urea + 12.5% RDN through FYM + 12.5% RDN through neem cake over control and land on par with all the other treatments. But significant influence of INM treatments was not observed on oil content. However, significantly higher oil yield was recorded with the application of 75% RDN through urea + 12.5% RDN through FYM + 12.5% RDN through neem cake over all the other treatments.

Effect of integrated nutrient management treatments on the tree parameters of *Pongamia* was found non significant.
Available N content was significantly higher in all the treatments than control. However, 75% inorganic + 25% organic sources showed higher levels of available N than 50% inorganic + 25% organic sources. The available N observed in 75% inorganic + 12.5% RDN through FYM + 12.5% through neem cake treatment was high. Whereas, slight increase in available P and K content was noticed after the harvest of the crop in all the treatments.

Significantly higher nitrogen uptake by the castor crop was recorded with 75% RDN-Inorganic + 12.5% through FYM +12.5% through neem cake over 100 % RDN-Inorganic. Maximum phosphorus and potassium uptake by the castor crop was recorded with 75% RDN-Inorganic + 12.5% through FYM +12.5% through neem cake and it was on par with all the INM treatments except with 75% RDN-Inorganic and control.

Significantly higher moisture content was recorded with 75% RDN through urea + 25% through FYM over 100% RDN through urea but on par with 50% RDN through urea + 25% through FYM at all the stages of crop growth. Total rainfall received during the crop growth period was 878.8 mm and the effective rainfall was 441.6 mm.

However, comparatively higher gross returns were recorded in 75% RDN through urea + 12.5% RDN through FYM + 12.5% RDN through neem cake over 100% RDN through urea but higher net returns and benefit cost ratio were recorded in 100% RDN through urea over the other treatments.
A field experiment was conducted during rabi, 2010 on clay loam soils of Agricultural College Farm, Bapatla. The experiment was laid out in a randomized block design with eight treatments comprising of T1-Handweeding twice at 20 and 40 DAS; T2-Pendimethalin @ 1.0 kg a.i. ha-1 as pre-emergence; T3-Propaquizafop @ a.i. ha-1 as post-emergence at 20 DAS; T4-Imazethapyr @ 75 g a.i. ha-1 as post-emergence at 20 DAS; T5-Pendimethalin @ 1.0 kg a.i. ha-1 as pre-emergence followed by hand weeding at 40 DAS; T6-Pendimethalin @ 1.0 kg a.i. ha-1 as pre-emergence followed by propaquizafop @ 75 g a.i. ha-1 as post-emergence at 20 DAS; T7-Pendimethalin @ 1.0 kg a.i. ha-1 as pre-emergence followed by imazethapyr @ 75 g a.i. ha-1 as post-emergence at 20 DAS and T8-Weedy check. The treatments were replicated three times.


Density of weeds was significantly reduced by all weed management practices over the weedy check. The minimum density was recorded with handweeding at 20 and 40 DAS (T1) which was on a par with application of pendimethalin followed by propaquizafop at 20 DAS (T6) and pendimethalin followed by imazethapyr at 20 DAS (T7). The lower dry weight of weeds and higher weed control efficiency was recorded with handweeding at 20 and 40 DAS (T1) which was on a par with T6, T7 treatments at 40 DAS and T6, T5 at 60 DAS. More than 50 per cent susceptibility of grasses and sedges was recorded with the treatments where post-emergence application of propaquizafop and imazethapyr involved, respectively. Minimum uptake of nutrients by weeds and lower weed index was recorded with handweeding at 20 and 40 DAS and it was on a par with application of pendimethalin followed by propaquizafop at 20 DAS (T6) and pendimethalin followed by imazethapyr at 20 DAS (T7).

Plant height, number of branches per plant was found to be significantly higher with handweeding twice and it was on par with application of pendimethalin followed by propaquizafop at 20 DAS. The dry matter accumulation and uptake of nutrients by the crop was higher with
handweeding at 20 and 40 DAS (T1) which was on a par with application of pendimethalin followed by propaquizafop at 20 DAS (T6) and pendimethalin followed by imazethapyr at 20 DAS (T7) treatments. Yield attributing characters and yield was significantly more with handweeding and it was on a par with application of pendimethalin followed by propaquizafop at 20 DAS (T6) and pendimethalin followed by imazethapyr at 20 DAS (T7) whereas, in weedy check an yield reduction of 37 per cent recorded.

Despite higher grain yield and net returns, returns per rupee of investment was low with handweeding due to higher labour wages. Therefore, pendimethalin followed by imazethapyr at 20 DAS (T7) and pendimethalin followed by propaquizafop at 20 DAS (T6) found to be more profitable than handweeding twice at 20 and 40 DAS.
Field experiments were conducted during two consecutive *rabi* seasons of 2008 and 2009 at Sri Venkateswara Agricultural College, Tirupati to develop certain agro-techniques for enhancing the productivity and quality of popcorn in Southern Agro climatic Zone of Andhra Pradesh. The experiment was laid out in split-split plot design, replicated thrice. It consisted of three planting patterns *viz.*, 60 x 20 cm (P1), 75 x 20 cm (P2) and 90 x 20 cm (P3) assigned to main plots and three nutrient levels *viz.*, 80-40-40 kg ha⁻¹ N, P₂O₅ and K₂O (N1), 100-50-50 kg ha⁻¹ N, P₂O₅ and K₂O (N2) and 120-60-60 kg ha⁻¹ N, P₂O₅ and K₂O (N3) assigned to sub plots and three times of nitrogen application *viz.*, ⅓rd basal + ⅓rd knee high stage + ⅓rd tasselling (T1), ¼th basal + ½ knee high stage + ¼th tasselling (T2) and ¼ th basal + ¼th knee high stage + ½ tasselling (T3) assigned to sub-sub plots. The test variety was Amber popcorn. The tallest plants with the largest LAI was produced with the planting pattern of 60 x 20 cm (P1), while the highest quantity of dry matter was produced with the planting pattern of 90 x 20 cm (P3). Increasing nutrient levels progressively enhanced all the growth parameters. The highest stature of growth parameters *viz.*, plant height, leaf area index and dry matter production were recorded with nutrient level 120-60-60 kg ha⁻¹ N, P₂O₅ and K₂O (N3). Application of nitrogen at ¼th basal + ½ knee high stage + ¼th tasselling (T2) produced the highest growth stature of popcorn. The highest stature of yield components *viz.*, number of cobs plant⁻¹, cob length, cob girth, number of kernel rows cob⁻¹, number of kernels cob⁻¹, kernel weight cob⁻¹ and hundred seed weight were recorded with the planting pattern of 90 x 20 cm (P3). Among the nutrient levels tried, the highest values of the above yield components were obtained with the nutrient level 120-60-60 kg ha⁻¹ N, P₂O₅ and K₂O (N3). Split application of nitrogen at ¼th basal + ½ knee high stage + ¼th tasselling (T2) recorded the increased stature of all yield parameters. With regard to interaction effect of planting patterns and nutrient levels, the combination of planting pattern of 90 x 20 cm along with the application of nutrient level 120-60-60 kg ha⁻¹ N, P₂O₅ and K₂O (P3N3) obtained the highest kernel weight cob⁻¹ and hundred seed weight.

The grain and stover yield were the highest with the planting pattern of 90 x 20 cm (P3). Increasing levels of nutrient supply from 80-40-40 kg ha⁻¹ N, P₂O₅ and K₂O (N1) to 120-60-60 kg ha⁻¹ N, P₂O₅ and K₂O (N3) progressively enhanced the grain and stover yield. Nitrogen application at ¼th basal + ½ knee high stage + ¼th tasselling (T2) produced the highest grain and stover yield. With regard to interaction effect of planting patterns and nutrient levels, the combinations of planting pattern of 90 x 20 cm along with the application of nutrient level 120-60-60 kg ha⁻¹ N, P₂O₅ and K₂O (P3N3) obtained the highest grain and stover yield. The perusal of data of all the
combinations of planting patterns, nutrient levels and time of nitrogen application (though the interaction effect was not significant) revealed that the highest grain and stover yield were recorded with the combination of planting pattern of 90 x 20 cm supplied with 120-60-60 kg ha-1 N, P₂O₅ and K₂O in three splits of nitrogen application at ¼th basal + ½ knee high stage + ¼th tasselling (P3N3T2).

The quality parameters of popcorn grain viz., protein, reducing sugars, non-reducing sugars and total sugars contents were the highest with the planting pattern of 90 x 20 cm (P3). All these quality parameters tended to increase progressively with increase in nutrient levels from 80-40-40 kg ha-1 N, P₂O₅ and K₂O (N1) to 120-60-60 kg ha-1 N, P₂O₅ and K₂O (N3). Application of nitrogen at ¼th basal + ½ knee high stage + ¼th tasselling (T2) recorded the highest values of reducing, non - reducing and total sugars, however there was no significant influence on protein content. With regard to interaction effect, planting pattern of 90 x 20 cm along with nutrient level 120-60-60 kg ha-1 N, P₂O₅ and K₂O (P3N3) recorded the highest reducing, non - reducing and total sugars.

The highest uptake of nitrogen, phosphorus and potassium was recorded with the planting pattern of 90 x 20 cm (P3). Among the nutrient levels tried, the highest uptake of nutrients was recorded with the nutrient level of 120-60-60 kg ha-1 N, P₂O₅ and K₂O (N3). Application of nitrogen at ¼th basal + ½ knee high stage + ¼th tasselling (T2) recorded the highest uptake of nitrogen, however there was no significant influence on phosphorus and potassium uptake.

The highest gross and net returns as well as benefit-cost ratio were realized with the planting pattern of 90 x 20 cm (P3). Increasing levels of nutrient supply progressively enhanced the economic parameters up to the highest level of nutrients tried i.e 120-60-60 kg ha-1 N, P₂O₅ and K₂O (N3). Nitrogen application at ¼th basal + ½ knee high stage + ¼th tasselling (T2) realized the highest economic returns. With regard to interaction effect of planting patterns and nutrient levels, planting pattern of 90 x 20 cm along with nutrient level of 120-60-60 kg ha-1 N, P₂O₅ and K₂O (P3N3) realized the highest gross and net returns as well as B-C ratio. The perusal of data of all the combinations of planting patterns, nutrient levels and time of nitrogen application (though the interaction effect was not significant) revealed that the highest gross and net returns as well as B-C ratio were realized with the combination of planting pattern of 90 x 20 cm along with nutrient level 120-60-60 kg ha-1 N, P₂O₅ and K₂O in three splits of nitrogen application at ¼th basal + ½ knee high stage + ¼th tasselling (P3N3T2).

Post harvest soil available nitrogen, phosphorus and potassium were the highest with the planting pattern of 60 x 20 cm (P1). Increasing levels of nutrient supply enhanced the post harvest soil nutrient status upto the highest level of nutrients tried i.e 120-60-60 kg ha-1 N, P₂O₅ and K₂O (N3).

In conclusion, the study revealed that the highest yield and economic returns were achieved with the planting pattern of 90 x 20 cm in combination with the application of 120-60-60 kg ha-1 N, P₂O₅ and K₂O along with the nitrogen application at ¼th basal + ½ knee high stage + ¼th tasselling. The above said package of agro-techniques was found to be the most efficient and economically viable, without any deterioration of soil fertility status.
The experiment was conducted during Kharif 2009 and 2010 at Agricultural Research Institute, Rajendranagar, Hyderabad to find out optimum sowing window by identifying critical weather parameters and optimum dose of nitrogen for higher productivity of hybrid maize and validation of CERES-Maize model. The soil of the experimental site was sandy loam in texture, neutral in reaction, low in available nitrogen, phosphorus and high in available potassium. The experiment was carried out with four dates of sowing 7 July (D1), 21 July (D2), 6 August (D3) and 22 August (D4) in 2009 and 18 June (D1), 02 July (D2), 17 July (D3) and 02 August (D4) in 2010 as main plots and five nitrogen levels (N0: 0 kg ha$^{-1}$ (control), N1: 100 kg ha$^{-1}$, N2: 200 kg ha$^{-1}$, N3: 300 kg ha$^{-1}$ and N4: 400 kg ha$^{-1}$) as sub-plots in split plot design replicated thrice.

In 2009, higher plant height, Leaf Area Index (LAI), dry matter production (DMP), yield attributes, grain and stover yield, and harvest index were observed in crop sown on 21 July (D2) and this was comparable with 7 July (D1) sown crop and significantly superior to 6 August (D3) and 22 August (D4) sown crops. On the other hand, in 2010, plant height, LAI, DMP, yield attributes, grain and stover yield, and harvest index of 18 June (D1) sown crop was on par with 2 July (D2) sown crop and significantly superior to crop sown on 17 July (D3) and 2 August (D4). However, 2 July (D2) sown crop was comparable with the crop that sown on 17 July (D3).

With graded levels of nitrogen, higher growth, yield, yield attributing characters and harvest index was noticed up to 400 kg N ha$^{-1}$ but the significant increase was observed only up to 200 kg N ha$^{-1}$. Significant positive correlation existed between growth parameters, yield attributes and yield of maize.

With respect to agrometeorological indices, the mean GDD accumulation varied from 1836 to 1796 in 2009 and 1876 to 1837 in 2010. from sowing to physiological maturity. PTU requirement ranged from 22778 to 21028 in 2009 and 23623 to 22018 in 2010 while HTU ranged from 9677 to 11630, and 7754 to 9007 in 2010 from sowing to physiological maturity.

Grain yield and DMP at physiological maturity had positive correlation with minimum temperature from emergence to silking stage. Stepwise regression analysis revealed that, minimum temperature alone from emergence to silking stage, accounted for 73% variation in total DMP at
physiological maturity and 67% variation in final grain yield of maize. Mean minimum temperature range of 22.8 to 23.2°C from emergence to silking (P6) was found to be optimum for higher grain yield at physiological maturity and higher DMP at silking and physiological maturity.

Early sown crop of 21 July (D2) and 7 July (D1) showed more N uptake in 2009. Whereas in 2010, 18 June (D1) and 2 July (D2) sown crop recorded highest N uptake and which was on par with 17 July (D3) sown crop. NUE and apparent N recovery was more with D1 and D2 sowings compare to D3 and D4 during both the years of study.

The crop sown on 21 July (D2) and 7 July (D1) in 2009 recorded highest net returns of Rs 28,737 and Rs 26,861 ha-1, respectively and B:C ratio of 1.96 and 1.89 respectively. Similarly in 2010, 18 June (D1) and 2 July (D2) sown crop recorded higher net returns of Rs. 27,078 ha-1 and Rs. 24,536 ha-1 respectively and B:C ratio of 1.90 and 1.81 respectively.

Highest total N uptake was observed upto 200 kg N ha-1 beyond that the uptake was not significant during both the years of study at silking and maturity stages. But increasing levels of nitrogen application caused reduction in agronomic efficiency and apparent nitrogen recovery. Even with increased levels of N beyond 200 kg ha-1, the recovery was only 100 kg ha-1.

Validation of CERES-Maize model confirmed that the model can be used as a research tool in the variable agro-environments of Andhra Pradesh to suggest suitable sowing window and optimum nitrogen level. Based on seasonal analysis the optimum sowing window for rainfed maize would be from 8 June to 29 June and optimum nitrogen would be 150 kg ha-1.
The present study was conducted at Students’ farm, College of Agriculture, Acharya N. G. Ranga Agricultural University, Rajendranagar, Hyderabad, during rabi seasons of 2007-08 and 2008-09. The experiment was laid out in split plot design with three replications. The treatments comprised of three irrigation levels at IW/CPE ratios of 0.75, 1.00 and 1.25 as main plots and combinations of four phosphorus levels (0, 40, 80 and 120 P2O5 kg ha\(^{-1}\)) and two boron levels (0 and 4 kg B ha\(^{-1}\)) as sub plots. Irrigations as per the treatment were scheduled according to the cumulative pan evaporation calculated based on evaporation data obtained from Class B meteorological observatory at Rajendranagar, Hyderabad. The recommended dose of nitrogen to Lucerne (30 kg N ha\(^{-1}\)) was applied in two splits at the time of sowing and 30 DAS. Phosphorus as per treatments and recommended potash (40 kg K2O ha\(^{-1}\)) were applied as basal. In case of boron treatment, 50% of the recommended B was applied as basal to soil and the remaining 50 % was applied as 0.1 % foliar spray at four stages i. e., at 35 DAS, 10 days after first cut, 10 days after second cut and at flower initiation stage. The total rainfall received during the experimental period was 252.5 mm in 12 rainy days during 2007-08 and 23 mm in 3 rainy days during 2008-09. The weekly mean maximum temperature ranged from 27.9 to 39.6 °C during 2007-08 and 26.9 to 41.4 °C during 2008-09, whereas the mean minimum temperature varied from 12.0 to 27.8 °C during 2007-08 and 12.0 to 26.7 °C during 2008-09.

The green fodder, dry fodder, crude protein and seed yields of Lucerne were highest when irrigations were scheduled at 1.25 IW/CPE ratio. Irrigation at this level brought about significant improvement in plant height and yield attributes viz., capsule number plant\(^{-1}\) and capsule weight plant\(^{-1}\) of Lucerne. The dry matter content and the uptake of N, P, K and B by Lucerne fodder and seed were also higher with irrigation at 1.25 IW/CPE ratio. Irrigation at 1.0 IW/CPE ratio was found comparable to 1.25 IW/CPE with respect to N and K uptake by Lucerne fodder and crude fiber content at all the cuts. On the other hand, number of leaves plant\(^{-1}\), leaf to stem ratio and crude protein content of Lucerne were highest with irrigation at 0.75 IW/CPE ratios.

The crop irrigated at 1.25 IW/CPE ratio received 19 and 22 irrigations in 2007-08 and 2008-09, respectively. Whereas, a total of 15 and 17 irrigations at 1.0 IW/CPE ratio and 11 and 13 irrigations at 0.75 IW/CPE ratio were given to the crop in first and second years, respectively. The water use efficiency of the crop and moisture extraction from lower layers was highest with irrigation at 0.75 IW/CPE ratio. Conversely, the consumptive use of water and moisture extraction from the upper layers was high with irrigations at 1.25 IW/CPE ratio.
Among the phosphorus levels, highest green fodder and seed yields with taller plants, more number of capsules plant\(^{-1}\) and highest capsule weight plant\(^{-1}\) were obtained when phosphorus was applied @ 80 kg P\(_2\)O\(_5\) ha\(^{-1}\). Phosphorus application at this level however was comparable to 120 kg P\(_2\)O\(_5\) ha\(^{-1}\) with respect to dry matter content, dry fodder yield, crude protein yield, nitrogen uptake and potassium uptake by fodder. On the other hand, highest level of phosphorus @ 120 kg P\(_2\)O\(_5\) ha\(^{-1}\) registered highest crude protein content, crude fiber content, phosphorus and boron uptake by fodder and seed and also soil nutrient status.

Application of boron @ 4 kg ha\(^{-1}\) has resulted in highest green fodder, dry fodder, crude protein and seed yields with highest plant height, leaf to stem ratio, capsule number plant\(^{-1}\), capsule weight plant\(^{-1}\), crude protein content, crude fiber content, nutrient uptake and soil nutrient status.

Irrigation scheduled at 1.25 IW/CPE ratio in combination with phosphorus @ 80 or 120 kg P\(_2\)O\(_5\) ha\(^{-1}\) registered taller plants with higher green fodder, dry fodder, crude protein and seed yields accounting to higher number of capsules plant\(^{-1}\) and capsule weight plant\(^{-1}\). The above combination also had favorably improved the uptake of nitrogen and potassium by fodder and seed at different cuts. Uptake of phosphorus by fodder and seed and uptake of boron by seed were highest when irrigation was given at 1.25 IW/CPE ratio with 120 kg P\(_2\)O\(_5\) ha\(^{-1}\). Contrary to this, application of phosphorus @ 80 and 120 kg P\(_2\)O\(_5\) ha\(^{-1}\) with irrigations at 0.75 IW/CPE ratio improved the leaf number and leaf to stem ratio. This combination also proved best with highest soil available nutrients.

Application of phosphorus @ 80 and 4 kg P\(_2\)O\(_5\) ha\(^{-1}\) improved the plant height and enhanced the green fodder yield, number of capsules plant\(^{-1}\), capsule weight plant\(^{-1}\) and hence seed yield. The above treatment was found at par to 120 kg P\(_2\)O\(_5\) ha\(^{-1}\) at the same level of boron and registered highest values of dry fodder yield, dry matter content, nitrogen and potassium uptake by fodder and seed. On the other hand, application of 120 kg P\(_2\)O\(_5\) ha\(^{-1}\) in combination with boron @ 4 kg ha\(^{-1}\) recorded highest crude protein content, phosphorus and boron uptake by fodder and seed and soil available nutrient status.

Fertilisation of Lucerne with boron @ 4 kg ha\(^{-1}\) with irrigation at 1.25 IW/CPE ratio recorded highest green fodder yield, dry fodder yield, seed yield with highest number of capsules plant\(^{-1}\), capsule weight plant\(^{-1}\) and dry matter content. Uptake of boron by fodder and uptake of boron and nitrogen by seed also were highest with this treatment. Conversely, application of boron with irrigation at 0.75 IW/CPE ratio registered higher leaf to stem ratios and crude protein contents at different cuts.

Irrigation at 1.25 IW/CPE ratio in combination with 80 and 4 kg phosphorus and boron, respectively was found best with highest plant height, dry matter content, number of capsules plant\(^{-1}\), capsule weight plant\(^{-1}\) and seed yield. On the other hand, soil available nitrogen was higher when irrigations were scheduled at 0.75 IW/CPE ratio with phosphorus and boron fertilization @ 120 and 4 kg ha\(^{-1}\). Irrespective of boron levels, crude protein content and soil available boron were highest with 0.75 IW/CPE ratio with phosphorus fertilisation @ 120 kg ha\(^{-1}\).

Irrigations scheduled at 0.75 IW/CPE ratio with no phosphorus and no boron application reported higher levels of nitrogen and potassium in the soil. The soil phosphorus on the other hand was maximum at 0.75 IW/CPE ratio + 120 kg P\(_2\)O\(_5\) ha\(^{-1}\) + 0 kg B ha\(^{-1}\). The net gain of boron was
favoured by irrigation at 1.25 IW/CPE ratio in association with boron @ 4 kg ha\(^{-1}\) even when no phosphorus was applied.

Scheduling irrigation at 1.25 IW/CPE ratio in combination with phosphorus and boron fertilization @ 80 and 4 kg ha\(^{-1}\) proved best with highest gross and net returns with a benefit cost ratio of 2.28 in 2007-08 and 2.43 in 2008-09 and was closely followed by 120 kg P\(_2\)O\(_5\) ha\(^{-1}\) at the same level of irrigation and boron with a benefit cost ratio of 2.21 in 2007-08 and 2.33 in 2008-09.
The field experiment was conducted in Alfisols at AICRP on Agroforestry, ANGRAU, Rajendranagar, Hyderabad during kharif season of 2008-09 and 2009-10. The experiment site of the plantation area (amla and terminalia) was characterized by semi arid climate with low organic carbon (0.28 to 0.57%), low available N (160 to 194 kg ha$^{-1}$), medium in available phosphorus (28 to 37 kg ha$^{-1}$) and available potassium (233 to 265 kg ha$^{-1}$).

The present investigation comprised of two agroforestry models i.e., aswagandha intercropped agri-horticultural system and andrographis intercropped agri-horticultural system. Two field experiments were laid out separately in split plot design with three replications in four year old amla and terminalia plantations. The treatments in aswagandha based agri-horticultural system consisted of three cropping situations as main plots viz., intercropping of aswagandha in amla, intercropping of aswagandha in terminalia and sole cropping of aswagandha while in andrographis based agri-horticultural system, the treatments included three cropping situations as main plots viz., intercropping in amla, intercropping in terminalia and sole cropping of andrographis. Commonly six nutrient management practices were imposed as sub plot treatments in both the agroforestry models studied. The sub plot treatments were viz., Control (no manuring), 20 kg N ha$^{-1}$ alone (through urea), Vermicompost @ 2 t ha$^{-1}$, FYM @ 5 t ha$^{-1}$, 20 kg N ha$^{-1}$ through urea + Vermicompost @ 2 t ha$^{-1}$ and 20 kg N ha$^{-1}$ through urea + FYM @ 5 t ha$^{-1}$.

The results indicated that among the different cropping situations studied in aswagandha based agri-horticultural system, growth parameters like plant height, dry matter production and leaf area per plant of aswagandha were markedly higher under sole cropping situation when compared to intercropping situation both in amla and terminalia. Days to physiological maturity of aswagandha was delayed by 9-10 days in intercropping situation in terminalia when compared to intercropping in amla. Root and seed yields (kg ha$^{-1}$) of aswagandha were the highest with sole cropping situation compared to either of the intercropping situations (328.9 and 303.5 kg ha$^{-1}$ increase in root yield in first and second year of sole crop over intercropping in terminalia). Aswagandha performed better to some extent as an intercrop in amla as compared to sole aswagandha. Withanolide content (%) was significantly more under sole cropping. PAR was more under sole cropping compared to intercropping situation. Similarly N, P and K uptake by aswagandha were more under sole cropping. Soil available N, P and K content after crop harvest
were more under terminalia intercropping situation followed by amla intercropping situation and with low status in sole cropping.

The results of the experiment on andrographis intercropped agri-horti system revealed that growth parameters of andrographis i.e., plant height, dry matter production and leaf area per plant were found maximum in sole cropping of andrographis followed by intercropping in amla and terminalia. Days to 50% flowering and physiological maturity were delayed by 3-4 days under intercropping situation over sole cropping. Herbage yield (kg ha\(^{-1}\)) of andrographis and andrographolide content (%) were the highest in sole cropping of andrographis compared to intercropping situations. The pattern of PAR, N, P and K uptake by andrographis as well as soil available N, P and K after crop harvest in andrographis showed the same trend as that of aswagandha.

Among different nutrient management practices studied, application of 20 kg N ha\(^{-1}\) through urea + Vermicompost @ 2 t ha\(^{-1}\) recorded maximum growth parameters like plant height, dry matter production and leaf area per plant in both the crops of aswagandha and andrographis over the rest of the treatments. But these parameters were the least in control followed by application of urea alone (inorganic) treatment. PAR values did not vary due to nutrient management practices. Root and seed yields (kg ha\(^{-1}\)) of aswagandha and herbage yield (5395.8 and 5192.6 kg ha\(^{-1}\) in first and second year) of andrographis were significantly more with INM practice i.e., M5. Uptake of N, P and K by crop and soil N, P and K status after crop harvest were also the highest under the treatment with 20 kg N ha\(^{-1}\) through urea + Vermicompost @ 2 t ha\(^{-1}\). Highest gross and net monetary returns were obtained with sole crops of both aswagandha and andrographis as compared to their respective intercropping in amla and terminalia plantations. INM treatment with vermicompost gave the maximum net monetary returns. The total gross and net monetary returns from the system (tree + crop) were the highest with andrographis intercropped in terminalia when compared to sole cropping of andrographis. In aswagandha also the same trend was observed. Intercropping of andrographis in terminalia with the application of 20 kg N ha\(^{-1}\) through urea + Vermicompost @ 2 t ha\(^{-1}\) gave maximum total gross monetary returns from the system (tree + crop). Profit per rupee investment also showed the same trend under the three cropping situations with the adoption of integrated nutrient management practices in both the agroforestry models. Land equivalent ratio (LER) / Income equivalent ratio (IER) values were also maximum under intercropping situation in terminalia as compared to amla intercropping.
A field experiment was conducted on clay loam soils of the Agricultural College Farm, Bapatla during the year 2010-11 under irrigated condition. The treatments consisted combination of three planting densities and four nitrogen levels arranged in a randomized block design with factorial concept and were replicated thrice.

Plant height of maize was not influenced significantly by different planting densities. The maximum plant height was attained when 240 kg N ha\(^{-1}\) was applied to the crop. However, no significant differences were observed among 240, 200 and 160 kg N ha\(^{-1}\) in increasing the plant height. Higher drymatter accumulation was observed with higher planting density of 133333 plants ha\(^{-1}\) significantly, than 66666 and 88888 plants ha\(^{-1}\). Application of 240 kg N ha\(^{-1}\) significantly enhanced the drymatter accumulation over 120, 160 and 200 kg N ha\(^{-1}\) at different stages of crop growth period. Lower planting density lessened the number of days to 50 per cent tasseling, silking and barrenness of maize over 88888 and 133333 plants ha\(^{-1}\). The number of days taken to 50 per cent tasseling and silking and barrenness was significantly lowered when the crop was fertilized with 240 kg N ha\(^{-1}\). Number of cobs per plant, number of grains per cob, test weight and shelling percentage of maize were significantly reduced with increase in planting density from 66666 to 133333 plants ha\(^{-1}\).

The yield parameters viz., cobs per plant, number of grains per cob, test weight and shelling percentage recorded were the highest when the crop was fertilized with 240 kg N ha\(^{-1}\). Application of 240 kg N ha\(^{-1}\) at lower planting density of 66666 plants ha\(^{-1}\) resulted in significantly more cob length and grain weight cob\(^{-1}\) over all other treatment combinations. The grain yield of maize recorded at lower plant density of 66666 plants ha\(^{-1}\) was significantly higher than 88888 plants ha\(^{-1}\). However, it was on a par with that obtained at 133333 plants ha\(^{-1}\). Stover yield produced by the planting density of 133333 plants ha\(^{-1}\) was significantly higher and resulted in lower harvest index than 88888 and 66666 plants ha\(^{-1}\). Nitrogen uptake by stover at planting density of 133333 plants ha\(^{-1}\) with 240 kg N ha\(^{-1}\) was significantly superior to all other treatment combinations. Whereas, in case of grain, significantly higher nitrogen uptake was recorded with lower plant population of 66666 plants ha\(^{-1}\) at 240 kg N ha\(^{-1}\). The highest net returns
and returns per rupee of investment were obtained with application of 240 kg N ha\(^{-1}\) at lower planting density (66666 plants ha\(^{-1}\)).

Overall, the results showed that sowing of maize at a planting density of 66666 plants ha\(^{-1}\) was found optimum with a linear response up to 240 kg N ha\(^{-1}\) during late rabi conditions that resulted in higher net returns and returns per rupee of investment.
A field experiment was conducted at agricultural college farm, Rajendranagar, Hyderabad, during kharif, 2010. The soil of the experimental field was sandy clay loam in texture with moderate drainage. The soil was low in available nitrogen (230 kg ha\(^{-1}\)), high in available phosphorus (28 kg ha\(^{-1}\)) and medium in available potassium (128 kg ha\(^{-1}\)) contents. The pH of the soil was 7.8. A medium slender grain type variety, MTU-1010 of 130-135 days duration was grown. The experiment was laid out in randomized block design with eleven weed control treatments \([T_1- (\text{Pyrzosulfuron} @ 25 \text{ g ha}^{-1}), T_2-(\text{Pretilachlor-S} @ 750 \text{ g ha}^{-1}), T_3-(\text{Cyhalofop-butyl} @ 90 \text{ g ha}^{-1}), T_4-(\text{Fenoxaprop butyl} @ 60 \text{ g ha}^{-1}), T_5-(\text{Cyhalofop-butyl}+(\text{Chlorimuron-ethyl}+\text{Metsulfuron-methyl}) @ 90+20 \text{ g ha}^{-1}), T_6-(\text{Fenoxaprop-p-ethyl}+(\text{Chlorimuron-ethyl}+\text{Metsulfuron-methyl}) @ 60+20 \text{ g ha}^{-1}), T_7-(\text{Bispyribac sodium} @ 25 \text{ g ha}^{-1}), T_8-(\text{Fenoxaprop-p-ethyl}+\text{Ethoxysulfuron} @ 60+15 \text{ g ha}^{-1}), T_9-(\text{Oxyfluorfen fb 2,4-D} @ 300 \text{ fb} 500\text{g ha}^{-1}), T_{10}-(\text{Two Hand weedings} \text{ at} 20 \text{ and } 40 \text{ DAS}), T_{11}-(\text{Weedy check})]\) with three replications.

The weed species associated with the experimental crop consisted of three groups of weeds like grasses, sedges and broad leaf weeds. Grasses \(\text{viz; Echinochloa colona, Echinochloa crusgalli, Cynodon dactylon, Digitaria sanguinalis, sedges \text{viz; Cyperus rotundus, Cyperus difformis} \text{ and broad leaf weeds \text{viz; Phyllanthus niruri, Physalis minima, Alternanthera sessilis, Commelina bengalensis, Digera arvensis, Celosia argentea, Parthenium hysterophorus, Cleome viscosa and Eclipta alba}. Among these, broad leaf weeds were dominant followed by sedges and grasses in dry seeded rainfed rice.}

The results indicated that the lowest weed density and minimum dry matter production of weeds and higher weed control efficiency (82.13\%) were recorded by \(T_5-(\text{Cyhalofop-butyl}+(\text{Chlorimuron-ethyl}+\text{Metsulfuron-methyl}) @ 90+20 \text{ g ha}^{-1})\) applied as early post emergence herbicide at 30 DAS. Significantly lower weed dry matter production was observed in farmers practice (i.e. two hand weeding at 20 and 40 DAS) treatmental plot as compared to other treatments.

As regards to the effect of treatments on rice crop, it was found that plant height, tillers per m\(^2\), dry matter production, panicles per m\(^2\) and filled grains per panicle were significantly higher with \(T_5-(\text{Cyhalofop-butyl}+(\text{Chlorimuron-ethyl}+\text{Metsulfuron-methyl}) @ 90+20 \text{ g ha}^{-1})\) in comparison to all treatments except \(T_{10}-(\text{Two Hand weedings} \text{ at} 20 \text{ and } 40 \text{ DAS})\). Significantly
lower tillers per m² were observed with T₁₁-Weedy check followed by T₄–(Fenoxaprop-p-ethyl @ 60 g ha⁻¹).

The higher grain yield was obtained with T₅–[Cyhalofop-butyl+ (Chlorimuron-ethyl+ Mestulfuron-methyl) @ 90+20 g ha⁻¹] and it was found at par with T₈–(Fenoxaprop-p-ethyl + Ethoxysulfuron @ 60+15 g ha⁻¹), T₆–[Fenoxaprop-p-ethyl + (Chlorimuron-ethyl+Metsulfuron-methyl) @ 60+20 g ha⁻¹], T₉–(Oxyfluorfen fb 2,4-D @ 300 fb 500g ha⁻¹), T₇–(Bispyribac sodium @ 25 g ha⁻¹) and also with farmers practice i.e. T₁₀–(Two Hand weedings at 20 and 40 DAS).

N, P and K uptake by grain at harvest was significantly more in T₁₀–(Two Hand weedings at 20 and 40 DAS) followed by T₅–[Cyhalofop-butyl+ (Chlorimuron-ethyl+ Mestulfuron-methyl) @ 90+20 g ha⁻¹]. Both T₁₀ and T₅ were significantly superior to other weed control treatments. The highest gross (Rs.41256), net returns (Rs.24369) and BCR (2.44) were recorded by T₅–[Cyhalofop-butyl+ (Chlorimuron-ethyl+Metsulfuron-methyl) @ 90+20 g ha⁻¹].

The results suggest for adoption of chemical weed control preferably with early post emergence like Cyhalofop-butyl+ (Chlorimuron-ethyl+Metsulfuron-methyl) @ 90+20 g ha⁻¹ at 30 DAS of dry seeded rainfed rice whenever labour shortage arises and not possible for hand weeding due to other reasons.
The investigation was executed in Mahaboobnagar district of Andhra Pradesh to estimate the area under major crops using remote sensing data, assess the yield of rice and to evaluate the overall performance of the irrigated command area during kharif 2009 and 2010. One representative distributary was selected at head, middle and tail reaches under each right and left main canal.

Crop area was monitored using two years remotely sensed data of IRS P6 LISS III sensor (2nd Nov and 14th Oct 2009) for kharif 2009 and AWiFs sensor (9th and 28th Oct 2010) for kharif 2010. The results of the supervised MXL classification showed that rice crop occupied 33 per cent of the gross command area (GCA) (70,955.7 ha) and very little area (4938 ha) was occupied by orchards and groundnut was grown in an area of 3217 ha in rabi season. The total irrigated cropped area in right and left main canal of Jurala command was 12,290 and 19,263 ha during the kharif 2009 and 12,138 and 21,463 ha during kharif 2010. Out of the total irrigated area, rice occupied 23403.6 ha, of which 37.2 and 62.8 per cent was under right and left canal, respectively. The rice irrigation intensity under right main canal remained same during both the years (61.0 and 61.6 %) where under left main canal, there was an increase in the intensity from 45 to 55 per cent.

The average measured yields from crop cut experiments (CCE) was 6.28 and 5.21 t ha-1 under PJP right main canal (28 plots) and 5.79 and 5.34 t ha-1 under PJP left main canal (36 plots) during kharif 2009 and 2010. Among the distributories, the yield variations ranged from 4.66 to 8.04 t ha-1 and 1.65 to 7.97 t ha-1 in the right main canal and from 4.40 to 7.40 t ha-1 and 3.31 to 7.50 t ha-1 in the left main canal during kharif 2009 and 2010, respectively. Satellite derived yields of the command area using yield model showed that average yields of the right main canal (2.52 and 2.16 t ha-1) were more than left canal (2.37 and 2.11 t ha-1) during kharif 2009 than in 2010. Root Mean Squared Error (RMSE) values computed for all the measured and predicted yields were 0.50 and 0.48 during kharif 2009 and 2010 explaining higher accuracy of the yield mode.

The rice responded well to the application of higher doses of N by the farmers during kharif 2009 and the relationship was positive with a R2 value of 0.703 explaining 84 per cent correlation between them. In the PJP right main canal, application of N @ 175 kg ha-1 gave higher rice grain yield (6285 kg ha-1) during kharif 2009, while lower yields (5212 kg ha-1) were obtained during kharif 2010. In PJP left main canal, application of 155 kg N ha-1 gave lower grain yield (5589 kg
ha-l) during *kharif* 2009, while higher yields (5336 kg ha-l) were obtained during *kharif* 2010. The monthly overall consumption rate (OCR) values computed were less than the set target value of 0.56 in command area. Temporal variability in supply demand ratio from July to November during 2009 and 2010 for PJP right and left main canal showed that the irrigation supply was more than demand and it was high (13.14 % for RMC and 4.12 % for LMC) during September month. The Water Utilization Index (WUI) computed using the equivalent wet area showed that during both the years it was less than the target value (141 ha Mm-3) and it was low for left canal (55.7 and 82.0 ha Mm-3) as compared to the right canal (69.6 and 90.8 ha Mm-3) during *kharif* 2009 and 2010. The average project water productivity was 0.154 and 0.185 kg m-3 of water for PJP right and left main canal and in general it was more during *kharif* 2009 than that of 2010.
A field experiment was conducted at Agricultural College Farm, Bapatla on a sandy clay loam soil during kharif season of 2010-11. The experiment consisted of two varieties V1: BPT 5204 (Samba Mahsuri), V2: NLR 33892 (Pardhiva) and seven treatments viz., Recommended NPK only (T1), T1 + 5 t ha⁻¹ FYM (T2), T1 + 50 kg ZnSO₄ ha⁻¹ as soil application (T3), T1 + 2% urea spray at flowering stage (T4), T1 + 0.5% ZnSO₄ spray at flowering stage (T5), T1 + 2% urea + 0.5% ZnSO₄ spray at flowering stage (T6), T1 + 2% ZnSO₄ enrichment of third split application of nitrogen (T7). The experiment was laid out in a Randomized Block Design with Factorial Concept with three replications.

The findings of the experiment revealed that the growth parameters such as plant height, number of tillers m⁻², drymatter production and chlorophyll content (SPAD reading) measured at different intervals were significantly influenced by varieties and treatments. However, interaction between varieties and treatments was non significant.

Significantly taller plants were produced with NLR 33892 variety and higher drymatter accumulation, whereas, more number of tillers were with BPT 5204. There was a significant improvement in all the growth parameters viz., plant height, number of tillers m⁻², drymatter production and chlorophyll content with soil application of 50 kg ZnSO₄ ha⁻¹, which was however, comparable with combined application of 2% urea and 0.5% ZnSO₄ spray at flowering stage.

The highest number of total (238) and filled grains panicle⁻¹ (224), test weight (18.2 g), grain yield (5052 kg ha⁻¹), harvest index (47.1), nitrogen (108.8 kg ha⁻¹) and zinc uptake (1027.1 g ha⁻¹) were observed with NLR 33892, whereas, the maximum productive tillers m⁻² (337), straw yield (6261 kg ha⁻¹) was with BPT 5204. Significant increase in yield attributing characters, grain and straw yields (5859 kg ha⁻¹ and 6406 kg ha⁻¹), harvest index (47.8), nitrogen and zinc uptake (118.5 kg ha⁻¹ and 1106.8 g ha⁻¹) were with soil application of 50 kg ZnSO₄ ha⁻¹, which was however, comparable with combined application of 2% urea and 0.5% ZnSO₄ spray at flowering stage. Significantly better quality parameters of rice grain such as protein, amylose contents, milling per cent, hulling per cent, head rice recovery, volume expansion ratio were noticed with the variety BPT 5204 and combined application of 2% urea and 0.5% ZnSO₄ spray at flowering stage, which was however, comparable with soil application of 50 kg ZnSO₄ ha⁻¹. However, interaction between
varieties and treatments was non significant. The highest gross returns, net returns and returns per rupee investment were registered with NLR 33892. Among different treatments, the highest gross and net returns (Rs. 56127 ha⁻¹) were obtained with the soil application of 50 kg ZnSO₄ ha⁻¹. Whereas, the returns per rupee investment was the maximum with conjunctive use of 2% urea and 0.5% ZnSO₄ spray at flowering stage.

From the present investigation, it can be concluded that under sandy clay loam soils of Bapatla, NLR 33892 performed better in giving the maximum yield, net returns and returns per rupee investment. Soil application of 50 kg ZnSO₄ ha⁻¹ and combined application of 2% urea and 0.5% ZnSO₄ spray at flowering stage were found to be better, which resulted in higher productivity, better economic returns and improved quality characteristics of rice. Quality characteristics of BPT 5204 manifested supremacy over NLR 33892.
A field experiment was conducted during *rabi*, 2010-11 on sandy clay loam soils of S.V. Agricultural College Dryland Farm, Tirupati Campus, Acharya N.G. Ranga Agricultural University, Andhra Pradesh to study the “Response of sweet corn to different sources of organic manures”. The experiment was laid out in a randomized block design, replicated thrice. The treatments consisted of T1 Recommended dose of nitrogen (120 kg ha$^{-1}$ through urea-F N100), T2-100 per cent N through farm yard manure (FYM N100), T3-100 per cent N through sheep manure (SM N100), T4-100 per cent N through poultry manure (PM N100), T5-100 per cent N through green manuring through *Glyricidia maculata* (GM N100), T6-100 per cent N through vermicompost (VC N100), T7-75 per cent N through FYM + 25 per cent N through *panchagavya* foliar spray (FYM N75 + PG N25), T8-75 per cent N through sheep manure + 25 per cent N through *panchagavya* foliar spray (SM N75 + PG N25), T9-75 per cent N through poultry manure + 25 per cent N through *panchagavya* foliar spray (PM N75 + PG N25), T10-75 per cent N through green manuring + 25 per cent N through *panchagavya* foliar spray (GM N75 + PG N25) and T11-75 per cent N through vermicompost + 25 per cent N through *panchagavya* foliar spray (VC N75 + PG N25).

Among the different manurial practices, recommended dose of nitrogen (T1 -F N100) registered the tallest plants, largest leaf area index and maximum dry matter production. This was on par with T9 (PM N75 + PG N25). This was in turn on par with the T8 (SM N75 + PG N25), while the shortest plants, lowest leaf area index and dry matter production were recorded with the application of the green manuring (T5-GM N100), which was however, on par with 100 per cent N through vermicompost (T6-VC N100).

The recommended dose of nitrogen (T1) resulted in increase in values for yield attributes which was followed by T9 (PM N75 + PG N25). The shortest cobs, smallest girth and the lowest cob weight were noticed with the application of the green manuring (T5- GM N100).

The highest green cob yield of 3930 kg ha$^{-1}$ and green fodder yield of 15951 kg ha$^{-1}$ were recorded with the application of 100 per cent recommended dose of nitrogen (T1-F N100). This was followed by T9 (PM N75 + PG N25) which was on par with T8 (SM N75 + PG N 25). The green cob and green fodder yield noticed with T2 (FYM N100) was on par with T6 (VC N100). The lowest green cob and green fodder yields of 1769 kg ha$^{-1}$ and 8795 kg ha$^{-1}$ were recorded with T5 (GM N100).
Different manurial practices significantly influenced the quality characters with regard to protein, carbohydrates, reducing sugars, non-reducing sugars, total sugars, iron and zinc. The recommended dose of nitrogen (T1) resulted in the best quality characters. This was followed by T9 (PM N75 + PG N25) and T8 (SM N75 + PG N25). The lower quality parameters of sweet corn kernels was registered with T5 (GM N100).

The highest post harvest soil available nitrogen was recorded with T5 (GM N100) and this was on par with T6 (VC N100). The post harvest soil available nitrogen was lowest in T9 (PM N75 + PG N25). The highest soil available phosphorus content was observed in T4 (PM N100), followed by T5 (GM N100). The lowest soil available phosphorus was registered with T1 (F N100). The highest potassium content was recorded with T6 (VC N100) and the lowest potassium content was noticed with T8 (SM N 5 + PG N25).

The highest gross and net returns of `.63735 ha^{-1} and `.58950 ha^{-1} were obtained respectively with the application of the recommended dose nitrogen (T1-F N100) and this was followed by T9 (PM N75 + PG N25). The lowest gross and net returns were observed with T5 (GM N100). Among the different organic manurial practices, the highest B: C ratio was registered with T1 (F N100), which was significantly superior to rest of the treatments and was followed by T4 (PM N100). The lowest B: C ratio was recorded with T10 (GM N75 + PG N25).

In conclusion, the results revealed that highest yield of sweet corn (3930 kg ha^{-1}) with better quality and net returns (`.58950 ha^{-1}) could be produced with 100 per cent recommended dose of nitrogen. However, application of poultry manure along with panthagavya was found to be next best alternative manurial practice for obtaining better yield and net returns.
An experiment was carried out during kharif and rabi 2010-2011 at the Student’s Farm, College of Agriculture, Rajendranagar, Hyderabad on red sandy loam soils to study the best establishment technique of stylo in guava based horti-pastoral system. The Farm was geographically situated at an altitude of 542.3 m above mean sea level at 17° 19’ N latitude and 78° 28’ E longitude and falls under the Southern Telangana Agro-climatic Zone of Andhra Pradesh. The experiment laid out in a randomized block design with three replications and the treatment consists of three different scarification treatments viz., overnight soaked seeds, mudball technique seeds and hot water treated seeds (80-85°C for 3-5 min), soil amendment like Trichoderma enriched FYM @ 5 tonnes ha⁻¹ and Rhizobium application @ 1 kg per 5 kg seed along with normal dry seed for sole application and their combination consisting of 12 treatments.

The morphological growth characters such as plant height, dry matter production and leaf to stem ratio were increased with the application Trichoderma enriched FYM on hot water treated seeds which were sown in solid rows. Among the various treatments line sowing of hot water treated with Trichoderma enriched FYM as inter crop with guava (T₁₁) has significantly recorded highest plant height, dry matter production and leaf to stem ratio.

Yield and yield attributes were influenced by the various treatments and line sowing of hot water treated with Trichoderma enriched FYM as inter crop with guava (T₁₁) recorded significantly highest green forage yield, dry forage yield, crude protein per cent crude protein and crude fibre yield than the other treatments and the treatments and broadcasting of seeds with mudball technique without Trichoderma and Rhizobium (T₉) has recorded lowest green, dry forage yield, crude protein per cent, crude protein yield and crude fibre yield compared to all other treatments.

The crude fibre percentage is influenced by various applied treatments and broadcasting of seeds with mudball technique without Trichoderma and Rhizobium (T₉) recorded significantly higher per cent compared with other treatments. The lowest crude fibre percent obtained by the treatment line sowing of hot water treated with Trichoderma enriched FYM as inter crop with guava (T₁₁).
Nutrient uptake (N, P and K) in both cuts and total uptake was varied with different treatments imposed on stylo. Higher nutrient uptake was observed in line sowing of hot water treated seeds with *Trichoderma* enriched FYM as inter crop with guava (T11).

The guava fruit and curry leaf yield varies with tree to tree as it was thirteen year established orchard the size of trees also varies. The highest guava fruit yield (3754 kg ha\(^{-1}\)) and curry leaf yield (345 kg ha\(^{-1}\)) obtained by guava + curry leaf treatment (T3).

The gross returns (38317 Rs ha\(^{-1}\)) with line sowing of hot water treated seeds with *Trichoderma* enriched FYM as inter crop with guava (T11) was maximum, but the net returns (27316 Rs ha\(^{-1}\)) and benefit : cost ratio (3.5) was high in sole tree component that was guava + curry leaf (T3).

Post harvest soil nutrient studies revealed that the available N, P and K in the soil have been increased after crop harvest in all treatments. The increase in the nutrient status was varies with the different treatments imposed.
Field experiments were conducted for two years (2007-08 and 2008-09) on zero till maize in rice-maize cropping system on sandy clay loam soil with medium organic carbon content, low available nitrogen; and medium phosphorus and potassium status. The experiment (I) on - Irrigation and nitrogen requirement of maize was laid out in split plot design with three irrigation levels in main plots (I1- Two irrigations at knee high and silking stages; I2- Three irrigations at knee high, pre-tasseling and silking stages and I3- Four irrigations at knee high, pre-tasseling, silking and grain filling stages) and five nitrogen levels in sub plots (N1: No nitrogen, N2: 50% Recommended dose of nitrogen (RDN), N3: 100% RDN-120 kg N ha\(^{-1}\), N4: 150% RDN and N5: 200% RDN) ; and the experiment (II) on - Phosphorus rates and its time of application to maize were conducted during dry season following rice in randomized block design (factorial concept) with three phosphorus levels (50% Recommended dose of phosphorus (RDP), 75% RDP and 100% RDP -60 kg P\(_2\)O\(_5\) ha\(^{-1}\)) and three phosphorus application times (at 10 days before harvest of rice, at the time of sowing of maize and at the time of first irrigation to maize), while the experiment-III on - Phosphorus management in rice-maize system was conducted during both the seasons in randomized block design (factorial concept) with fifteen P fertilizer treatment combinations applied to rice (5 levels) followed by maize (3 levels), respectively in rice-maize sequence (P\(_0\)-30, P\(_0\)-45, P\(_0\)-60, P\(_10\)-30, P\(_10\)-45, P\(_10\)-60, P\(_20\)-30, P\(_20\)-45, P\(_20\)-60, P\(_30\)-30, P\(_30\)-45, P\(_30\)-60, P\(_40\)-30, P\(_40\)-45 and P\(_40\)-60; the treatment abbreviations used include ‘P’ applied to rice followed by ‘P’ applied to maize both in kg P\(_2\)O\(_5\) ha\(^{-1}\)). Each experiment was replicated three times and conducted at College Farm, College of Agriculture, Rajendranagar, ANGRAU, Hyderabad with a major objective to develop a comprehensive agronomic package on N, P and irrigation requirement of zero till maize following wet season rice.

The results of the experiment (I) on “Irrigation and nitrogen requirement of zero till maize” indicated that among the irrigation schedules, providing four irrigations to crop resulted in better growth in terms of plant height, leaf number plant\(^{-1}\), LAI and dry matter production over providing 3 and 2 irrigations during second year. However, the former two treatments did not differ at silking stage in both the years and at maturity in first year. Four irrigations treatment also resulted in better
yield components in maize over lower irrigations (3 and 2 irrigations) in the second year. During first year yield components in maize did not vary between four and three irrigations given to crop. Providing 4 irrigations to zero till maize resulted in significantly higher grain yield (4704 and 5067 kg ha$^{-1}$) over providing three (4429 and 4043 kg ha$^{-1}$) and two (3816 and 1875 kg ha$^{-1}$) irrigations respectively in first and second years. However, the former two irrigation treatments were found at par in the first year. Stover yield, harvest index and nutrient uptake also followed same trend. The post harvest soil available N, P and K status was lower when four irrigations were given to crop compared to providing 3 and 2 irrigations. The actual water use by crop with four irrigations was higher (405 and 310 mm) with greater WUE values of 11.58 and 16.24 kg ha$^{-1}$ mm$^{-1}$ over providing 3 and 2 irrigations, except in first year where in former two were found at par. Significantly higher gross returns (Rs.38956 and 45425 ha$^{-1}$), net returns (Rs.22469 and 28830 ha$^{-1}$) and benefit : cost ratio (1.34 and 1.73) were recorded by 4 irrigations over providing 3 and 2 irrigations, respectively during two years; however it was found at par with 3 irrigations during first year.

Among nitrogen levels, application of 200% RDN (240 kg N ha$^{-1}$) and 150% RDN being at par recorded taller plants, greater number of leaves plant$^{-1}$ and higher dry matter production at all the stages of the crop growth and superior LAI at silking stage and better yield components over lower N levels. Similarly, the grain yield (5314 and 4254 kg ha$^{-1}$) and stover yield (7164 and 6383 kg ha$^{-1}$) at 200% RDN was comparable to that of 150% RDN (5098 and 4115 kg ha$^{-1}$) grain yield and 6954 and 6258 kg ha$^{-1}$ stover yield) and both were found superior to lower N levels during two years of study. The N, P and K uptake also followed same trend. Lower post harvest soil P and K status and higher soil N status was observed at higher N levels (200 and 150% RDN) compared to lower N levels. Application of 200% RDN resulted in significantly higher actual crop water use (407 and 280 mm) and WUE (13.04 and 14.64 kg ha$^{-1}$ mm$^{-1}$), gross returns (Rs.43955 and 38289 ha$^{-1}$), net returns (Rs.26562and 21105 ha$^{-1}$) with higher benefit-cost ratio (1.52 and 1.20) over lower N levels, except 150% RDN which recorded identical values of actual crop water use (403 and 278 mm), WUE (12.63 and 14.30 kg ha$^{-1}$ mm$^{-1}$), gross returns (Rs.42199 and 37070 ha$^{-1}$), net returns (Rs.25458 and 20538 ha$^{-1}$) with higher benefit-cost ratio (1.52 and 1.21) in both years, respectively.

The results of experiment (II) on “Levels and time of application of phosphorus to maize” revealed that application of recommended dose of phosphorus (RDP) i.e., 60 kg P$_2$O$_5$ ha$^{-1}$ recorded superior growth parameters at all the stages of crop growth and LAI at silking stage over that of 75% RDP and 50% RDP. It also produced significantly higher yield components which ultimately resulted in higher grain (5283 and 5034 kg ha$^{-1}$) and stover (7316 and 6827 kg ha$^{-1}$) yields during 2007-08 and 2008-09, respectively over lower P rates. The nutrient uptake (NPK) at silking and at crop harvest by grain, stover and total uptake was also followed same trend. Application of 100% RDP left behind the soil with lower amount of available N and K and higher P status after harvest of crop. The 100% RDP treatment gave significantly higher gross returns (Rs.43771 and 45012 ha$^{-1}$), net returns (Rs.27124 and 28533 ha$^{-1}$) and BCR (1.63 and 1.73) values over lower P levels.

Application of phosphorus at 10 days before harvest of rice and at the time of sowing of maize being on par resulted in better growth parameters and yield components over its delayed
application at the time of first irrigation. The former two treatments respectively recorded a grain yield of 5020 and 4849 kg ha\(^{-1}\) in first year and 4810 and 4741 kg ha\(^{-1}\) in second year when compared to delayed application. The stover yield, nutrient uptake (NPK) at silking stage and at crop harvest also followed same trend. The application of P at 10 days before harvest of rice or at the time of sowing of maize depleted greater amount of available P than its application along with first irrigation. These treatments gave significantly higher gross returns, net returns and BCR values over that of delayed P application at the time of first irrigation.

The experiment (III) on “Phosphorus management in rice-maize sequence” showed that application of 50% RDP to rice, being on par with 75 and 100% RDP (40 kg P\(_2\)O\(_5\) ha\(^{-1}\)) treatments, produced superior yield attributes of rice (number of panicles m\(^{-2}\), panicle length, number of filled spikelets panicle\(^{-1}\), test weight), grain yield (5240 and 5008 kg ha\(^{-1}\)) and higher N uptake over no phosphorus and 25% RDP. The P uptake was increased significantly upto 100% RDP, while K uptake upto 75% RDP. The values of post harvest soil available N and K were lower with 50,75 and 100% RDP compared to lower levels, where as soil P status was greater with 100% RDP when compared to lower P levels.

The residual effect of P levels applied to maize @100% RDP (60 kg P\(_2\)O\(_5\) ha\(^{-1}\)) in the previous year in rice-maize sequence significantly improved the yield attributes of second year rice over lower levels. It produced 5034 and 5795 kg ha\(^{-1}\) of grain and straw yields, respectively. Similarly, its application resulted in significantly higher uptake of N, P and K of rice and lower soil N and K status during second year over 75 and 50% RDP. In contrast, post harvest soil available phosphorus status was higher at higher P levels. In terms of absolute residual effect on second year rice, the P\(_{0.60}\) treatment gave higher rice grain yield (4833 kg ha\(^{-1}\)) compared to P\(_{0.45}\) (4566 kg ha\(^{-1}\)) and P\(_{0.30}\) (4246 kg ha\(^{-1}\)).

The interaction effect of P levels applied to rice and maize in the system indicated that P\(_{20-60}\) treatment produced significantly higher yield attributes; and grain (5155 kg ha\(^{-1}\)) and straw yield (5955 kg ha\(^{-1}\)) of rice during second year over P\(_{10-30}\), P\(_{10-45}\), P\(_{0-30}\), P\(_{0-45}\) and P\(_{0-60}\) treatment combinations. The P\(_{40-60}\) treatment showed higher uptake of P and left behind soil with lower soil P status over rest of the treatment combinations, except P\(_{30-60}\). These treatments also showed higher uptake of N and K by rice and more depletion of these nutrients in soil.

The performance of maize in the system due to P levels revealed that application of 100% RDP (60 kg P\(_2\)O\(_5\) ha\(^{-1}\)) to maize recorded significantly taller plants, greater leaf number plant\(^{-1}\) and dry matter production at all the stages of crop growth and LAI at silking stage over application of 75 and 50% RDP. The yield components were also better at 100% RDP which resulted in higher grain (5144 and 5198 kg ha\(^{-1}\)) and stover (7324 and 7234) yield of maize over lower P levels, confirming the results of experiment (II). The nutrient (N, P and K) uptake at silking stage and at harvest by grain and stover as well as total uptake was also followed same trend. It showed lower soil available status of N and K and higher status of P at the end of the dry season over 75 and 50% RDP.
The effect of 100% RDP (40 kg P$_2$O$_5$ ha$^{-1}$) and/or 75% RDP applied to rice during wet season had a greater positive influence on the growth parameters of dry season maize and yield components over lower phosphorus levels. The grain yield (5097 and 5094 kg ha$^{-1}$ at 100% RDP; 4937 and 5032 kg ha$^{-1}$ at 75% RDP) and nutrient uptake with these treatments was greater over 50% RDP with lower N and K status and higher P status.

The effect of levels of P applied to rice and maize in the system indicated that application of 100% RDP to both the crops (P$_{40-60}$) and 75% RDP to rice and 100% RDP to maize (P$_{30-60}$) had a positive effect on maize and produced significantly greater growth parameters and yield components over other phosphorus management strategies. The P$_{40-60}$ and P$_{30-60}$ treatments, respectively produced higher grain yield (5339 and 5213 kg ha$^{-1}$ in first year; 5398 and 5272 kg ha$^{-1}$ in second year) and stover yield (7565 and 7328 kg ha$^{-1}$ in first year; 7512 and 7285 kg ha$^{-1}$ in second year) of maize. The uptake of N, P and K at silking stage and N and K uptake at harvest also followed same trend. The P uptake at crop harvest was significantly higher with P$_{40-60}$ over rest of the treatment combinations. The P$_{40-60}$ treatment left behind the soil with lower quantity of available N and K and higher status of P over other treatment combinations, except P$_{30-60}$ treatment combination.

The balance sheet of available P in soil at the end of fourth season revealed that input-output balance was positive with P$_{40-60}$ (6.67 kg ha$^{-1}$) and P$_{30-60}$ (1.07 kg P ha$^{-1}$) treatments. The initial fertility could be maintained by the application of 75% RDP and/or 100% RDP to rice and 100% RDP to maize in rice-zero till maize cropping system.

In terms of system productivity (maize grain equivalent yield kg ha$^{-1}$ annum$^{-1}$) of rice–maize cropping system, the P$_{40-60}$ (11161 and 10614) and P$_{30-60}$ (10945 and 10460) treatments were found better than other P management strategies. The economic analysis also showed higher gross returns (Rs.92959 and 95738 ha$^{-1}$), net returns (Rs.57588 and 60435 ha$^{-1}$) and BCR values (1.63 and 1.71) in both years with P$_{40-60}$ treatment over other treatment combinations. The next best treatment P$_{30-60}$ also fetched comparable gross returns (Rs.91157 and 94331 ha$^{-1}$), net returns (Rs.56011 and 59253 ha$^{-1}$) and BCR (1.59 and 1.69) values respectively in two years of study.
A field experiment was conducted on a sandy clay loam soil at Agriculture Research Institute during kharif season, 2010–11 and the treatments consisted of four dates of transplanting viz., D₁ (July 23), D₂ (August 5), D₃ (August 20) and D₄ (September 5) and four varieties viz., V₁ (MTU 1010), V₂ (RNR 2354), V₃ (RNR 2458) and V₄ (JGL 384) summing up to 16 treatment combinations laid out in Randomized Block Design (Factorial concept) with three replications. The weekly mean meteorological data during the crop growth period (23-07-2010 to 20-12-2010) was used to characterize the crop – weather relationship. The experimental soil had a soil pH of 7.8 and S₁ salinity class. The soil was low in nitrogen and medium in phosphorus and potassium. The crop was planted as per the date of transplanting treatments.

Transplanting of rice crop in the 3rd week of July (D₁ = July 23) registered significantly higher grain yield owing to improved performance of growth and yield components under this treatment. On the other hand delayed transplanting on August 5 (D₂), August 20 (D₃) and September 5 (D₄) had a detrimental effect on growth and yield attributes owing to unfavourable weather conditions and markedly reduced the grain yield of rice. Regression of grain yield on date of transplanting expressed as day of the year revealed a significant correlation with regressions accounting for (R²) 99%, 96%, 99% and 96% in MTU 1010, RNR 2354, RNR 2458 and JGL 384, respectively. Variety MTU 1010 (V₁) produced significantly higher grain yield over RNR 2354 (V₂), RNR 2458 (V₃) and JGL 384 (V₄) owing to improved growth and yield traits. Interaction effect between dates of transplanting and varieties was not significant on grain yield.

Grain yield was found to be significantly and positively correlated to growth and yield components with regressions accounting for 0.582** to 0.99** variability in grain yield. Similarly correlation studies between growth and yield traits and yield showed positive association between themselves except for spikelet sterility %.

Agro-meteorological indices indicated that number of calendar days, accumulated growing degree days (AGDD), heliothermal units (HTU), heat use efficiency (HUE) and heliothermal unit use efficiency (HTUE) were markedly affected by both dates of sowing and varieties. Regression of
calander days on AGDD and HTU indicated that the rice crop phenology can be predicted using these functions adequately for all the tested varieties. The regressions had an $R^2$ of 0.984**, 0.929**, 0.951** and 0.988** for MTU 1010, RNR 2354, RNR 2458 and JGL 384, respectively with a significant variance ratio. Growth and yield components, and yield showed linear and positive correlation with weather elements *viz.*, mean temperature, relative humidity, solar radiation and seasonal rainfall.

Finally it was concluded that transplanting of rice in the 3rd week of July under Rajendranagar agro-climatic conditions improved growth and yield traits contributing to higher grain yield (6234 kg/ha). Delayed planting beyond July 23 affected the crop performance and significantly reduced grain yield. Performance of variety MTU 1010 was superior in terms of growth, yield components and yield (5983 kg/ha) over RNR 2354, RNR 2458 and JGL 384. Rice crop phenology can be predicted using accumulated growing degree days and heliothermal units.
A field experiment was conducted during rabi, 2010-11 on sandy clay loam soils of S.V. Agricultural College Wetland Farm, Tirupati Campus, Acharya N.G. Ranga Agricultural University, Andhra Pradesh to study the “Management of organics and micronutrients in aerobic rice (Oryza sativa L.)”. The experiment was laid out in a split plot design, replicated thrice. The treatments consisted of three organic management practices, viz., M1- farm yard manure @ 10 t ha-1, M2- green leaf manure through Glyricidia maculata @ 5 t ha-1, M3- no organics, allotted to main plot and seven micronutrient management practices, viz., S1- soil application of FeSO4 @ 25 kg ha-1 as basal, S2- soil application of ZnSO4 @ 25 kg ha-1 as basal, S3- soil application of FeSO4 and ZnSO4 @ 25 kg ha-1 each as basal, S4- foliar application of 0.25% FeSO4 at 20 and 30 DAS, S5- foliar application of 0.50% ZnSO4 at 20 and 30 DAS, S6- foliar application of 0.25% FeSO4 and 0.50% ZnSO4 at 20 and 30 DAS, S7- control (no micronutrient) were allotted to sub plots with Sravani (NLR-33359) as test variety. An uniform dose of 100-50-50 kg N, P2O5 and K2O ha-1 was applied to all the plots.

The soils of the experimental site were sandy clay loam in texture, low in organic carbon (0.25%) and available N (188.20 kg N ha-1), high in Phosphorus (26.5 kg P2O5 ha-1), potassium (293.75 kg K2O ha-1), iron (22.58 mg kg-1 of soil) and zinc (2.70 mg mg kg-1 of soil).

Organics as well as micronutrient management practices had profound influence on growth parameters, yield attributes, yield, nutrient uptake of aerobic rice as well as post harvest soil fertility status.

Significantly higher growth stature (plant height, LAI and dry matter production) was observed with the incorporation of FYM @ 10 t ha-1 (M1), while the lowest was registered with control (M3). Among the micronutrient management practices tried, foliar application of iron and zinc (S6) resulted in the highest stature of growth parameters, while the lowest values of crop growth parameters were recorded with control (S7).

The incorporation of FYM (M1) resulted in the enhanced level of yield attributes (productive tillers m-2, filled and total number of grains panicle-1 and 1000-grain weight), grain and straw yield. While the lowest values of all the yield attributes, grain and straw yield were associated without organics (M3). Regarding the micronutrient management practices, foliar application of iron and zinc (S6) resulted in the highest stature of yield attributes, grain and straw yield while, the
lowest level of all the yield attributes, grain and straw yield were observed with non-supply of micronutrients (S7).

FYM incorporation (M1) resulted in the highest nutrient uptake (N, P, K, Fe and Zn) by the crop, while the lowest was recorded with the non incorporation of organics (M3). The highest uptake of N, P and K by aerobic rice was reported from foliar application of iron and zinc (S6) which was on par with the soil application of iron and zinc, but the lowest was registered without the application of any micronutrient (S7).

The higher post harvest soil available nutrient status (N, P2O5, K2O, Fe and Zn) was obtained with the incorporation of FYM, while the lowest values were recorded with no organics. Soil application of both the micronutrients increased the post harvest soil nutrient status viz., N, P2O5 and K2O. Among the micronutrient management practices, the higher post harvest soil iron and zinc content was reported with the individual application of respective micronutrients either to foliage or soil, which were comparable among themselves. The lowest values of post harvest soil nutrient status was recorded with non-supply of micronutrients.

The highest gross and net returns as well as benefit-cost ratio were realized with the incorporation of FYM (M1), while the lowest economic returns were realized with control (M3). With regard to the micronutrient management practices, foliar application of micronutrients (S6) resulted in the highest gross and net returns as well as benefit-cost ratio, while control (S7) resulted in the lowest economic returns.

In conclusion, the study revealed that the highest yield as well as economic returns could be realized in aerobic rice with the incorporation of FYM @ 10 t ha-1 coupled with foliar application of 0.25% FeSO4 and 0.50% ZnSO4 at 20 and 30 DAS.
A field experiment was conducted at the Agricultural College Farm, Bapatla on a sandy clay loam soil during kharif 2010-11, laid out in a Randomised Block Design with three replications. The treatments consisted of T1: Weedy check; T2: Hand weeding at 20 & 40 DAS; T3: Oxadiargyl @ 100 g a.i ha-1 (as SMA at 3 DAS); T4: Pyrazosulfuron ethyl @ 20 g a.i ha-1 (as SMA at 3 DAS); T5: Penoxsulam @ 25 g a.i ha-1 as post at 20 DAS; T6: Azimsulfuron @ 35 g a.i ha-1 as post at 20 DAS; T7: Oxadiargyl @ 100 g a.i ha-1 (as SMA at 3 DAS) followed by penoxsulam @ 25 g a.i ha-1 at 20 DAS; T8: Oxadiargyl @ 100 g a.i ha-1 (as SMA at 3 DAS) followed by azimsulfuron @ 35 g a.i ha-1 at 20 DAS; T9: Pyrazosulfuron ethyl @ 20 g a.i ha-1 (as SMA at 3 DAS) followed by penoxsulam @ 25 g a.i ha-1 at 20 DAS; T10: Pyrazosulfuron ethyl @ 20 g a.i ha-1 (as SMA at 3 DAS) followed by azimsulfuron @ 35 g a.i ha-1 at 20 DAS.

The predominant weed flora identified in the experimental field were Echinochloa colonum, Cynodon dactylon, Paspalum conjugatum, Leptochloa chinensis, Cyperus rotundus, Scirpus articulates, Eclipta alba, Ludwigia parviflora, Ammania baccifera, Bergia capensis and Euphorbia hirta.

The results of the investigation revealed that all the herbicide treatments significantly reduced the density and dry weight of weeds at all stages compared to weedy check. Among the sequential application of herbicides oxadiargyl @ 100 g a.i ha-1 followed by penoxsulam @ 25 g a.i ha-1 (T7) recorded the lowest weed growth and it was on a par with other sequential treatments and comparable with also hand weeding twice at 20 and 40 DAS.

Among the weed management treatments, hand weeding twice was significantly superior to rest of the treatments and recorded highest weed control efficiency (68.2 per cent) and crop dry matter accumulation (8829 kg ha-1). All the sequential herbicide treatments recorded the higher weed control efficiency ranging from 55.4 to 61.3 per cent at harvest and improved yield attributing characters such as number of productive tillers, number of filled grains panicle-1 and recorded higher grain yield. However, sequential application of herbicides oxadiargyl @ 100 g a.i ha-1 followed by penoxsulam @ 25 g a.i ha-1 T7 proved significantly superior over rest of the treatments.

Among the alone application of herbicide treatments, pre emergence application of oxadiargyl @ 100 g a.i ha-1 at 3 DAS (T3) proved superior in related to weed indices, crop growth parameters and yield attributing characters over rest of the treatments.
Maximum uptake of N, P and K was significantly recorded by rice and nutrient depletion by weeds was significantly lower in sequential application of herbicides (T7 to T10) when compared to alone treatments (T3 to T6). However hand weeding twice (T2) was found best over rest of the treatments.

Thus the present investigation indicated that hand weeding was found to be effective for weed control in wet seeded rice. On considering economics, oxadiargyl @ 100 g a.i ha-1 as Pre (T3) recorded highest incremental benefit cost ratio and proved as cost effective method.
A field experiment was conducted at Agricultural College Farm, Bapatla on sandy loam soil during the late kharif 2010-11. The treatments consisted of three crop establishment methods viz., drum seeding in puddled condition, drilling in friable soil and transplanting assigned to main plots and four weed management practices viz., weedy check, hand weeding at 20 and 40 DAS, bispyribac @ 30 g a.i. ha⁻¹ at 15 DAS and bispyribac @ 30 g a.i. ha⁻¹ at 15 DAS fb ethoxysulfuron @ 20 g a.i. ha⁻¹ at 30 DAS to sub plots. The design adopted was in split-plot with three replications.

Weed density was significantly the lowest with transplanting method over drilling but it was on par with that of drum seeding method of crop establishment. Among weed management practices, the lowest weed density was recorded with sequential application of bispyribac-sodium and ethoxysulfuron which was significantly superior over application of bispyribac alone. However, it remained at par with hand weeding. Similar trend was observed at all the stages of crop growth. The minimum weed drymatter observed with the transplanting was significantly lower than that of drilling and drum seeding throughout the growth period. Weed drymatter recorded in drilling was significantly higher than that of other establishment methods at maturity. Application of bispyribac along with ethoxysulfuron reduced the drymatter significantly over the application of bispyribac alone at maturity.

The highest weed control efficiency was recorded with hand weeding and it was significantly superior to all other treatments. Significantly higher weed control efficiency was recorded with sequential application of bispyribac-sodium and ethoxysulfuron over the application of bispyribac-sodium alone.

The taller plants were observed with transplanting method which was significantly superior to that of drum seeding and drilling. Significantly the tallest plants were recorded with sequential application of herbicides and it was on a par with hand weeding.

More number of tillers was recorded under transplanting which was at par with drum seeding at maturity. However, number of tillers under drum seeding and drilling did not differ statistically at 80 DAS/T and maturity. The highest number of tillers under hand weeding recorded was significantly
superior to rest of weed management treatment. The treatment $W_3$ and $W_4$ were at par with each other and recorded significantly higher number of tillers over weedy check at all stage of crop growth.

All the weed management practices were found to be on a par with each other and accumulated significantly more drymatter over weedy check under transplanting. However, application of bispyribac along with ethoxysulfuron found superior to application bispyribac-sodium alone but remained at par with hand weedings.

Number of productive tillers recorded with transplanting was significantly higher than drum seeding and drilling. The lowest number of productive tillers recorded with drilling was, however, on a par with drum seeding. Similarly, transplanting recorded with significantly higher number of grains per panicle and more test weight over drum seeding and drilling. Among the weed management practices, the maximum numbers of productive tillers, grains per panicle and test weight were noticed in hand weeding twice followed by sequential application of bispyribac-sodium and ethoxysulfuron and the lowest were recorded by bispyribac-sodium alone.

The highest grain and straw yields were recorded with transplanting followed by drum seeding and the least was recorded with drilling. Transplanting was found to be significantly superior to both the methods of sowing. However, grain and straw yields under drilling and drum seeding methods did not differ significantly. The maximum grain and straw yields were recorded by hand weeding while the minimum grain and straw yields were recorded by the weedy check. Sequential application of herbicides was found better in increasing the yields significantly than the application of bispyribac-sodium alone.

Transplanting found profitable compared with drilling and drum seeding. Among the direct seeding methods, the maximum gross return, net return and returns per rupee invested were obtained from drum seeding over drilling.

From the present investigation, it can be concluded that, though transplanting is superior to other methods, direct seeding by drum and drill can be recommended under non-availability of labour and to reduce cost of cultivation. Sequential application of bispyribac-sodium and ethoxysulfuron emerged as a suitable and effective early post emergence herbicide in transplanted as well as in direct seeded rice.
A field experiment was conducted at College Farm, College of Agriculture, Rajendranagar, Hyderabad on sandy clay loam soils with slightly alkaline in soil reaction, medium in organic carbon, low in available nitrogen and medium in available phosphorous and potassium. The treatments comprised of five sowing dates (S1 - September 15, S2 - October 1, S3 - October 16, S4 - November 1 and S5 - November 16) and three spacings (D1 - 45 cm x 30 cm, D2 - 60 cm x 30 cm and D3 - 90 cm x 30 cm of 74,55 and 37 thousand plants ha$^{-1}$ respectively). The experiment was laid out in a Factorial Randomized Block Design and replicated thrice.

The results revealed that sowing dates, spacings and their interaction significantly influenced the growth parameters, yield attributes and yield of Dhaincha crop. Among the five different sowing dates studied, Dhaincha sown on September 15 performed better in plant height, drymatter production and number of branches plant$^{-1}$ and seed vigour than the other sowing dates.

The yield attributes viz., number of pods plant$^{-1}$, seeds pod$^{-1}$ and test weight, yield (seed and stalk), NPK content and uptake and Benefit-cost ratio were also higher with the September 15 sowing date as compared to other sowing dates. All these parameters of Dhaincha decreased considerably due to delay in the sowing time beyond September 15, but in some characters it maintained on par with October 1st and 16th sowing.

Dhaincha sown at closer spacing of 45 cm x 30 cm recorded more drymatter production, yield (seed and stalk) and NPK uptake. Wider spacing of 90 cm x 30 cm produced more number of pods plant$^{-1}$, seeds pod$^{-1}$ and test weight than other spacings (45 cm x 30 cm and 60 cm x 30 cm). But test weight was not at all influenced significantly due to varied spacings. The improved per plant yield attributes at 90 cm x 30 cm has not reflected in per hectare seed and stalk yield of Dhaincha. September 15 sowing date and at 45 cm x 30 cm spacing (S1D1) produced the highest drymatter production, yield (seed and stalk) and NPK uptake, gross monetary returns, net monetary returns and benefit - cost ratio.

From the present investigation, it can be inferred that Dhaincha can be grown successfully if sown early from September 15 to October 1 with a plant spacing of 45 cm x 30 cm during rabi season.
season under Southern Telangana Agro-climatic conditions. A few more years of field testing; however, is necessary before making it as a general recommendation.
A field experiment was conducted during kharif 2010 on sandy clay loam soil at College Farm, College of Agriculture, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad. The experiment was laid out in Randomized Block Design, with factorial concept, replicated three times. The treatments consisted three plant densities viz., 18,518 plants ha\(^{-1}\) (90 cm x 60 cm), 24,691 plants ha\(^{-1}\) (90 cm x 45 cm) and 37,037 plants ha\(^{-1}\) (90 cm x 30 cm) and four canopy management practices viz., control (no spray), de-topping at 50–60 DAS, single spray of growth regulator chloro mepiquat chloride @ 0.2 ml l\(^{-1}\) at 50-60 DAS and two sprays of chloro mepiquat chloride @ 0.2 ml l\(^{-1}\) at 50-60 and at 80-90 DAS.

Crop growth measured at different stages as plant height and dry matter production of Bt cotton was significantly higher when planted at a plant density of 37,037 plants ha\(^{-1}\) (90 cm x 30 cm) over that of lower densities of 24,691 plants ha\(^{-1}\) (90 cm x 45 cm) and 18,518 plants ha\(^{-1}\) (90 cm x 60 cm). The growth regulator chloro mepiquat chloride, as such, had a profound influence on all the growth parameters. The plant height, height to node ratio and dry matter accumulation was significantly reduced with its application compared to control plot and de-topping treatment.

At 110 DAS, as well as at final harvest the number of sympodial branches per plant were significantly higher with 90 cm x 60 cm (20.36) followed by 90 cm x 45 cm (20.16) and 90 cm x 30 cm (19.81) spacing. The number of bolls per plant and boll weight (g boll\(^{-1}\)) were significantly higher with 90 cm x 60 cm (35.10 plant\(^{-1}\), 5.58 g) followed by 90 cm x 45 cm (29.24 plant\(^{-1}\), 5.50 g) and 90 cm x 30 cm (20.76 plant\(^{-1}\), 5.39 g) spacing. The better yield components observed at wider spacings could not compensate the gain due to higher number of plants per hectare at closer spacing of 90 cm x 30 cm (37,037 plants ha\(^{-1}\)) which has ultimately resulted in greater seed cotton yield (1668 kg ha\(^{-1}\)) over that of lower plant densities.

The yield parameters like sympodial branches per plant (20.76), number of bolls per plant (35.89) and boll weight (5.62 g) were greater with spraying of chloro mepiquat chloride twice followed by single spray (20.43 plant\(^{-1}\), 32.38 plant\(^{-1}\), 5.56 g) compared to control (19.61 plant\(^{-1}\), 22.33 plant\(^{-1}\), 5.38 g) and de-topping (19.64 plant\(^{-1}\), 22.89 plant\(^{-1}\), 5.40 g) treatment. Similarly the seed cotton yield was significantly higher with two sprays of chloro mepiquat chloride (1635 kg ha\(^{-1}\)) compared to single spray (1556 kg ha\(^{-1}\)), de-topping (1310 kg ha\(^{-1}\)) and control (1282 kg ha\(^{-1}\)) plot.

At higher plant populations (90 cm x 30 cm and 90 cm x 45 cm spacings) nitrogen, phosphorus and potassium uptake by stalk was significantly higher compared to lower density (90 cm x 60 cm) spacings.
The chloro mepiquat chloride treatments recorded higher uptake of nitrogen and lower uptake of phosphorus and potassium compared to de-topping treatment and control plot at 110 DAS and at crop harvest.

The high density planting of Bt cotton coupled with application of chloro mepiquat chloride @ 0.2 ml l⁻¹ twice at 50-60 DAS and at 80-90 DAS recorded higher seed cotton yield (1905 kg ha⁻¹) and net returns (29,204 Rs ha⁻¹) with a B:C recorded of 2.05 than other treatment combinations.
A field experiment was conducted at S.V. Agricultural College Farm, Tirupati campus of Acharya N.G. Ranga Agricultural University of Andhra Pradesh, during rabi, 2010, to identify the suitable pre-and post-emergence herbicides for the management of weeds in sunflower.

The present investigation was laid out in a randomized block design with three replications. There were ten treatments viz., pre-emergence application of pendimethalin @ 1000 g a.i ha-1 (T1), pre-emergence application of oxadiargyl @ 250 g a.i ha-1 (T2), pre-emergence application of pendimethalin @ 1000 g a.i ha-1 + fenoxaprop @ 60 g a.i ha-1 at 20 DAS (T3), pre-emergence application of oxadiargyl @ 250 g a.i ha-1 + fenoxaprop @ 60 g a.i ha-1 at 20 DAS (T4), pre-emergence application of pendimethalin @ 1000 g a.i ha-1 + propaquizafop @ 60 g a.i ha-1 at 20 DAS (T5), pre-emergence application of oxadiargyl @ 250 g a.i ha-1 + propaquizafop @ 60 g a.i ha-1 at 20 DAS (T6), pre-emergence application pendimethalin @ 1000 g a.i ha-1 + quizalofop @ 50 g a.i ha-1 at 20 DAS (T7), pre-emergence application of oxadiargyl @ 250 g a.i ha-1 + quizalofop @ 50 g a.i ha-1 at 20 DAS (T8), two hand weedings at 20 and 40 DAS (T9) and unweeded check (T10).

Weed species belonging to eight taxonomic families were observed in the experimental field, of which seven species were grasses, two species were sedges and nine species were broad leaved weeds.

Among the weed management practices tried, two hand weedings at 20 and 40 DAS resulted in significantly lesser density and dry weight of total weeds with higher weed control efficiency. Pre-emergence application of pendimethalin @ 1000 g a.i ha-1 + propaquizafop @ 60 g a.i ha-1 applied at 20 DAS was the next best weed management practice, followed by pre-emergence application of pendimethalin @ 1000 g a.i ha-1 + quizalofop @ 50 g a.i ha-1 applied at 20 DAS. The highest values of the above mentioned weed parameters with the lowest weed control efficiency were recorded with unweeded check, followed by pre-emergence application of oxadiargyl alone.

Pre-emergence application of pendimethalin @ 1000 g a.i ha-1 + propaquizafop @ 60 g a.i ha-1 applied at 20 DAS resulted in significantly higher stature of growth parameters viz., plant
height, LAI, dry matter production and yield components viz., head diameter, total number of seeds and filled seeds head-1 and test weight followed by hand weeding twice at 20 and 40 DAS.

The highest gross and net returns were realized with pre-emergence application of pendimethalin @ 1000 g a.i ha-1 + propaquizafop @ 60 g a.i ha-1 applied at 20 DAS, followed by two hand weedings at 20 and 40 DAS. However, the highest benefit-cost ratio was registered with pre-emergence application of pendimethalin @ 1000 g a.i ha-1 + propaquizafop @ 60 g a.i ha-1 or quizalofop @ 50 g a.i ha-1 applied at 20 DAS.

Thus, the present study has revealed that pre-emergence application of pendimethalin @ 1000 g a.i ha-1 + propaquizafop @ 60 g a.i ha-1 applied at 20 DAS resulted in the highest seed yield and maximum economic returns, followed by two hand weedings at 20 and 40 DAS. Out of these two weed management practices, the choice of selection should be based on the time of weeding, availability and cost of labour.
AGRONOMY

Author: SOUMYA, B.

Title of the thesis: “STANDARDIZATION OF SEED RATE FOR PROMISING GROUNDNUT VARIETIES UNDER RAINFED CONDITIONS OF SOUTHERN TELANGANA ZONE, ANDHRA PRADESH”

Major Advisor: Dr. K. B. SUNEETHA DEVI

Degree: M.Sc. (Ag.)

College: COLLEGE OF AGRICULTURE, RAJENDRANAGAR

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A field experiment was conducted on sandy loam soil at college farm, college of Agriculture, Acharya N.G. Ranga Agricultural University during kharif 2010. The treatments consisted of four groundnut varieties (Narayani, ICGV 91114, K 6 and JCG 88) and four seed rates (75, 100, 125 and 150 kg ha\(^{-1}\)). The experiment was laid out in randomized block design with factorial concept and replicated thrice.

The results indicated that among the four varieties evaluated, the growth characters viz., plant height, total dry matter production, LAI, CGR and RGR were higher with the varity Narayani followed by K 6 variety which were significantly superior than JCG 88 and ICGV 91114 varieties.

Similarly, the yield components like number of pods per plant, shelling percentage, pod yield, haulm yield, harvest index and oil yield were also higher with Narayani and closely followed by K 6 variety which were significantly better over JCG 88 and ICGV 91114 varieties. However oil percentage was higher in JCG 88 variety.

As regards to the effect of seed rates, each increment of seed rate (i.e., 75 >100 >125 >150 kg ha\(^{-1}\)) significantly increased the growth characters viz., plant height, LAI, dry matter production, CGR and RGR of all groundnut varieties. Similarly pod yield, haulm yield, kernel yield, harvest index and oil yield also increased with increase in seed rate and were more at seed rate of 150 kg ha\(^{-1}\) and were at par with seed rate of 125 kg ha\(^{-1}\). However the yield component i.e. number of pods per plant significantly decreased due to increase in seed rate.

Maximum 100 kernel weight (40.83 g) was recorded by ICGV 91114 and followed followed by JCG 88, K6 and Narayani. The 100 kernel weight was at par among 75, 100 and 125 kg ha\(^{-1}\) seed rates and lower value was noticed with a seed rate of 150 kg ha\(^{-1}\).

Interaction between varieties and seed rates was found significant and maximum LAI, dry matter production, CGR and pod yield (2150 kg ha\(^{-1}\)) was observed with Narayani variety at a seed rate of 150 kg ha\(^{-1}\) which was at par with same variety at a seed rate of 125 kg ha\(^{-1}\) which in turn was at par with K 6 at a seed rate of 150 kg ha\(^{-1}\). However in JCG 88, they were maximum at a seed rate of 125 kg ha\(^{-1}\) which was at par with same variety at150 kg ha\(^{-1}\) seed rate.
Maximum net returns were obtained with Narayani variety at a seed rate of 150 kg ha\(^{-1}\) and then by same variety at the seed rate of 125 kg ha\(^{-1}\). Next to Narayani higher returns were noticed with K 6 variety at a seed rate of 150 followed by 125 kg ha\(^{-1}\) which were on par with each other. B: C ratio also followed similar trend as that of net returns and highest B: C ratio was recorded by Narayani variety at 150 kg ha\(^{-1}\) seed rate and was on par with same variety at seed rate of 125 kg ha\(^{-1}\). Benefit cost ratio of all varieties except JCG 88 was highest at seed rate of 150 kg ha\(^{-1}\) and was at par with seed rate of 125 kg ha\(^{-1}\). Whereas in JCG 88, benefit cost ratio at seed rate of 125 kg ha\(^{-1}\) was higher (1.57) and was at par with that of 150 kg ha\(^{-1}\) seed rate.

The results suggest that for obtaining maximum pod yields and economic returns, cultivation of the variety Narayani with a seed rate of 125 kg ha\(^{-1}\) would be advisable under rainfed conditions of Southern Telangana zone, Andhra Pradesh.
A field experiment was conducted during two consecutive seasons of kharif and rabi of 2007-08 and 2008-09 to “Study on water productivity of rice-maize system under two methods of rice establishment, levels of irrigation and phosphorus in zero-tillage maize” at Water technology centre, College farm, College of Agriculture, Rajendranagar, Hyderabad on sandy clay loam soil. The experiment was laid out in split-plot design replicated four times. During kharif, the experimental field was divided into two blocks in each replication where in two methods of rice crop establishment (Transplanted and aerobic method) were evaluated. During rabi, zero-tilled maize was grown in sequence to rice while considering the two previous rice crop establishment methods as main-plot treatments and two levels of irrigation (1.0 and 0.8 IW:CPE) and four levels of phosphorus (0, 30, 60 and 90 kg P₂O₅ ha⁻¹) as sub-plot treatments. The objective of the study was saving irrigation water with alternate method of rice growing in kharif followed by maize under zero-tillage and to estimate the water productivity of rice-maize system and also to standardize irrigation scheduling and phosphorus nutrition in zero-tillage maize.

There was significant improvement in growth characters like plant height, tillers m⁻², dry matter, LAI, LAD, CGR, RGR and NAR under transplanted method of rice establishment compared to the aerobic rice establishment method. All the yield attributing characters viz., number of panicles m⁻², panicle weight, panicle length, number of filled spikelets panicle⁻¹ and 1000 grain weight except the spikelet sterility were significantly more with transplanted rice over aerobic rice.

Plant nutrient (N, P and K) uptake and soil available nutrient status of N, P and K at crop harvest was greater under transplanted method as compared to aerobic method of establishment. However, aerobic method recorded higher water productivity by utilizing less irrigation water compared to transplanting. Among the two rice establishment methods, transplanted rice registered higher gross and net returns and also cost : benefit ratio over aerobic method of establishment.

In maize significantly higher values of growth characters like plant height, dry matter production, root mass density, LAI, LAD, CGR, RGR and NAR, yield attributes such as cob number ha⁻¹, cobs plant⁻¹, cob weight, grains cob⁻¹, grain weight cob⁻¹, 100 grain weight and yield both grain and stover were observed when grown after aerobic rice method as compared to transplanted
method. Higher nutrient (N, P and K) uptake was also recorded by the maize grown after aerobic method of rice establishment with higher nutrient available status of N, P and K at harvest. The maize crop grown after transplanted method of rice establishment recorded less consumptive use of water as compared to aerobic method of rice establishment in both the years. The water productivity was more with maize grown after transplanted rice method over aerobic method of rice establishment.

There was significant improvement in all the growth and yield parameters of maize with irrigation scheduled at IW: CPE of 1.0 as compared to IW: CPE of 0.8. The influence of irrigation frequencies are more pronounced on consumptive use rather than water productivity. Higher water productivity was observed with IW:CPE of 0.8.

The growth and yield characters improved significantly from 0 to 30 and 60 kg $P_2O_5$ ha$^{-1}$. Application of phosphorus for both rice and maize during both the seasons improved the soil available phosphorus status and resulted in net gain of phosphorus balance at the end of two seasons in rice-maize system. The results on soil moisture studies revealed that consumptive use of water increased due to increasing levels of phosphorus in both the years of study. The water productivity at 30 kg $P_2O_5$ ha$^{-1}$ was comparable with that of 60 kg and 90 kg $P_2O_5$ ha$^{-1}$ and superior to control. Based on the yield–input relation ship, the optimum level of phosphorus was 85.4 kg $P_2O_5$ ha$^{-1}$ for realizing higher grain yield of maize (7309 kg ha$^{-1}$). However, the economic level of phosphorus was 80.7 kg ha$^{-1}$ to produce 7303 kg grain ha$^{-1}$ on pooled basis.

The soil physical properties (soil penetration resistance, bulk density, moisture content and mean diameter of aggregates) improved when rice was grown under aerobic method of rice cultivation followed by maize.

The higher gross and net returns and BCR were recorded with maize crop grown after aerobic method of establishment. As a system, rice-maize sequence under aerobic method recorded higher BCR over that of transplanted rice–maize system. Moreover, the aerobic rice–maize system recorded higher system water productivity compared to transplanted rice-maize system.

Based on the results, it is concluded that maize crop grown after aerobic method was more productive and profitable in terms of benefit-cost ratio as well as system water productivity. It also maintained better soil physical conditions. Scheduling of irrigation at IW: CPE of 1.0 and phosphorus application @60 kg $P_2O_5$ ha$^{-1}$ each for both rice and maize crops were productive and profitable in rice-maize crop sequence.
A field experiment was conducted on Silty clay soil at Directorate of Rice Research farm, Rajendranagar, Hyderabad under the Southern Telangana agro-climatic zone of Andhra Pradesh to study the performance of Rice (*Oryza sativa* L.) cultivars and hybrids under different nutrient management practices in SRI. The study was conducted during kharif, 2010 and the experiment was laid in split plot design replicated thrice to assess the performance of three varieties (Vasumathi, Krishnahamsa and KRH-2) in main plots and with six nutrient management practices [100% RDN through inorganic fertilizer; 75% RDN (inorganic) + 25% RDN (organic) through FYM/vermicompost; 50% RDN (inorganic) + 50% RDN (organic) through FYM/vermicompost; 25% RDN (inorganic) + 75% RDN (organic) through FYM/vermicompost; 100% RDN (organic) through FYM/vermicompost; Control (No manure and no fertilizer)] in sub-plots under System of Rice Intensification (SRI).

The hybrid KRH-2 performed better in terms of growth and yield components resulting in significantly higher grain yield (6157.5 kg ha$^{-1}$) over Krishnahamsa (4947.8 kg ha$^{-1}$) and Vasumathi (3198 kg ha$^{-1}$) respectively. Nutrient uptake was also significantly greater with KRH-2 than Krishnahamsa and Vasumathi.

Among the different nutrient management practices, integrated treatment of 50% RDN (through urea) + 50% RDN (organic) through vermicompost recorded significantly higher grain yield (5520.8 kg ha$^{-1}$) and straw yield (6265 kg ha$^{-1}$) as well as nutrient uptake (N: 85.8 kg ha$^{-1}$, 72.1 kg ha$^{-1}$, P: 18.8 kg ha$^{-1}$, 12.0 kg ha$^{-1}$ and K: 61.3 kg ha$^{-1}$, 104.7 kg ha$^{-1}$) by grain and straw, respectively over rest of the treatments and was followed by 100% RDN (inorganic) and 75% RDN (through urea) + 25% RDN (organic) through vermicompost.

The interaction effect between varieties and integrated nutrient management practices was significant as far as the grain yield and yield components are concerned. When all the three varieties are imposed with different nutrient management practices, KRH-2 responded well to 50% RDN (through urea) + 50% RDN (organic) through vermicompost by recording highest grain yield (7084 kg ha$^{-1}$) compared to Krishnahamsa and Vasumathi. The next best grain yield was recorded under 100% RDN (inorganic) indicating good response to inorganic fertilizers also. KRH-2 gave the
highest grain and straw yield over Vasumathi and Krishnahamsa. The maximum B: C ratio (2.07) was found associated with the hybrid KRH-2 in combination with 100% RDN (through urea).
A field experiment was conducted during the *kharif* and *Rabi* seasons of 2008-2009 and 2009-2010 to study the effect of integrated nutrient management in rice-maize cropping system on sandy clay loam soil at Agricultural college farm, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad, Andhra Pradesh under irrigated conditions. The main objective was to assess the influence of pre-*rice* incorporation of organic manures viz., green manure and farm yard manure (FYM) on immediate *rice* crop and their residual and cumulative effect on sequence *rabi* maize crop. At the same time, the effect of inorganic source of Nitrogen at different levels was also studied to assess the influence of graded Nitrogen levels on productivity of *kharif* rice and; residual and cumulative effect on *rabi* maize in relation to graded levels of Nitrogen applied to *rabi* maize crop. Accordingly the present experiment was planned with three organic manural options viz., no manuring, *in-situ* incorporation of green manure crop (*Sesbania aculeata*) and farm yard manure @ 10 t. ha\(^{-1}\) (M\(_1\), M\(_2\) and M\(_3\), respectively) and four levels of Nitrogen viz., 0, 50, 100 and 150% RDN (N\(_1\), N\(_2\), N\(_3\) and N\(_4\)) and also three more levels of Nitrogen i.e., 50, 100 and 150% RDN (N\(_5\), N\(_6\) and N\(_7\)) included among sub plot treatments to observe their residual and cumulative effect on sequence crop of *rabi* maize in relation to different levels of Nitrogen i.e., 0, 50, 100 and 150% RDN imposed to maize crop.

During *kharif* season, three organic manural options as main plot treatments and seven nitrogen levels (N\(_1\), N\(_2\), N\(_3\), N\(_4\), N\(_5\), N\(_6\) and N\(_7\)) as sub plot treatments were tested in a split plot design and replicated thrice. In the same experimental lay out, *rabi* maize was sown with three organic manural treatments imposed to *kharif* rice as main plot treatments and seven Nitrogen levels as sub plots; and replicated thrice. The experimental data was recorded on plant growth, development; yield attributes and yield of rice and also in *rabi* maize crop during both the years of study. In addition, the rice grain quality parameters were also estimated along the soil nutrient status in respect of N, P, K, Zn and Fe after harvest of each crop.

The results indicated that the organic manural options i.e., *in-situ* incorporation of green manure crop (*Sesbania aculeata*) and farm yard manure @ 10 t. ha\(^{-1}\) (M\(_2\) and M\(_3\), respectively) significantly influenced the plant growth of rice in terms of plant height, dry matter production, leaf area index etc., in comparison to no manuring treatment (M\(_1\)). Similarly, the yield attributes and grain yield were also significantly enhanced due to both the organic manural options.
Among organic treatments, *in-situ* incorporation of green manure (*Sesbania aculeata*) proved its superiority in increasing grain and straw yields of rice over farm yard manure @ 10 t. ha\(^{-1}\) in the first year only (4479 and 5211 kg ha\(^{-1}\), respectively). The advantage due to M\(_2\) and M\(_3\) in increasing the grain yield was by 17.4 and 10.4% in the first year and; 19.2 and 21.1% in the second year, respectively over no manuring treatment. Similarly, the soil nutrient status (N, P, K, Zn and Fe) was also improved due to organic manural options in comparison to no manuring treatment. As regards to the influence of Nitrogen levels, increasing the levels from 0 to 150% RDN brought significant improvement in plant growth, development, yield attributes and yield of *kharif* rice during both years of study. Application of 150% RDN increased the grain yields to an extent of 11.8% in the first year and 8.7% in the second year over 100% RDN. Sole application of inorganic Nitrogen at different levels did not bring considerable change in the nutrient status of soil.

Pre-rice organic manural treatments i.e., *in-situ* incorporation of green manure crop (*Sesbania aculeata*) and farm yard manure @ 10 t. ha\(^{-1}\) (M\(_2\) and M\(_3\), respectively) significantly enhanced the growth, development, yield attributes and yield of sequence *rabi* maize during both the years (4224 and 3905 kg ha\(^{-1}\) in the first year; and 4428 and 4499 kg ha\(^{-1}\) in the second year, respectively). The influence of residual effect of pre-rice green manuring was more pronounced than FYM incorporation. Whereas, the residual effect of inorganic Nitrogen under different levels was not observed on growth and development of maize. Similarly, soil nutrient status was also not changed due to inorganic Nitrogen levels.

While evaluating the system productivity, it was observed that integration of *Sesbania* green manure along 150% RDN followed by FYM @ 10 t ha\(^{-1}\) in conjunction with 150% RDN recorded the highest mean rice equivalent yields (REY) of 12427 and 12067 kg ha\(^{-1}\), respectively. A close perusal of the data indicated that M\(_2\) N\(_6\) (green manure + 100% RDN) and M\(_3\) N\(_6\) (FYM + 100% RDN) were found very close to M\(_1\) N\(_7\) (no manuring + 150% RDN) indicating the beneficial effects of organic manuring in minimizing the application of inorganic with saving of 50% of RDN to both the crops of the system. Similarly, the advantage of integration of organic and inorganic sources of Nitrogen was also reflected on economic returns, wherein, M\(_2\) N\(_7\) (green manure + 100% RDN) recorded the highest B:C ratio (2.23) with 44.5% improvement in net returns over sole application of 100% RDN to both the crops.

The INM concept not only enhanced the crop yields, but also benefited the soil through enrichment with N, P, K, Zn and Fe in comparison to sole application of organic and inorganic sources of Nitrogen separately. The present experimental results strongly suggest that adoption of integrated nutrient management in rice-maize cropping system is very essential from the point of productivity and sustainability.
A field experiment was conducted during kharif, 2010 on a coastal sandy clay loam soil of the Agricultural College Farm, Bapatla to study the performance of redgram cultivars under transplanted conditions. The experiment was laid in Randomized Block Design with factorial concept having 12 treatments and replicated thrice using 3 redgram varieties viz., LRG-41, PRG-158 and WRG-53 and 4 ages of seedlings viz., conventional sowing, 15, 30 and 45 day aged seedlings.

Results of the experiment indicated that neither redgram varieties, age of seedlings nor their interaction could influence initial and final plant stands and survival percentage.

Among the growth parameters, plant height was not influenced by redgram varieties or age of seedlings while, primary and secondary branches were significantly influenced by seedlings age. Drymatter production measured at different intervals and days to 50 per cent flowering were influenced by redgram varieties, age of seedlings and their interaction while days to maturity was influenced only by redgram varieties. Significantly the highest number of primary (19) and secondary (25) branches plant-1 were registered by transplanting 15 day aged seedlings.

At all the phases of redgram crop growth, transplanting 15 day aged seedlings of LRG-41 variety registered significantly the highest drymatter production of 375, 1683 and 12369 kg ha-1 at 60, 90 DAT and at harvest, respectively compared to other treatment combinations. Transplanting 45 day aged seedlings of PRG-158 variety registered significantly the lowest drymatter production.

Conventional sowing of PRG-158 variety took significantly the lowest number of days (100) for 50 per cent flowering, while, LRG-41 variety tookB significantly the highest number of days (208) to mature over other age of seedlings.

Yield attributes like number of pods plant-1 were significantly influenced by varieties, age of seedlings and their interaction while, number of seeds pod-1 were non significant. Test weight and harvest index were significantly influenced by varieties and age of seedlings. Seed and stalk yields were influenced by varieties, age of seedlings and their interaction. Transplanting 15 day aged seedlings of LRG-41 variety recorded significantly the highest number of pods plant-1 (295) and transplanting 45 day aged seedlings of PRG-158 variety registered the lowest number of pods plant-
Among the varieties, LRG-41 recorded significantly the highest test weight (9.8 g) over other varieties and transplanting 15 day aged seedlings recorded significantly the highest test weight (9.9 g) over other aged seedlings.

Transplanting 15 day aged seedlings of LRG-41 variety recorded significantly the highest seed yield (2057 kg ha\(^{-1}\)) and stalk yield (10312 kg ha\(^{-1}\)) and transplanting 45 day aged seedlings of PRG-158 variety recorded the lowest seed yield (1526 kg ha\(^{-1}\)) and stalk yield (9200 kg ha\(^{-1}\)). LRG-41 variety recorded significantly the highest harvest index (16.8) over other varieties and transplanting 15 day aged seedlings recorded significantly the highest harvest index (15.9) over other aged seedlings.

NPK uptake was significantly influenced by varieties and age of seedlings only. LRG-41 variety recorded significantly the highest NPK uptake i.e. 200.6, 26.1 and 63.6 kg ha\(^{-1}\) respectively compared to other varieties and transplanting 15 day aged seedlings recorded significantly the highest NPK uptake i.e. 206.8, 26.2 and 64.8 kg ha\(^{-1}\) respectively, compared to other aged seedlings.

The higher gross returns (76,136 Rs. ha\(^{-1}\)) and higher net returns (59,686 Rs.ha\(^{-1}\)) and returns per rupee investment of 3.62 was recorded by transplanting 15 day aged seedlings of LRG-41 variety.

From the results of the present investigation, it can be concluded that LRG 41 redgram variety transplanted with 15 day aged seedlings performed better with higher growth parameters, yield attributes and yield, nutrient uptake and monetary returns over other treatment combinations.
AGRONOMY

Author: TRIVENI, U.
Title of the thesis: SEED PRODUCTION OF DHAINCHA [Sesbania aculeata (Wills.) Poir.] AS INFLUENCED BY SOWING TIME AND PLANTING DENSITY
Major Advisor: Dr. M. MARTIN LUTHER
Degree: M.Sc. (Ag.)
College: AGRICULTURAL COLLEGE, BAPATLA
Accession Number: D 9020

A field study was carried out on clay loam soils of the Agricultural College Farm, Bapatla, during kharif, 2010 to determine the optimum sowing time and planting density for maximizing the seed production potential of dhaincha. The study consisted of 18 treatment combinations resulted from six dates of sowing (S1-July 1, S2-July 15, S3-August 1, S4-August 15, S5-September 1 and S6-September 15) and three row spacings (D1 -30 cm × 15 cm, D2 - 45 cm × 15 cm and D3 - 60 cm × 15 cm) arranged in a randomized block design following the factorial concept with three replications.

The results revealed that sowing dates, spacings and their interaction significantly influenced the growth parameters, yield attributes and yield of dhaincha crop.

Among the six different sowing dates studied, dhaincha sown early on July 1 showed better performance in plant height, number of branches per plant and drymatter accumulation followed by July 15 sowing. July 1 sown crop took significantly maximum number of days to attain 50% flowering and maturity over other sowing dates.

The yield attributes (pods per plant and test weight), yields (seed and stalk) and harvest index were also higher with the July 1 sowing followed by July 15 sowing. All these parameters decreased considerably due to delay in sowing time beyond July 15.

Dhaincha sown at closer spacing of 30 cm × 15 cm recorded taller plants. Drymatter accumulation per plant was higher at 60 cm × 15 cm spacing but the total drymatter accumulation was higher with 30 cm × 15 cm which was followed by 45 cm × 15 cm and 60 cm × 15 cm spacings. Close spaced (30 cm × 15 cm) crop reached the stage of 50% flowering and maturity earlier followed by 45 cm × 15 cm and 60 cm × 15 cm spacings.

Yield components viz., number of pods per plant and 1000 seed weight were increased with increase in row spacing from 30 cm to 60 cm. Among the three spacings (30 cm × 15 cm, 45 cm × 15 cm and 60 cm × 15 cm), the seed and stalk yields were significantly higher with 30 cm × 15 cm spacing. However, the harvest index was higher in 60 cm × 15 cm spacing.
Drymatter accumulation with 30 cm × 15 cm spacing at each sowing date was significantly higher over 45 cm × 15 cm and 60 cm × 15 cm spacings. However, drymatter accumulation recorded at July 1 sowing at 30 cm × 15 cm spacing was significantly higher over all other treatment combinations at all the stages of crop growth.

Higher number of pods per plant was recorded at wider spacing of 60 cm × 15 cm with July 1 sowing and it was on a par with July 15 sowing at the same spacing. However, the seed, stalk yields and returns per rupee investment were significantly higher with July 1 sowing at 30 cm × 15 cm spacing which was closely followed by 45 cm × 15 cm spacing at the same sowing and also July 15 sowing at 30 cm × 15 cm spacing.

Overall, the study indicated the need for early sowing from July 1 to July 15 with a row spacing of 30 cm × 15 cm to 45 cm × 15 cm to achieve maximum seed production under Bapatla conditions.
A field experiment was conducted during Kharif 2009 on sandy clay loam soil of Agricultural College Farm, Bapatla, Guntur district, Andhra Pradesh. The experiment was laid out in a randomized block design and replicated four times with eight treatments comprising of T1: Weedy check; T2: Hand weeding at 20 and 40 DAT; T3: Oxadiargyl 80 WP @ 100 g a.i. ha-1 at 3 to 5 DAT; T4 Bipyribac sodium 10 SC @ 30 g a.i. ha-1 at 20 DAT; T5: Azimsulfuron 50 DF @ 30 g a.i. ha-1 at 20 DAT; T6: Penoxsulam 24 SC @ 20 g a.i. ha-1 at 20 DAT; T7: 2,4-D amine salt 58 SL @ 0.58 kg a.i. ha-1 at 20 DAT; T8: Pyrazosulfuron ethyl 10 WP @ 20 g a.i. ha-1 at 20 DAT.

The results of the investigation revealed that pre-emergence application of oxadiargyl 80 WP @ 100 g a.i. ha-1 (T3) applied at 4 DAT recorded lowest weed dry matter at 20 DAT. Hand weeding at 20 and 40 DAT (T2) was on a par with preemergence application of oxadiargyl 80 WP @ 100 g a.i. ha-1 at 4 DAT (T3).

Hand weeding at 20 and 40 DAT (T2) recorded significantly higher weed control efficiency over all other pre and post-emergence herbicides at all crop growth stages, except at 20 DAT, whereas pre-emergence application of oxadiargyl 80 WP @ 100 g a.i. ha-1 at 4 DAT (T3) recorded highest weed control efficiency at 20 DAT.

All growth parameters such as plant height, number of tillers per m-2, and drymatter accumulation by crop measured at different growth stages were significantly affected by the weed management treatments. Consistently better growth was observed at all the stages with hand weeding at 20 and 40 DAT (T2) except at 20 DAT. At all other stages hand weeding at 20 and 40 DAT (T2) recorded highest plant height followed by pre-emergence application of oxadiargyl 80 WP @ 100 g a.i. ha-1 (T3) and there was no significant difference among all other herbicides which were on a par with each other throughout the crop growth period.

The highest drymatter accumulation by rice crop was registered with hand weeding (T2) followed by penoxsulam 24 SC @ 20 g a.i. ha-1 (T6) at all the stages of crop growth, except at 20 and 80 DAT, where oxadiargyl 80 WP @ 100 g a.i. ha-1 at 4 DAT recorded the highest plant drymatter at 20 DAT and hand weeding at 20 and 40 DAT (T2) recorded highest drymatter by rice crop at 80 DAT.
The differences observed in growth parameters among the treatments studied also reflected the trend with that of yield attributes. The number of productive tillers m-2 observed with bispyribac sodium 10 SC @ 30 g a.i. ha-1 was markedly higher than the weedy check. However, the number of productive tillers m-2 observed with various herbicides were comparable with that of hand weeding.

Maximum number of filled grains per panicle were observed with the hand weeding at 20 and 40 DAT. The number of grains per panicles observed with the penoxsulam 24 SC @ 20 g a.i. ha-1 and oxadiargyl 80 WP @ 100 g a.i. ha-1 were markedly higher than that of weedy check.

The grain and straw yields observed with oxadiargyl 80 WP @ 100 g a.i. ha-1 and penoxsulam 24 SC @ 20 g a.i. ha-1 were comparable with hand weeding at 20 and 40 DAT, which recorded the highest grain (6227 kg ha-1) and straw (7331 kg ha-1) yields.

Highest net returns (Rs. 48183 ha-1) was recorded with the post-emergence application of penoxsulam 24 SC @ 20 g a.i. ha-1 followed by pre-emergence application of oxadiargyl 80 WP @ 100 g a.i. ha-1.

Thus, the present investigation clearly indicated that post-emergence application of penoxsulam 24 SC @ 20 g a.i. ha-1 at 20 DAT (T6) or pre-emergence application of oxadiargyl 80 WP @ 100 g a.i. ha-1 at 4 DAT (T3) were found to be effective in controlling weeds and increased rice productivity as well as economic returns in transplanted rice.
A field experiment was conducted at the Agricultural College Farm, Bapatla on a sandy clay loam soil during kharif season of 2010. The treatments comprised of three genotypes (Two hybrids viz., PA-6444 and KRH-2 and one local variety, BPT-5204), four levels of potassium (0, 40, 60 and 80 kg K\textsubscript{2}O ha\textsuperscript{-1}) and two times of potassium application (basal and basal + P.I stage). The experiment was laid out in a Randomized Block Design with factorial concept with three replications.

The findings of the experiment revealed that the growth parameters viz., plant height, number of tillers m\textsuperscript{-2} and drymatter production were significantly influenced by cultivars only. However, the levels and time of potassium application and their interaction were not significant.

Among the different cultivars, the hybrid PA-6444 recorded the maximum plant height, number of tillers m\textsuperscript{-2} and higher drymatter production.

Days to 50 per cent flowering was significantly influenced by cultivars, levels and time of potassium application. Days to 50 per cent flowering was more with BPT-5204 and minimum for KRH-2.

The highest number of filled grains per panicle, test weight, grain yield, straw yield and harvest index were recorded with PA-6444, while higher total number of grains per panicle was recorded with BPT-5204. Total and filled grains per panicle, test weight, straw yield were significantly influenced by cultivars, levels and time of potassium application but not due to their interaction. Whereas, grain yield was significantly influenced by cultivars, levels of potassium application only but not due to their interaction. The per cent, increase in grain yield with PA-6444 and KRH-2 was 23.9 and 23.3 \%, respectively over local variety, BPT- 5204.

The potassium uptake was significantly influenced by cultivars and levels but not due to time of potassium application and their interaction. The highest potassium uptake was recorded with hybrid PA-6444 at all the crop growth periods. Application of potassium @ 80 kg K\textsubscript{2}O ha\textsuperscript{-1} significantly increased the potassium uptake over control.
Soil available nitrogen was significantly influenced due to cultivars and levels of potassium only, but not due to times of application and their interaction. Among the cultivars, BPT-5204 recorded highest available nitrogen than the rest of the cultivars. The treatment that received 60 kg K₂O ha⁻¹ recorded the highest available nitrogen. Soil available phosphorus and potassium was neither significantly influenced by cultivars, levels and times of potassium application nor by their interaction.

The higher gross returns, net returns and returns per rupee investment were recorded with the hybrid, PA-6444. The gross returns, net returns and returns per rupee investment were found to be higher with higher level of potassium (80 kg K₂O ha⁻¹) and also with split application.

From the present investigation, it can be concluded that under sandy clay loam soils of Bapatla during kharif 2010, the rice hybrid PA-6444 performed better with superior growth, yield attributes, yield, net returns and returns per rupee investment. Application of 80 kg K₂O ha⁻¹ and its split application recorded higher performance of growth, yield attributes, yield, net returns and returns per rupee investment.
Organic fertilizers namely Bio Phos, Bio Potash, Bio Zinc, New Suryamin and Aishwarya obtained from Prathista Industries Ltd, Hyderabad, A.P. were analyzed in the laboratory with standard procedures. The results revealed that the Bio Phos was strongly acidic in reaction with pH of 5.03 and EC of 4.88 dS m⁻¹ and organic carbon was 3.23 percent. The total N, P and K contents were 0.016, 1.91 and 1.00 percent, respectively. Triacid extractable Zn was 1136 mg kg⁻¹. The Bio Potash was slightly acidic in reaction with pH of 6.54 and EC of 6.66 dS m⁻¹ and organic carbon was 3.97 mg kg⁻¹. The total N, P and K contents were 0.042, 0.4 and 2.0 percent, respectively. Triacid extractable Zn was 1520 mg kg⁻¹. Bio Zinc was medium acidic in reaction with pH of 6.31, EC of 6.45 dS m⁻¹ and organic carbon was 4.42 mg kg⁻¹. The total N, P and K contents were 0.032, 0.49 and 1.25 percent, respectively. Triacid extractable Zn was 2300 mg kg⁻¹. New Suryamin indicated that it was strongly acidic in reaction with a pH of 5.77, EC was 1.198 dS m⁻¹ and total organic carbon content was 3.054 percent. Total N, P and K contents of New Suryamin were 0.95, 0.91 and 0.59 percent, respectively. Triacid extractable zinc content was 1244 mg kg⁻¹. Aishwarya was acidic in reaction with a pH of 6.02, EC was 5.05 dS m⁻¹ and organic carbon content was 27.8%. Total N, P and K contents of Aishwarya were 1.2, 0.68 and 2.3 percent, respectively. Triacid extractable zinc was 1378 mg kg⁻¹.

A pot culture experiment was conducted using medium textured soil to study the effect of organic and inorganic fertilizers on plant growth, yield and quality of tomato and also to study the effect of these fertilizers on soil properties. The experiment was completely randomized with factorial design replicated thrice consisting of ten treatments. The treatments consists of T1 (control), T2 (Inorganic N@120 kg ha⁻¹ + Inorganic P@60 kg ha⁻¹ + Inorganic K@60 kg ha⁻¹), T3 (T2 + ZnSO₄ @ 25 kg ha⁻¹), T4 (Inorganic N@120 kg ha⁻¹ + Bio Phos @75 kg ha⁻¹ + Bio Potash @75 kg ha⁻¹), T5 (T2 + Bio Zn @ 13 kg ha⁻¹) and T6 (T4 + Bio Zinc @ 13 kg ha⁻¹), T7 (New Suryamin @ 25 kg ha⁻¹), T8 (T2 + T7), T9 (Aishwarya @ 125 kg ha⁻¹) and T10 (T2 + T9). Inorganic N, P and K were supplied through urea, single super phosphate and muriate of potash.

In each pot, 6 kg of soil was taken. Fertilizers were applied as per the treatments. The pots were arranged in two sets. The first set of plants were collected at vegetative phase (30 DAT) and second set at the harvest stage (90 DAT). At both the stages soil
samples were collected. Plant parameters like plant height and dry weight were recorded at both the stages whereas chlorophyll content and leaf area were recorded only at vegetative stage. Fruit weight was recorded at harvest. The plant samples were analyzed for N, P, K and Zn. Fruit samples were analyzed for lycopene content. Soil samples were analyzed for pH, EC, OC, available N, P, K and Zn.

At vegetative stage, highest plant height was recorded in T3 (Inorganic NPK + zinc sulphate) and dry matter in T10 (Aishwarya + Inorganic NPK). At harvest stage, both plant height and dry matter were highest in treatments where combinations of organics and in organics were used i.e., in T6 (Inorganic N + Bio Phos + Bio Potash + Bio Zinc) followed by T10 (Aishwarya + Inorganics NPK). The results of the plant analysis in treated soils indicated that uptake of N, P, K and Zn was more than the plants grown on untreated soils. The highest fruit weight was recorded by T10 (Aishwarya + Inorganics NPK) with 212 g pot-1. Lycopene content, a fruit quality parameter was recorded highest in T6 (Inorganic N + Bio Phos + Bio Potash + Bio Zinc) with 49 µg g-1.

There was no significant variation in pH and EC of soil samples at both the stages among different treatments. The organic carbon content was highest in T9 (Aishwarya) with 1.41% followed by T10 (Aishwarya + Inorganics NPK) with 1.39%. Available N, P2O5, K2O and Zn of soils at both stages indicated that the availability of nutrients were increased by the application of organic fertilizers and their combination with in organics.

The highest bacterial load was recorded by T10 (Aishwarya + Inorganics NPK) with 153 x 10^9 and 200 x 10^9 CFU at vegetative and harvest stages, respectively. There was a decline in microbial load from vegetative stage to harvesting stage in the soils where inorganic fertilizers alone were applied, whereas an increase was recorded in the soils where organic fertilizers were applied. Similar trend was observed in fungal load also. The highest fungal load was recorded by T10 (Aishwarya + Inorganics NPK) at both the stages with 18 x 10^4 and 22 x 10^4 CFU at vegetative and harvest stages, respectively followed by T9 (Aishwarya) with 16 x 10^4 CFU at vegetative stage and 18 x 10^4 CFU at harvest stage.

The above study indicated that the application of organic fertilizers either alone or in combination with in organics is highly beneficial from the view of nutrient availability and microbial activity of soils; plant parameters and yield of tomato. Aishwarya with inorganic NPK recorded highest yield.
Field experiment was carried out during Rabi, 2010-11 at Student’s Farm, College of Agriculture, Rajendranagar, Hyderabad wherein the efficacy of nine insecticides viz., flubendiamide 480 SC at 60 g a.i. ha\(^{-1}\), thiacloprid 240 SC at 120 g a.i. ha\(^{-1}\), flubendiamide 480 SC + thiacloprid 240 SC at 48 + 48 g a.i. ha\(^{-1}\), lambdacyhalothrin 5 SC at 18.75 g a.i. ha\(^{-1}\), indoxacarb 14.5 SC at 21.75 g a.i. ha\(^{-1}\), thiamethoxam 25 WG at 31.25 g a.i. ha\(^{-1}\), lambdacyhalothrin 5 SC + thiamethoxam 25 WG at 15.625 + 31.25 g a.i. ha\(^{-1}\), triazophos 40 EC at 500 g a.i. ha\(^{-1}\) and azadirachtin 0.15 EC at 1500 ppm was evaluated against pumpkin caterpillar, *Diaphania indica* Saunders, serpentine leaf miner, *Liriomyza trifolii* Burgess, cotton aphid, *Aphis gossypii* Glover and cowpea aphid, *Aphis craccivora* Koch on gherkin. The dissipation pattern of three effective treatments viz., flubendiamide 480 SC at 60 g a.i. ha\(^{-1}\), thiacloprid 240 SC at 120 g a.i. ha\(^{-1}\) and flubendiamide 480 SC + thiacloprid 240 SC at 48 + 48 g a.i. ha\(^{-1}\) was studied by collecting gherkin fruits at 0, 1, 3, 5, 7, 10 and 15 days after third spray at AINP on Pesticide Residues, College of Agriculture, Rajendranagar, Hyderabad.

Among all the chemicals, flubendiamide (60 g a.i. ha\(^{-1}\)) was found to be the most effective one with a maximum reduction in *D. indica* population (65.50%), followed by flubendiamide + thiacloprid at 48 + 48 g a.i. ha\(^{-1}\) (62.12%) and lambdacyhalothrin at 18.75 g a.i. ha\(^{-1}\) (59.22%).

Thiacloprid (120 g a.i. ha\(^{-1}\)) was found to be most effective treatment in reducing *L. trifolii* (74.96%), followed by flubendiamide + thiacloprid at 48 + 48 g a.i. ha\(^{-1}\) (71.57%) and flubendiamide at 60 g a.i. ha\(^{-1}\) (61.92%).

The reduction of *A. gossypii* population was more with thiacloprid at 120 g a.i. ha\(^{-1}\) (86.34%), flubendiamide + thiacloprid at 48 + 48 g a.i. ha\(^{-1}\) (74.36%) and thiamethoxam at 31.25 g a.i. ha\(^{-1}\) (61.09%).

Thiacloprid (120 g a.i. ha\(^{-1}\), flubendiamide + thiacloprid at 48 + 48 g a.i. ha\(^{-1}\) and lambdacyhalothrin + thiamethoxam at 15.625 + 31.25 g a.i. ha\(^{-1}\) were highly effective in controlling *A. craccivora* population to 72.25, 71.35 and 62.61 per cent, respectively.
The residues recorded for flubendiamide at 60 g a.i. ha\(^{-1}\) were found to be 1.35, 0.86, 0.40, 0.16, 0.01 mg kg\(^{-1}\) and BDL at 0, 1, 3, 5, 7 and 10 days after third spray respectively. The half life value (RL\(_{50}\)) and waiting period (T\(_{tol}\)) were 1.65 and 5.13 days, respectively.

Thiacloprid at 120 g a.i. ha\(^{-1}\) recorded residues of 1.49, 1.09, 0.43, 0.08, 0.01 mg kg\(^{-1}\) and BDL after 0, 1, 3, 5, 7 and 10 days after third spray respectively. The half life value was worked out to be 1.4 days and the waiting period was 3.69 days.

In the combination product flubendiamide + thiacloprid at 48 + 48 g a.i. ha\(^{-1}\), residues recorded for flubendiamide at 48 g a.i. ha\(^{-1}\) were 0.92, 0.62, 0.28, 0.05 and BDL at 0, 1, 3, 5 and 7 days after last spray respectively. The half-life of flubendiamide (48 g a.i. ha\(^{-1}\)) was worked out to be 1.78 days with waiting period of 4.13 days.

In the combination product flubendiamide + thiacloprid at 48 + 48 g a.i. ha\(^{-1}\), thiacloprid at 48 g a.i. ha\(^{-1}\) after three sprays left the initial deposit of 0.81 mg kg\(^{-1}\). The residues degraded to an extent of 0.46, 0.12 and 0.02 mg kg\(^{-1}\) and BDL at 1, 3, 5 and 7 days, respectively. The half life value and waiting period were 1.96 and 1.15 days, respectively.
Thirty two genotypes of groundnut were grown and their reaction to insect pest complex was studied during *rabi* 2010. ICG (FDRS-79) and Bheema hosted lowest mean larval population of *S. litura* and *H. armigera*. Based on leaf damage, ICG (FDRS-79), Bheema and TCGS-901(A) are considered as moderately resistant cultures to *S. litura*. *H. armigera* incidence is very less in the season and hence the damage levels are not used for categorization of genotypes. TCGS-647 recorded lowest thrips population followed by TPT-4. All the 32 genotypes were found to be either moderately susceptible or susceptible to thrips attack. Leaflet length and width were positively correlated with defoliators incidence and negatively associated with thrips incidence.

Out of 7 insecticides tested, chlorfenapyr (0.02%) was superior over others especially against *S. litura*. Thiodicarb (0.075%), emamectin benzoate (0.005%) and flubendiamide (0.004%) also provided considerable suppression of caterpillars over control. Imidacloprid (0.05%) and dimethoate (0.05%) were found effective for management of thrips. Monocrotophos (0.07%) gave average control (60-70% reduction over control) of all the three pests. Thiodicarb (0.075%) and flubendiamide (0.004%) were not that effective against thrips.
Experiments were conducted in the laboratory of the Department of Entomology, Andhra Pradesh Rice Research Institute and Regional Agricultural Research Station, Maruteru, during 2008-09 and 2009-10 to determine the degree of resistance acquired by Rice brown planthopper, *Nilaparvata lugens* (Stal) to eight insecticides, the occurrence of PBO and TPP suppressible metabolic resistance, the possibility of managing resistance with selected novel insecticides and the influence of insecticide resistance on the biology of *N. lugens*.

The BPH populations of the three districts *viz.*, West Godavari, East Godavari and Karimnagar differed in the degree of resistance acquired by them to each of the eight test insecticides. The West Godavari strain of *N. lugens* was found to be 3.63 and 3.16; 3.01 and 3.07; 2.80 and 2.79; 2.22 and 2.30; 1.39 and 1.69; 1.50 and 1.36; 46.66 and 47.14; 13.11 and 12.94 folds resistant at LC$_{50}$ and 2.60 and 2.52; 1.31 and 1.49; 1.10 and 1.28; 1.40 and 1.40; 1.06 and 1.50; 1.23 and 1.11; 9.4 and 14.66; 2.84 and 2.51 folds resistant at LC$_{90}$ to endosulfan, monocrotophos, acephate, phosphamidon, fenobucarb, ethofenprox, imidacloprid and thiamethoxam during 2008-09 and 2009-10, respectively compared to susceptible strain.

The East Godavari strain of *N. lugens* acquired 3.53 and 3.02; 2.37 and 2.50; 2.42 and 2.36; 1.98 and 2.04; 1.41 and 1.44; 1.40 and 1.15; 28.75 and 34.76; 8.51 and 7.82 fold resistance at LC$_{50}$ and 2.87 and 2.66; 1.07 and 1.31; 0.00 and 1.19; 1.35 and 1.38; 1.12 and 1.26; 1.27 and 1.02; 6.25 and 8.38; 3.73 and 4.05 fold resistance at LC$_{90}$ to endosulfan, monocrotophos, acephate, phosphamidon, fenobucarb, ethofenprox, imidacloprid and thiamethoxam during 2008-09 and 2009-10, respectively compared to susceptible strain.

The Karimnagar strain of *N. lugens* showed 2.11 and 2.00; 2.34 and 2.52; 0.00 and 1.31; 1.93 and 2.12; 1.28 and 1.33; 1.10 and 1.03; 36.66 and 41.90; 12.70 and 11.41 fold resistance at LC$_{50}$ and 1.26 and 1.25; 1.08 and 1.31; 0.00 and 0.00; 1.51 and 1.53; 1.06 and 1.30; 1.01 and 1.02; 8.05 and 13.38; 2.70 and 1.98 fold resistance at LC$_{90}$ to endosulfan, monocrotophos, acephate, phosphamidon, fenobucarb, ethofenprox, imidacloprid and thiamethoxam during 2008-09 and 2009-10, respectively compared to susceptible strain.
The synergistic effect of PBO with the test insecticides viz., endosulfan, monocrotophos, acephate, phosphamidon, fenobucarb, ethofenprox, imidacloprid and thiamethoxam revealed that the relatively resistant West Godavari strain of *N. lugens* recorded the synergistic ratios of 10.08 and 9.66; 13.88 and 11.43; 18.82 and 13.45; 15.95 and 11.52; 2.41 and 1.55; 3.75 and 1.37; 3.2 and 6.19; 3.46 and 1.97 at LC<sub>50</sub> and LC<sub>90</sub> levels, respectively during 2008-09. While, the corresponding values of synergistic ratios during 2009-10 were 8.48 and 11.42; 19.81 and 10.91; 21.35 and 17.20; 15.69 and 9.92; 2.44 and 1.73; 3.21 and 1.88; 2.67 and 5.89; 3.48 and 1.98 at LC<sub>50</sub> and LC<sub>90</sub> levels, respectively.

The synergistic effect of TPP with the test insecticides viz., endosulfan, monocrotophos, acephate, phosphamidon, fenobucarb, ethofenprox, imidacloprid and thiamethoxam revealed that the relatively resistant West Godavari strain of *N. lugens* recorded the synergistic ratios of 6.66 and 7.41; 16.13 and 10.62; 14.22 and 11.60; 1.28 and 1.14; 1.59 and 1.33; 1.80 and 1.65; 1.09 and 1.12; 1.03 and 1.03 at LC<sub>50</sub> and LC<sub>90</sub> levels, respectively during 2008-09. While, the corresponding values of synergistic ratios during 2009-10 were 6.16 and 8.61; 14.2 and 9.75; 12.49 and 12.94; 1.29 and 1.22; 1.72 and 1.51; 1.95 and 1.34; 1.08 and 1.21; 1.24 and 1.19 at LC<sub>50</sub> and LC<sub>90</sub> levels, respectively. The synergism with TPP was more in monocrotophos followed by acephate, endosulfan, ethofenprox, fenobucarb, phosphamidon, imidacloprid and thiamethoxam.

Among the novel insecticides tested, buprofezin was found to be the best alternative insecticide for managing the resistant strain followed by pymetrozine and imidacloprid + ethiprole and ethiprole alone.

The BPH populations of different districts recorded significantly more egg periods compared to the susceptible population. But no significant differences were observed in other biological parameters viz., number of progeny, total nymphal period, adult longevity, pre oviposition period, oviposition period and total life cycle.
ENTOMOLOGY

Author : MALYADRI, M.

Title of the thesis : “MONITORING OF INSECTICIDE RESISTANCE IN COTTON LEAFHOPPER, AMRASCA BIGUTTULA BIGUTTULA (ISHIDA) AND ITS MANAGEMENT”

Major Advisor : Dr. G.M.V. PRASADA RAO

Degree : M.Sc. (Ag.)

College : AGRICULTURAL COLLEGE, BAPATLA

Accession Number : D 9045

Studies on monitoring of insecticide resistance in cotton leafhopper, Amrasca biguttula biguttula (Ishida) and its management was taken up during kharif 2010 to determine the insecticide resistance in cotton leafhopper to major insecticides viz., monocrotophos, dimethoate, acephate, imidacloprid, acetamiprid, thiamethoxam and fipronil and to manage it.

The population of cotton leafhopper was tested against test insecticides viz., monocrotophos, dimethoate, acephate, imidacloprid, acetamiprid, thiamethoxam and fipronil following the leaf dip method. The mortality data was subjected to probit analysis and the LC50 and LC90 values were calculated. The LC90 values were also compared with the recommended concentrations of the respective insecticides (AICCIP, 2010). The relative degree of resistance acquired by leafhopper population to monocrotophos, imidacloprid and thiamethoxam was calculated by comparing the LC50 values with values of kharif 1999 reported by Chalam and Subbaratnam (1999). At LC50 cotton leafhopper developed 16.67 and 47.50 fold resistance to imidacloprid and thiamethoxam and there was no resistance to monocrotophos.

Dimethoate and fipronil were seven times more toxic than monocrotophos while acephate, imidacloprid, acetamiprid and thiamethoxam were less toxic than monocrotophos at LC50. Dimethoate and fipronil were 7.04 and 2.47 times more toxic while acephate, imidacloprid, acetamiprid and thiamethoxam were less toxic than monocrotophos at LC90.

The order of toxicity of insecticides at LC50 is dimethoate ≥ fipronil > monocrotophos > acephate > imidacloprid > thiamethoxam > acetamiprid and at LC90 it is dimethoate > fipronil > monocrotophos > imidacloprid > acephate > thiamethoxam > acetamiprid.

In the management trial, the efficacy of insecticides against cotton leafhopper was studied. The experiment was laid out with eleven treatments including untreated control and replicated thrice in a simple Randomized Block Design. The treatments were imposed four
times with an interval of 10 days. The incidence of leafhoppers per three leaves per plant was recorded on five randomly selected plants per plot one day before and 1st, 3rd, 7th and 10th day after treatment.

All the insecticides tested were significantly superior over untreated control by recording lower leafhopper population except T1 (Seed treatment with imidacloprid 70 WS 5 g/kg) and T2 (Seed treatment with imidacloprid 70 WS 5 g/kg + stem application with monocrotophos 36 SL (1:4)) which were at par with untreated control. Among the different treatments tested T7 (Seed treatment with imidacloprid 70 WS 5 g/kg + stem application with monocrotophos 36 SL (1:4) and spraying of imidacloprid 17.8 SL @ 0.5 ml/l + spraying of acephate 75 SP @ 1.5 g/l + spraying of fipronil 5 SC @ 2 ml/l) was found to be superior against leafhoppers, followed by T5 (Seed treatment with imidacloprid 70 WS 5 g/kg + stem application with monocrotophos 36 SL (1:4) + spraying of fipronil 5 SC @ 2 ml/l) and are at par with the remaining treatments.

Highest yield of 1497 kg/ha was recorded in T7 (Seed treatment with imidacloprid 70 WS 5 g/kg + stem application with monocrotophos 36 SL (1:4) and spraying of imidacloprid 17.8 SL @ 0.5 ml/l + spraying of acephate 75 SP @ 1.5 g/l + spraying of fipronil 5 SC @ 2 ml/l) and is significantly at par with remaining treatments except, T1(Seed treatment with imidacloprid 70 WS 5 g/kg), T2 (Seed treatment with imidacloprid 70 WS 5 g/kg + stem application with monocrotophos 36 SL (1:4)) and untreated control which were significantly inferior to all other treatments.
The brown planthopper (BPH), *Nilaparvata lugens* (Stal) is a serious threat to the rice production throughout Asia. BPH can cause heavy infestations, complete drying and plant death, a condition known as hopper burn and also acts as a vector for Rice Grassy Stunt Virus and Rice Ragged Stunt Virus. The indiscriminate application of various xenobiotics in rice eco-system is perceived as one of the factors for the frequent outbreaks of BPH. Hence, a concerted study on the effect of various chemicals such as insecticides, fungicides, botanicals and fertilizers on the plant resistance and BPH hormesis is essential for their optimal use in rice eco-system without compromising yield and to develop a sustainable IPM programme for BPH. In the present study a few representative chemicals / botanicals from herbicide, fungicide, insecticide, fertilizer and soil amendments were selected and their effect on innate BPH resistance of three rice varieties, hormesis of BPH and induction of its carboxylesterase titer was studied. Different xenobiotics were used in this experiment, viz., insecticides deltamethrin, imidacloprid, herbicide 2,4-D, fungicide carbendazim, green manure *Calotropis* leaves, botanicals Neem Seed Powder and fertilizer urea which were applied to the TN1, PTB 33 and Swarna varieties comprising 15 treatments. The treatments were replicated thrice. The observations on population build up, direct toxicity of xenobiotics on BPH, feeding rate of BPH, susceptibility of BPH reared on xenobiotics treated plants to imidacloprid, qualitative and quantitative changes in biochemical constituents such as sucrose, amino acids, phenols and C/N ratio in the rice plant treated with different xenobiotics, qualitative and quantitative changes in carboxylesterase titer in BPH upon different xenobiotics were recorded.

The second generation BPH nymphs emerged from the TN1 variety (244.3 nymphs) were significantly higher (18.4 fold) than the resistant PTB 33 (13.3 nymphs) and the commercially grown Swarna variety (191.0 nymphs; 1.3 fold). The PTB 33 plants treated with 2,4-D or carbendazim or deltamethrin or their combined applications as well as excessive urea (T13) recorded significantly more nymphal population over untreated PTB 33 plants.
The feeding rate of BPH on resistant PTB 33 variety recorded significantly lower honeydew excretion (13 mm² areas) than that on TN1 and Swarna varieties (116 and 110 mm² respectively). Excessive honeydew excretion was recorded due to increased feeding by BPH on PTB 33 plants treated with high dose of nitrogenous fertilizer, urea (T13) (47.0 mm²) and sprays with 2,4-D plus carbendazim (74.3 mm²) and deltamethrin (65.6 mm²). However, the honeydew excretion in BPH adults was significantly increased due to feeding on PTB 33 plants treated with 2,4-D, carbendazim or their combined application with deltamethrin, whereas it was decreased with the treatment of imidacloprid and soil amendment with neem seed powder (19.0 and 16.3 mm²) as compared to the untreated control plants.

Present study critically analysed the sub lethal and secondary effects of representative xenobiotics intended for different purposes in rice field on certain plant and insect parameters that promote outbreak of BPH. Application of 2,4-D, carbendazim, deltamethrin and urea reduced the innate BPH resistance of PTB 33 rice variety due to favourable alterations in free amino acid and sucrose content and led to enhanced feeding and population build up in BPH. Soil amendment with neem seed powder and Calotropis leaves improved the plant innate resistance to the BPH and at the same time did not enhance the feeding and reproductive capacity of BPH. In addition, deltamethrin stimulated BPH carboxylesterase titer. Native PAGE analysis of esterases from whole body homogenate of BPH revealed at least five esterase isozyme bands, prominent being E1 and E2. However, no difference in esterase banding pattern was observed between treatments. All these esterase bands are classified under carboxylesterase based on their inhibition by class specific esterase inhibitors.
ENTOMOLOGY

Author: PARVATHY VINOD
Title of the thesis: ECOLOGICAL PERSPECTIVES AND HOST PLANT RESISTANCE STUDIES OF POD FEEDERS IN FIELD BEAN, Lablab purpureus (L.) Sweet
Major Advisor: Dr. K. SREEDEVI
Degree: M.Sc. (Ag.)
College: S.V. AGRICULTURAL COLLEGE, TIRUPATI
Accession Number: D 8945

The present studies on ecological perspectives and host plant resistance studies of pod feeders in field bean, Lablab Purpureus (L.) Sweet were carried out at S.V. Agricultural College, Tirupati during rabi 2010.

The insect pest complex associated with field bean, their population dynamics, spatial distribution, diversity in different cultivars, screening of accessions against pod feeders, correlation with various aspects of plant phenological parameters, biochemical assays, weather parameters of certain genotypes of field bean were studied.

Sixteen insect species from 9 families under 4 orders, eleven insect species from 10 families under 3 orders and nine insect species from 9 families under 4 orders were recorded at early vegetative phase of the crop, late vegetative phase and flowering phase of the crop, respectively. It was found that the occurrence of flea beetle was severe from September to November with peak infestation during September and October in TFB-1 and TFB-5. The incidence of all pod feeders were on par with each other with respect to TFB-1 whereas there was significant difference in TFB-5. The highest incidence was that of plume moth followed by Maruca vitrata, Coptosoma cribraria and Riptortus pedestris. Overall, the plume moth and Riptortus pedestris incidence was low to moderate while M. vitrata and C. cribraria incidence was moderate to high in field bean crop. The infestation of N. viridula was found to be less throughout the cropping period. At the early vegetative phase, flea beetle was found to be severe devastating the tender foliage.

Among the pod feeders, Coptosoma cribraria showed aggregate distribution in relatively more number of accessions followed by Riptortus and Maruca vitrata indicating high colonization in those accessions. Plume moth and Nezara viridula showed regular distribution in almost all accessions except in PLS-18 and GKVK-625, respectively.

The diversity of insect species was high in field bean ecosystem as evidenced by Shannon’s and Simpson’s indices.
The plume moth and green stink bug incidence showed no significant correlation with any of the weather parameters. *Maruca vitrata* exhibited significant negative correlation with maximum temperature and positive association with rainfall. *Coptosoma cribraria* showed significant negative correlation with relative humidity. *Riptortus pedestris* showed significant positive correlation with maximum temperature.

Screening of 40 field bean accessions against major pod feeders revealed that there was no significant difference in plume moth and *M. vitrata* incidence across the cultivars. *C. cribraria* and *R. pedestris* exhibited differential responses in their incidence among the accessions.

Among the phenological parameters, the studies revealed that plume moth and *Maruca* incidence had positive correlation with per cent flowers. The *Coptosoma* population established significant positive correlation with per cent full mature pods and *Riptortus* exhibited negative association with per cent flowers.

Among the biochemical and biophysical parameters, the pod damage exhibited significant positive correlation with protein content, reducing sugars and pod length and negative correlation with total phenols.

Based on the damage in harvested pods inflicted by pod borers and yield obtained the accessions were grouped into different categories of resistance. EC-92956 was least susceptible while TFB-110, EC-83 A, MAC- 7-1, PLS-42, K-18532-1 were moderately susceptible. Rest of the accessions showed high susceptibility to pod porers.
Experiments were conducted during rabi, 2010-11 under field and green house conditions at College of Agriculture, Rajendranagar Hyderabad. Screening of maize genotypes against pink borer were carried out at Maize Research Center, All India Coordinated Maize Improvement Project (AICMIP), ARI, Rajendranagar, Hyderabad.

Twenty maize genotypes were evaluated for resistance to pink stem borer, *S. inferens* under artificial infestation in the field during rabi season, 2010-2011. Data were recorded on leaf injury on 1-9 scale. The maize genotypes viz., HQPM 1, DHM 117, Winsynthetic, HKI 193-1, HKI 163-1, V 351, BML 6, HKI C 322, CM 202, 30 V 92, BML 7, HKI MBR 139, CM 212 recorded a mean leaf injury rating (LIR) of 4.85, 5.08, 5.29, 6.21, 6.22, 6.49, 7.31, 7.31, 7.56, 7.87, 8.37, 8.50, 8.62, respectively. Among all only HQPM 1 with lowest LIR of 4.85 was found to be moderately resistant and the remaining genotypes were moderately susceptible to pink stem borer, *S. inferens*. The genotypes, CM 144, CM 139, CM 137, CM 132 and DMRQPM 58 have recorded mean LIR ranging from 8.87 to 9.00 above the susceptible check which were grouped as highly susceptible.

The effect of larval densities of *S. inferens* during different stages of crop growth of maize hybrid, DHM 117 under unprotected conditions indicated that with increase in the larval density there was an increase in LIR. Leaf injury rating was significantly more at two leaf stage (7 DAG) of the crop as compared to 14, 21, 28 day old plants. The highest mean LIR was recorded when 20 larvae were released at 2 leaf stage (7 DAG) and the lowest was at 8 leaf stage (28 DAG) when 5 larvae were released. The LIR increased with increase in larval density irrespective of the crop age. Based on the findings, maize crop at 2 leaf stage was considered as the most critical stage for *S. inferens* irrespective of the larval densities.

Experiments conducted for evaluation of different management practices for *S. inferens* with maize hybrid, DHM 117 under green house conditions made clear that when different chemical insecticides viz., carbofuran, endosulfan, and bio pesticides viz., *Beauveria bassiana* and *Bacillus thuringiensis* were used against *S. inferens* and tested for efficacy expressed in terms of mean leaf injury rating, percent dead hearts, stem tunneling and number of exit holes per plant, percentage of live larvae recovered, indicated that the insecticidal treatments were effective over the untreated control. Among the treatments
endosulfan was found to be more effective with 4.55 leaf injury rating, 26.25 per cent dead hearts, 0.33 cm per metre stem tunneling, 0.45 number of exit holes per plant, and 41.66 percentage of live larval recovery followed by carbofuran, *B. bassiana* and *B. thuringiensis*. 
A field experiment was conducted at Regional Agricultural Research Station, Lam, Guntur during kharif, 2010 to carry out the impact of Bollgard II Bt cotton on biological parameters of Spodoptera litura (Fab.). In the investigations monitoring of S. litura through pheromone traps, performance of cotton hybrids containing Cry1Ac (BG I) and Cry1Ac+Cry2Ab (BG II) of Tulasi-9, Mallika and their corresponding non Bt versions on the survival of S. litura larval stages in the field conditions and the effect of Cry1Ac+Cry2Ab (purified protein) larval diet on the mortality of larva in the laboratory were studied.

At the time of sowing of cotton crop, the initial incidence of S. litura was 32.50 moths/trap/week in 34th standard week (third week of August). Thereafter there was decline in moth catches in succeeding weeks due to high amount of rainfall received during the corresponding weeks. The peak moth incidence was observed at 6th standard week (first week of February) with 157.50 moths/trap/week and during this period low minimum temperature was observed. High moth catches were recorded from January to first fortnight of February (102.00 to 157.50 moths/trap/week) when minimum temperature and evening relative humidity are low, however there were wide fluctuations in moth catches.

The correlation between the moth catches and minimum temperature was negative and significant, whereas sunshine hours showed positive and significant influence on moth catches. The cumulative effect of all the weather parameters were non significant and together accounted for 62.00 per cent of total variation (R² = 0.62) on the moth catches.

The mortality of 1st and 2nd instar larvae of S. litura was high with reduced mortality rates in 3rd and 4th instar larvae on BG II hybrids, where as the mortality was very low and more or less similar in BG I and non Bt cotton hybrids. The BG II cotton hybrids were found promising at 40 and 70 days inflicting high larval mortality compared to 100 and 130 days old crop. This might be due to high level expression of dual toxin at vegetative stages of the crop compared to reproductive stages of the crop. The survival of early larval instars of S. litura was very low than the later instars on the leaves of both the BG II cotton hybrids and the 1st instar larvae showed highest mortality compared to 2nd instar larvae. The survival rate of 3rd instar larvae was higher and recorded only 50 per cent mortality, whereas the influence
of BG II hybrids on grown up 4th instar larvae was very minimal and equal to BG II and non Bt hybrids at 130 DAS.

The mean weight of larva fed on BG II cotton leaves was found to be very low. The weight reduction of late instars of *S. litura* was lower than the early instars on the leaves of both the BG II versions at all stages of the crop, whereas BG I and non Bt versions did not effect the larval or pupal weight and weight gains were more or less similar through out the crop season.

The mean leaf area consumed by 1st instar larvae of *S. litura* on BG II cotton hybrids were found to be significantly very low at 40 & 70 DAS due to higher mortality rates and the same trend was also observed in 2nd instar larvae.

The mean leaf area consumption by 3rd & 4th instar larvae of *S. litura* were higher at all the stages of the crop as the larvae were not effected by BG II hybrids leading to considerable damage of the crop. In BG I and non Bt hybrids the leaf area consumption was very high for all the instars during the entire crop period.

In the diet incorporation bioassay studies, the highest concentration of 96.00 μg/ml tested showed corrected mean mortality of 66.67 per cent in 1st instar larvae, whereas same concentration was able to record only 36.67 per cent in 2nd instar larvae and there was no influence of this concentration on 4th instar larvae recording zero per cent mortality at 72 hours after feeding.
The present studies on population dynamics and development of weather based forewarning models for thrips in groundnut were carried out at Agricultural Research Institute, Hyderabad during kharif, 2010.

To study the effect of sowing dates and age of the crop on groundnut thrips and Bud Necrosis Disease incidence, the crop was sown in four different dates. The first sowing was taken up on 19th June 2010 and the remaining three sowings were taken up at 15 days interval i.e. on 4th July, 19th July and 4th August. The results indicated the prevalence of high incidence of thrips and PBND in late sown crop (August 4th), while early sown crop (June 19th) escaped from both thrips and PBND incidence in the initial stage and recorded high yield.

Species composition of thrips identified in groundnut indicated the presence of two species of thrips Scirtothrips dorsalis Hood, and Thrips palmi Karny in leaf terminals while three species of thrips viz., Megalurothrips usitatus Bagnall, Frankliniella schultzei Trybom and Thrips palmi Karny inhabited the groundnut flowers. S. dorsalis was the dominant species in groundnut leaves while M. usitatus was found in greater proportion in flowers. The dominant species of thrips existing in leaves (S. dorsalis) and flowers (M. usitatus) were found throughout the crop growth period with their peak population occurring at 34 and 41 days age of the crop, respectively.

The correlation studies conducted between thrips incidence and preceding one week weather had more significant relation than preceding two weeks weather. Among the weather parameters minimum temperature, morning and evening relative humidity showed significant positive correlation, while sunshine hours played a significant negative role. For PBND incidence preceding two weeks weather had more significant relation. Leaf wetness showed significant positive correlation while evaporation and morning relative humidity showed significant negative correlation with PBND incidence.

Linear and non linear models developed for thrips incidence with crop and observatory parameters (preceding one week) together predicted the thrips incidence to an extent of 32 per cent with linear and 69 per cent with non linear models than used
individually. For PBND incidence also the crop and observatory weather parameters (preceding two weeks) together played a major role in predicting the incidence to an extent of 93 per cent with linear and 96 per cent with non linear multiple regression models.

All the 19 leafhopper species are described and illustrated. A key for distinguishing all these leafhopper species with line diagrams and colour photographs is given for easy identification.


The species, *Nephotettix nigropictus* (Stal), *Nephotettix virescens* (Distant) and *Maiestas dorsalis* (Motschulsky) acts as vectors and spreading Rice tungro, Rice yellow orange leaf and Rice grassy stunt.

The species, *Nephotettix nigropictus* (Stal), *Nephotettix virescens* (Distant) and *Maiestas dorsalis* (Motschulsky) reached pest status in rice crop ecosystem and the
remaining leafhopper species have not attained pest status on rice crop at present. These leafhoppers may be feeding on rice crop or may be casual visitors and may attain pest status in due course of time. Hence, accurate identification is necessary for effective pest management, in case of pest outbreak.
Studies on the seasonal incidence, biology and efficacy of different acaricides against rice leaf mite, *Oligonychus oryzae* were carried out at S.V. Agricultural College, Tirupati, during July, 2010 to June 2011.

Observations on the incidence of rice leaf mite in Chittoor and Nellore districts in relation to abiotic factors were carried out during July, 2010 to June, 2011. The peak activity of rice leaf mite, *Oligonychus oryzae* was observed during the months of May, June and July in Chittoor district and June and July in Nellore districts whereas the incidence of rice leaf mite during second fortnight of November to first fortnight of March was negligible with fall down of maximum and minimum temperatures in both Chittoor and Nellore districts.

Rice leaf mite was found to complete its life cycle with typical epimorphosis and different stages viz., egg, larva, protonymph, deutonymph and adult. The immature stages were followed by a quiescent stage. The incubation period of the egg was 2.94 days. The larval period lasted for 1.63 days. The corresponding protonymphal and deutonymphal average periods were 1.51 and 1.63 days, respectively. Thus, the total development period (egg to adult) was completed in 6.91 days in males and 9.09 days in females, respectively. The preoviposition, oviposition and postoviposition average periods were 0.715, 8.03 and 2.66 days, respectively. The adult longevity of male was 6.13 days and female was 9.54 days, respectively. The average egg laying capacity per female was 32 eggs.

The average size of the eggs was 117.6 μ in diameter. The average length and width of the larva was 143.6 μ and 96.7 μ, respectively. The average length and width of the protonymph was 186.2 μ and 117.6 μ, respectively. The deutonymph average length and width was 250.6 μ and 127.4 μ respectively. The adult males measured 246.6 μ in length and 119.0 μ in width whereas the adult females measured 324.8 μ in length and 162.4 μ in width, respectively.

Field trial conducted to evaluate the efficacy of different acaricides against rice leaf mite, *Oligonychus oryzae* revealed that spiromesifen (0.2 %) was the most effective acaricides with 95.77 per cent reduction in population of both nymphs and adults. The remaining chemicals in the descending order of their efficacy were profenofos (0.1 %),
propargite (0.05 %), fenazaquin (0.01 %), abamectin (0.001 %), dicofol (0.05 %) and sulphur (0.2 %) with 89.65, 89.55, 84.36, 82.83, 69.23 and 54.00 per cent reduction in population of rice leaf mite, *Oligonychus oryzae*, respective over untreated control. Studies on the ovicidal action of different acaricides conducted in the laboratory also revealed that low egg hatching percentage of 62.50 per cent was recorded in spiromesifen treated plots when compared to sulphur (86.67 per cent).
Experiments were carried out during 2010 in the Department of Entomology, Agricultural College, Bapatla, Guntur district, Andhra Pradesh to evaluate the cross resistance pattern in *Spodoptera litura* (Fab.) to certain new insecticide molecules.

Chlorfenapyr 10SC @ 0.015% was found to be most effective against *S. litura* larvae followed by flubendiamide 480SC @ 0.0118%, chlorantraniliprole 18.5SL @ 0.0083% and thiodicarb 75 WP @ 0.15% treatments. Thiodicarb 75 WP @ 0.15% was least effective with high pupation and survival percentage of 57.5 among all the treatments.

Larvae of *S. litura* (Guntur strain) resistant to chlorfenapyr in the F\textsubscript{1} and F\textsubscript{2} generations when subjected to different insecticides viz., chlorfenapyr, thiodicarb, chlorantraniliprole, and flubendiamide showed positive cross resistance of 1.5 folds to flubendiamide in the F\textsubscript{3} generation.

*S. litura* larvae resistant to chlorfenapyr in the F\textsubscript{1} & F\textsubscript{2} generations (Warangal) showed positive cross resistance of 2 fold to thiodicarb and 1 fold to chlorantraniliprole, chlorfenapyr and flubendiamide treatments in the F\textsubscript{3} generation.

Larvae resistant to chlorfenapyr and flubendiamide in the F\textsubscript{1} and F\textsubscript{2} generations (Guntur) showed positive cross resistance to larvae treated with chlorfenapyr (1.5 fold), flubendiamide (2 fold) and thiodicarb (1 fold) whereas negative cross resistance was recorded in chlorantraniliprole (0.9 fold) treatment.

Guntur population of *S. litura* resistant to chlorantraniliprole in F\textsubscript{1} and F\textsubscript{2} generations showed positive cross resistance to thiodicarb (1 fold) and chlorantraniliprole (2 fold) whereas negative cross resistance was recorded in chlorfenapyr (0.9 fold) and flubendiamide (0.9 fold) treatments during F\textsubscript{3} generation.

*S. litura* larvae (Warangal strain) resistant to chlorantraniliprole and thiodicarb in the F\textsubscript{1} and F\textsubscript{2} generations recorded positive cross resistance of 1 fold to thiodicarb and
chlorantraniliprole treatments whereas negative cross resistance was noticed in larvae subjected to flubendiamide (0.6 fold) and chlorfenapyr (0.9 fold) treatments.

Warangal population of *S. litura* resistant to chlorantraniliprole in the F₁ and F₂ generations recorded positive cross resistance of 1 fold to all the treatments viz., chlorfenapyr, thiodicarb, chlorantraniliprole, and flubendiamide.

*S. litura* larvae of Guntur population resistant to thiodicarb in the F₁ and F₂ generations showed positive cross resistance of 2 fold to thiodicarb and negative cross resistance was recorded in larvae subjected to chlorfenapyr (0.8 fold), chlorantraniliprole (0.7 fold) and flubendiamide (0.6 fold) treatments in the F₃ generation.

Warangal population of *S. litura* resistant to thiodicarb in the F₁ and F₂ generations showed positive cross resistance of 2 fold to thiodicarb whereas negative cross resistance was observed in chlorfenapyr (0.9 fold), chlorantraniliprole (0.9 fold) and flubendiamide (0.6 fold) treatments.

*S. litura* larvae resistant to flubendiamide in the F₁ and F₂ generations (Guntur and Warangal) recorded positive cross resistance of 2 fold to chlorfenapyr and 1 fold to the thiodicarb, flubendiamide and chlorantraniliprole treatments.

The Guntur strain of *S. litura* recorded 1.25 folds resistance to chlorfenapyr, 0.024 folds resistance to thiodicarb and 1.0 fold resistance to flubendiamide at LC₅₀ level and 3.28 folds resistance to chlorantraniliprole at LC₉₀ level.
ENTOMOLOGY

Author : SUBHAKAR, G.
Title of the thesis : POLLINATOR DIVERSITY AND ABUNDANCE IN MAJOR CUCURBITACEOUS CROPS
Major Advisor : Dr. K. SREEDEVI
Degree : M.Sc. (Ag.)
College : S.V. AGRICULTURAL COLLEGE, TIRUPATI
Accession Number : D 8946

The present studies on pollinator diversity and abundance in major cucurbitaceous crops were carried out at S.V. Agricultural College, Tirupati during 2010 and 2011. Pollinator diversity, species relative abundance, foraging activity, foraging behaviour and its correlation with floral morphometrics and abiotic factors in bitter gourd, bottle gourd and ridge gourd were studied. A total of 17 insect species viz., six hymenopterans, five lepidopterans, three dipterans and three coleopterans were observed to visit bitter gourd flowers. The pollinator diversity in bottle gourd was moderate with 10 insect species from nine families of five orders viz., six lepidopterans and one species each from hymenoptera, coleoptera, orthoptera and dictyoptera. In ridge gourd, 12 insect species from eight families of five orders viz., seven lepidopterans, two orthopterans and one species each from hymenoptera, coleoptera and dictyoptera were recorded. The relative abundance of bee species belonging to Apidae family was predominant in bitter gourd constituting 79.22 per cent. Among these, Trigona iridipennis, Halictus gutturosus and Apis florea were found to be the most frequent pollinators. In bottle gourd and ridge gourd the abundance of lepidopteran flower visitors constituted 70.07 and 76.68 per cent, respectively. Out of which Pyralid group alone contributed 55.22 per cent in bottle gourd and 51.99 per cent in ridge gourd. Among these, Hippotion celerio and Diaphania indica were the most frequent visitors in bottle gourd and ridge gourd.

The mean foraging activity of major pollinators in bitter gourd was high during 0900 h and 1000 h. Trigona iridipennis (10.83 bees/m2/5 min) was highest followed by H. gutturosus (1.06 bees/m2/5 min) and A. florea (0.37 bees/m2/5 min). In case of both bottle gourd and ridge gourd the peak foraging activity was observed during 1900 h and 2000 h. The mean foraging activity in bottle gourd was high for D. indica (2.06 visitors/m2/5 min) followed by A. hilarialis (2.02 visitors/m2/5 min) and H. celerio (1.87 sphingids/m2/5 min). In ridge gourd the peak foraging activity was recorded for D. indica (3.15 visitors/m2/5 min) followed by lepidopteran moth (2.42 visitors/m2/5 min) and H. celerio (2.30 sphingids/m2/5 min).

In bitter gourd the higher visitation rate was observed in H. gutturosus followed by A. florea. The mean time spent on flower was maximum in case of T. iridipennis followed by H. gutturosus. Although the time spent on flower was minimum for H. celerio, the visitation
rate was high in both bottle gourd and ridge gourd. A. hilarialis spent most time on bottle gourd flowers followed by D. indica and visitation rate was low and more or less similar for two pollinators. In case of ridge gourd un-identified moth mean time spent on flower was high followed by D. indica. However, the visitation rate was minimum for both pollinators.

The fruit set was high in open pollination in all three gourds ranging from 50.14 to 85.46 per cent and there was no fruit set in closed pollination where pollinators were excluded.

The foraging activity of major pollinators in bitter gourd showed no significant correlation with floral traits viz., lengths of corolla tube, anther, ovary, style, stigma except for stamen length which showed significant positive correlation with H. gutturosus activity. In bottle gourd, A. hilarialis activity showed significant positive correlation with stigma length. Whereas, in ridge gourd H. celerio foraging activity showed significant negative association with the lengths of stamen and style and un-identified moth activity showed significant negative correlation with ovary length. The pollinators activity did not show any significant correlation with abiotic factors in all three gourds.

It is concluded that hymenopteran bees were the dominant species among diurnal foragers whereas, lepidopteran moths were dominant among nocturnal foragers. This study reveals that the insect pollinators play a major role in fruit set and production of cucurbits. Hence, the conservation of the same is necessary in lines of biodiversity and sustainability.
Experiments for screening of advanced (promising) rice cultures against panicle mite *Steneotarsonemus spinki*, chemical management strategies against *S. spinki* and identification of pathogens associated with panicle mite or glume discolouration were carried out during *kharif*, 2010. Among the 49 rice cultures evaluated, eight cultures viz., RNR 898, RNR 9038, RNR 8913, RNR 8860, RNR 2458, Godavari Isukalu, NSN 21184 and NSN 34949 were moderately resistant against panicle mite due to their well exerted panicles and early duration. Among the chemical treatments evaluated for their performance against panicle mite, spiromesifen + propiconazole, diafenthuron + propiconazole and fenpyroximate alone treatments effectively controlled panicle mite and associated grain discolouration. In terms of increase in grain yield, spiromesifen + propiconazole, with 24.77 per cent increase in grain yield over untreated control, was the best. Seven pathogens were identified to be associated with grain discolouration / panicle mite based on their morphological and colony growth characters of seed microflora observed on PDA medium which includes *Aspergillus, Fusarium, Alternaria, Curvularia, Rhizopus, Xanthomonas* and *Actinomycetes*. 
Studies were conducted in the Department of Entomology, College of Agriculture, Rajendranagar, Hyderabad to determine the relative toxicity of selected organophosphate insecticides viz., profenofos and chlorpyriphos and carbamates viz., thiodicarb and methomyl against third instar larvae of *Spodoptera litura* (Fabricius) of local and Nalgonda populations by topical application method. Enzymatic studies were conducted in the Department of Pharmacology and Toxicology, College of Veterinary Science, Rajendranagar, Hyderabad to determine AChE activity in the populations of *S. litura* larvae treated with LC50 by the method of Ellman *et al.* (1961).

LC50 values based on bioassay studies indicated that among four insecticides, chlorpyriphos exhibited greater toxicity by topical application method after 24 hrs of exposure. The relative toxicity of these insecticides against local population was found to be in the order of chlorpyriphos (1.00) > thiodicarb (0.60) > profenofos(0.58) > methomyl (0.30). While against Nalgonda population it was chlorpyriphos (1.00) > thiodicarb (0.68) > profenofos (0.60) > methomyl (0.56) after taking the toxicity of chlorpyriphos as check as unity.

The mean AChE activity in μmoles/min/ml based on enzyme assay studies showed the highest AChE activity (1.266) in control followed by profenofos (0.988) and lowest AChE activity (0.628) for thiodicarb in Local population, while, the values were 1.387, 1.120, and 0.688, respectively for Nalgonda population.

The mean AChE activity in μ moles/min/ml of sample and the change in per cent AChE activity in the sample containing the selected insecticides viz., profenofos, chlorpyriphos, thiodicarb and methomyl for a period of 30 min was gradually decreased with the progress of time in both the populations.

The per cent AChE activity was the highest for profenofos with 78.8 % with respect to control and lowest (48.7 %) for thiodicarb in Local population, while for Nalgonda population the values were 81.1 % and 49.3 %, respectively.
Positive correlation between the toxicity and AChE activity was observed for organophosphate insecticides and no correlation was observed in case of carbamate insecticides.
ENTOMOLOGY

Author : SWETHA, K.

Title of the thesis : EVALUATION OF DRY FORMULATIONS OF *Nomuraea rileyi* (FARLOW) SAMSON AND MOLECULAR CHARACTERIZATION OF ITS ISOLATES

Major Advisor : Dr. K. MANJULA

Degree : M.Sc. (Ag.)

College : S.V. AGRICULTURAL COLLEGE, TIRUPATI

Accession Number : D 8942

The *N. rileyi* was mass cultured on SMAY medium to prepare the dry formulations (wp). Five carriers viz., talc, wheat flour, corn flour, broken rice flour and vermiculite were used as inert materials to prepare wettable powder formulations. The inert materials were prepared by following standard procedure, and mixed with 2 grams of harvested *N. rileyi* spores by adding 0.005% Tween 20 as wetting agent. The prepared formulations were transferred to sterilized polythene bags, packed tightly and stored at 20°C in an incubator, and all these wettable powder formulations were evaluated for conidial viability and virulence against *S. litura* larvae in monthly intervals.

The results proved that broken rice flour and corn flour were more suitable material for storage for short period i.e. upto two months in terms of viability. Whereas talc may be considered best to store and use the formulation for still longer periods. Corn flour and broken rice flour occupies next position for longer storage. Vermiculite found to record lowest viable conidia than other inert materials. Among the dry formulations tested for virulence against third instar *S. litura* larvae after one month of storage, corn flour recorded highest larval mortality of 67.50 per cent. The broken rice flour followed the corn flour. In the second month also the corn flour recorded highest larval mortality of 52.50 per cent, followed by talc and rice flour. From the third month onwards, the talc showed higher larval mortality upto 150 days after storage. Out of the five wettable powder formulations talc and corn flour recorded virulence upto 5 months. The broken rice flour, recorded larval mortality upto 120 days of storage, thereafter no mortality was recorded. Wheat flour and vermiculite recorded larval mortalities after 90 days of storage, there after there is no effect on treated III instar *S. litura* larvae with either of the formulations. There was reduction of pupal mortalities with increase in storage period with all the five formulations.

A Roving survey was carried out in four Agricultural divisions viz., Puttur, Srikalahasti, Palamaneru and Madanapalli divisions of Chittoor district for the natural occurrence of entomopathogenic fungi on lepidopteran caterpillars. The major silkworm growing villages of chittoor district also visited for mummified *Bombyx mori* larvae. From groundnut fields of Ramachandrapuram village and in some of the silk worm rearing units in Kanumakupalli (Palamaneru division), Kosuvaripalli and Taruguvaripalli (Madanapalli
division), a few fungal infected and died (mummified) cadavers of *S.litura* and *B.mori* were found and collected.

The molecular characterization of 7 isolates of *N.rileyi* was done by RAPD-PCR for studying genetic variability/similarity. RAPD banding profiles with 12 different random primers *viz.*, 3 primers from OPD, 3 primers from OPY, 2 primers from OPM, 2 primers from OPA, 1 primer from OPC and 1 primer from OPW (Operon technology) revealed the existence of genetic variability to a considerable extent among the isolates. These primers showed 88.60% polymorphism as all the bands obtained were polymorphic with size ranging from 100 bp to 3000 bp. Jaccards similarity co-efficients between the *N.rileyi* isolates produced shows 97.50% genetic variation between isolates of Tirupati and V.Kota-1 closely followed by Dharwad and V.Kota-1 (95.60%). While the isolate V.Kota-2 and Madanapalli were found to be genetically similar as 70.30% similarity was observed between the isolates followed by 68.10% similarity between V.Kota-2 and Kanumakupalli isolates. In the resulted dendrogram, V.Kota-2 and Madanapalli isolates formed one group and V.Kota-2 and Kanumakupalli in another group and remaining isolates did not form any group.
Investigations were carried out to evaluate the pathogenicity of *Beauveria bassiana* (Balsamo) Vuillemin against tobacco caterpillar, *Spodoptera litura* Fabricus and diamond back moth, *Plutella xylostella* L. and the compatibility of *B. bassiana* with commonly used insecticides for cabbage pest management. Influence of different spore concentrations viz., $1 \times 10^5$, $1 \times 10^6$, $1 \times 10^7$, $1 \times 10^8$ and $1 \times 10^9$ spores per ml were tested for the pathogenicity of *B. bassiana*. Similarly compatibility of *B. bassiana* with commonly used insecticides viz., novaluron 10 EC, fenvalerate 20 EC, spinosad 2.5% SC, endosulfan 35 EC, acetamiprid 20 SP and chlorofenapyr 10 SC was studied.

Result of the present studies indicated that among different spore concentrations of *B. bassiana* $1 \times 10^7$ spores per ml was found to be more effective and promising concentration. This was evidenced by the fact that $1 \times 10^7$ spores per ml concentration of *B. bassiana* in general was found promising in terms of increased per cent larval mortality, reduced pupation and reduced per cent adult emergence of both *S. litura* and *P. xylostella*. When five different concentrations viz., $1 \times 10^5$, $1 \times 10^6$, $1 \times 10^7$, $1 \times 10^8$ and $1 \times 10^9$ spores per ml were used against *S. litura* and *P. xylostella*, a dose dependent mortality was observed that has resulted in about to 85.0 per cent larval mortality in case of *S. litura* and 100.0 per cent in case of *P. xylostella*. The median lethal concentration (LC50) recorded in case of *S. litura*, $15.103 \times 10^7$ spores per ml and for *P. xylostella*, $3.5248 \times 10^7$ spores per ml of *B. bassiana*.

Results obtained from the compatibility studies revealed that *B. bassiana* was relatively compatible with novaluron and chlorofenapyr, both in terms of highest radial growth of 33.5 mm and 27.5 mm, respectively with least per cent inhibition of 62.72 per cent and 69.4 per cent, respectively, among different insecticides tested. However, acetamiprid was found to be highly toxic and incompatible reducing the fungal growth and increasing inhibition showing no radial growth with 100.0 per cent inhibition. Fenvalerate, spinosad and endosulfan were moderately compatible with *B. bassiana* with radial growth of 26.25, 25.5 mm and 23.25 mm, respectively and 70.80, 71.62 and 74.12 per cent inhibition, respectively.

Overall results suggested that *B. bassiana* at spore concentration of $1 \times 10^7$ spores per ml was proved to be the most effective concentration recording highest pathogenicity.
especially, when it is used along with novaluron, which was found to be compatible with *B. bassiana*, recorded highest radial growth and least per cent inhibition. Though the two insecticides novaluron and chlorfenapyr have revealed maximum radial growth ranging from 27.5 to 33.5 mm but they could result in inhibiting the fungal growth to an extent of 62.72 to 69.4 per cent. Results also revealed that acetamiprid shouldn’t be mixed with *B. bassiana* that totally inhibit the fungus growth.
Laboratory experiments on growth and development of Bihar hairy caterpillar *Spilosoma obliqua* on Castor under elevated CO$_2$ conditions were undertaken during September 2010 – February 2011. The host plant Castor was grown inside the Open Top Chambers (OTCs) at three levels of CO$_2$ concentration (550 ppm, 700 ppm and ambient condition) to obtain the feed for laboratory culture of *S. obliqua*. The experimental results showed that *S. obliqua* consumed significantly higher quantity of Castor foliage under elevated CO$_2$ condition as compared to ambient condition. The final larval weight, leaf weight consumed and faecal matter weight were observed more significant among all the treatments and the larval duration was increased to one day in the elevated CO$_2$ condition than the ambient condition. There was significant difference in the pupal weight recorded and it was more in the ambient condition as compared to the elevated CO$_2$ condition. There were no significant differences in other parameters like, pupal duration and adult longevity.

The multiple generation studies (four) were conducted to know the effect of elevated CO$_2$ on *S. obliqua* on Castor crop. Feeding trials were continued with castor leaves by maintaining the corresponding CO$_2$ conditions. Significant differences were observed in growth and development of *S. obliqua* when fed on elevated CO$_2$ foliage across generations. The consumption of foliage was found to be higher under elevated CO$_2$ conditions (3.652g in 550 ppm and 3.671g in 700 ppm) than ambient CO$_2$ condition (3.309g). Similarly the consumption pattern significantly varied across generations starting from first (3.089g) to fourth (3.945g) generation. This was more evident in the third (3.956g) and fourth (3.945g) generations than the first (3.089g) and second (3.187g) generations. The mean larval weight was found to be higher under elevated CO$_2$ condition (0.864g in 550 ppm and 0.864g in 700 ppm) than the ambient CO$_2$ condition (0.772g). Similarly, the mean larval weight significantly varied across generations starting from first (0.788g) to fourth (0.869g) generations. This was more evident in the third (0.856g) and fourth (0.869g) generations than the first (0.788g) and second (0.795g) generations. The mean faecal matter weight was found to be higher under elevated CO$_2$ condition (1.032g in 550 ppm and 1.099g in 700 ppm) than the ambient CO$_2$ condition (0.964g). Similarly, the mean faecal matter weight significantly varied across generations starting from first (0.853g) to fourth (1.155g) generations. This was
more evident in the third (1.207g) and fourth (1.155g) generations than the first (0.853g) and second (0.91g) generations.

The consumption of foliage, larval weight and faecal matter were significantly higher in all the four generations under elevated CO₂ condition as compare to the ambient condition. The larval duration showed significant differences in the four generations. In the first generation larvae fed with elevated CO₂ foliage developed slower and took 21 days in 550 ppm, 700 ppm and 20.2 days in ambient (350 ppm) condition. The result showed that an increase of nearly one day of larval duration was observed with elevated CO₂ conditions. Duration of larvae was increased in second generation when reared on elevated CO₂ foliage and took 22 days in 550 ppm and 22.2 days in 700 ppm and 21 days in ambient (350 ppm) condition. Where as in the third and fourth generation larvae took 23 days in 550 ppm, 700 ppm and 21 days in ambient condition. There was no difference in larval duration of third and fourth generation. Result showed that an increase of one day of larval duration in second generation and two days in the third and fourth generation was observed with elevated CO₂ conditions.
Laboratory studies were conducted in the Department of Entomology, College of Agriculture, Rajendranagar, Hyderabad during 2010-11.

The performance of 16 pigeonpea varieties/genotypes to *C. chinensis* was assessed based on the development of the insect and seed damage. Significant variation was observed among the varieties with respect to pest development and seed damage. The varieties were classified into 5 categories based on index of susceptibility as resistant, moderately resistant, moderately susceptible, susceptible, and highly susceptible. PRG-158 and PRG-100 which recorded 0.0 and 0.8 index of susceptibility were categorized as resistant while seven varieties viz., Lakshmi, ICPL-87119, LRG-38, ICPL-8863, LRG-41, WRG-79 and WRG-65 exhibited moderate resistance (2.9 to 5.0) and the remaining 7 varieties/genotypes viz., MRG-66, LRG-30, WRG-27, WRG-53, WRGE-18, WRGE-14 and Durga showed moderate susceptibility (5.1 to 6.0 index of susceptibility) to bruchid infestation.

Among the physical parameters, seed colour played a significant role on fecundity of the test insect while inter granular space showed significant influence on fecundity, developmental period, adult emergence and seed infestation. The chemical parameters like high ash, potash content of test varieties were detrimental to the growth and development of test insect while protein content of the test varieties favoured the successful development of bruchids.

The grain protectants used in the study indicated that all the 4 oils viz., soyabean, sesamum, eucalyptus and karanj used @ 3ml/kg seed significantly reduced the fecundity, adult emergence and seed infestation and were on par with the chemicals deltamethrin 2.8 EC (0.04ml/kg seed) and spinosad 45 SC (4 ppm). The chemicals caused 100% mortality at 24 hours after treatment while the oils were slow in their action and caused 66.76% mortality of test insect after 7 days of treatment except karanj oil which exhibited 82.67% mortality at 24h after treatment.

The efficacy of bags and bag treatment on *C. chinensis* infestation showed the superior performance of untreated and insecticide treated (deltamethrin and spinosad)
polythene and magik bags and they protected the stored grain from bruchid infestation up to 3 months of storage than cloth and gunny bags when subjected to natural infestation.
A column experiment was undertaken to study the ‘Influence of zeolite on sewage irrigated soils in peri urban areas of Hyderabad, AP’. The laboratory analysis was conducted to know the efficiency of zeolite in treating sewage collected from two sources viz., Noor Mohammed sewage treatment plant (NMK STP) and Mir Alam sewage treatment plant (MA STP), maintained by Greater Hyderabad Municipal Corporation. The other objective of the study was to elicit the information about the effectiveness of zeolite at different concentrations.

Cylindrical polyvinyl chloride tubes of 50 cm height with internal diameter of 10.5 cm, were mounted on the wooden stand for the research study. The columns were filled up to 30 cm with red sandy loam soil, and rest of the 15 cm of the column was filled with zeolite on weight basis, according to treatments (six) from T1 to T6 viz., 0.25%, 0.50%, 0.75%, 1.00%, 1.25% and 1.50%. The last seventh treatment T7 (control) was without any zeolite application. Funnels were kept at the bottom of the columns to collect the leachates. 480 ml of sewage water which constituted 1/3rd of the pore volume of the column (1440 ml) was added for each leaching event.

The results indicated that, the zeolite has good potential of reducing ion concentration from sewage. The increase in concentration of zeolite from T1 (0.25%) to T6 (1.50%) exhibited increase in efficiency of zeolite in reducing the toxic ions concentration viz., nitrates, phosphates, bicarbonate, calcium and magnesium. Similarly, concentration of heavy metals such as cobalt, lead and cadmium present in inlet sewage from both the sources, was reduced due to its high cation exchange capacity. The average cobalt removal efficiency of 12.05 %, lead of 33.77 % and cadmium of 27.48 % was observed in both the sources. But, removal efficiency of heavy metals was not found up to their permissible limit. The treatment T6, where highest percentage of zeolite (1.50 %) was added showed more removal efficiency for ions like, bicarbonate, calcium, magnesium, nitrates, phosphates, cobalt, lead and cadmium contents of sewage collected from both the sources. It also resulted in significant reduction in BOD, COD and increase in pH and EC of the sewage.
The soil was removed from the columns of both the sources, according to different layers viz., 0-15 cm (D1), 15-30 cm (D2) and 30-45 cm (D3), after leachates collection and analyzed for various physical and chemical parameters viz., pH, EC, organic carbon, available nitrogen, phosphorus, potassium and available heavy metals contents (cobalt, lead and cadmium).

The results showed that the zeolite did not affect the pH, EC and OC of the soil while, it increased the available nitrogen content of the soil. The available potassium content was found to be decreased corresponding to the increase in rate of zeolite application.

Heavy metal removal efficiency of zeolite was found to be increased with the increase in rate of zeolite application, but not significantly.

Conclusively, the heavy metal content in soils applied with sewage from Mir Alam STP was found to be higher as compared to that of the soils applied with the sewage from NMK STP, indicating more load of pollutants in sewage of former STP as compared with later. However, further research should be carried out with higher concentrations of zeolite to ascertain its role in sewage water management.
The experimental material used in the study consisted of six segregating populations in F2 and seven parents. The F2 populations were derived from six crosses i.e., Tirupati-1 x GPBD-4, Narayani x GPBD-4, Abhaya x GPBD-4, Kadiri-6 x GPBD-4, TLG-45 x GPBD-4 and TCGS-876 x GPBD-4. The material was grown in dry land farm of Regional Agricultural Research Station (RARS), Tirupati during kharif, 2010 in a randomized block design with three replications. The data recorded on yield and its component characters and disease resistance component characters were analyzed for variability, heritability, genetic advance, character association and inheritance studies. Mean values, in respect of pod yield, mature pods per plant, harvest index and number of primary branches were high in TLG-45 x GPBD-4, TCGS-876 x GPBD-4 and Abhaya x GPBD-4. Shelling out-turn was high in crosses Tirupati-1 x GPBD-4, Kadiri-6 x GPBD-4 and TCGS-876 x GPBD-4.

With regard to foliar disease resistance parameters, lower mean values in respect of percentage of leaves affected by LLS, rust and LLS and rust severity were recorded in TLG-45 x GPBD-4, TCGS-876 x GPBD-4 and Abhaya x GPBD-4 and higher mean latent period was also registered in these three crosses.

Genotypic coefficient of variation, heritability and genetic advance as percentage of the mean were relatively high for pod yield, mature pods per plant, immature pods per plant and primary branches per plant in four crosses, Abhaya x GPBD-4, TLG-45 x GPBD-4, Narayani x GPBD-4 and TCGS-876 x GPBD-4. For harvest index, moderate values of GCV, heritability and GAM were recorded in only one cross, TCGS-876 x GPBD-4. In these crosses, these characters appear to be highly influenced by additive gene action. Hence simple phenotypic selection would be effective for the improvement of these traits. In the cross, TLG-45 x GPBD-4, higher values of GCV, heritability and GAM were recorded for latent period. For LLS and rust severity, genetic parameters were high in Tirupati 1 x GPBD-4 and Narayani x GPBD-4 in which female parents were highly susceptible to LLS and rust. In these crosses, selection for disease resistance would be effective in early generations. In Abhaya x GPBD-4, selection for LLS resistance would be more fruitful in early generations. Considerable variation was
observed for percentage of leaves affected by rust in five crosses except in TCGS-876 x GPBD-4.

In majority of the crosses, there was significant positive association of pod yield with harvest index, mature pods per plant and latent period and negative significant association with percent of leaves affected by LLS, rust and severity of LLS and rust. Abhaya x GPBD-4 showed non-significant negative association with percent of leaves affected by LLS and rust. The association of pod yield with LLS and rust severity was negative and non significant in the crosses, TLG-45 x GPBD-4 and TCGS-876 x GPBD-4. Harvest index showed a positive significant association with mature pods per plant and shelling out-turn. Changes both in sign and intensity of correlation among characters were found in some of the F2 populations i.e., between pod yield and shelling out-turn in Narayani x GPBD-4, between mature pods and LLS severity in Abhaya x GPBD-4, indicating the disruption of linkage between characters resulting in new recombinations.

From preliminary studies on inheritance of LLS resistance, it was found to be governed by two genes which exhibit coupling phase linkage in all the crosses. Studies on inheritance of resistance to rust in three crosses indicated the involvement of two genes with duplicate gene action.

From an overall examination, Abhaya x GPBD-4, TLG-45 x GPBD-4 and TCGS-876 x GPBD-4 appear to be best combinations which would throw up desirable segregants in later generations for most of the characters including yield and yield attributes and disease resistance components. These crosses should be studied in greater detail for isolating desirable recombinants in later generations.
An investigation on genetic divergence in pigeonpea was carried out during kharif, 2009-2010 at Regional Agricultural Research Station, Lam, Guntur with 45 genotypes of pigeonpea [Cajanus cajan (L.) Millsp.] to elicit the information on nature and extent of the genetic variability, heritability, genetic advance, character association, path analysis and genetic divergence. Observations were recorded on twenty one characters, viz., plant height (cm), days to 50% flowering, days to maturity, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, pod length (cm), number of seeds per pod, shelling percentage (%), 100 seed weight (g), seed yield per plant (g), grain protein content (%), harvest index, LAI at vegetative stage, LAI at flowering stage, SLA at vegetative stage(cm²/g), SLA at flowering stage (cm²/g), SLW at vegetative stage (mg/cm²), SLW at flowering stage (mg/cm²), RWC at vegetative stage (%) and RWC at flowering stage (%).

The genotypic coefficients of variation for all the characters studied were lesser than the phenotypic coefficients of variation indicating the effect of the environment. High genetic variability coupled with high heritability and genetic advance as per cent of mean was observed for number of primary branches per plant, number of secondary branches per plant, number of pods per plant and seed yield per plant indicating the role of additive gene action governing the inheritance of these traits.

The correlation study indicated that the plant height, days to 50% flowering, number of secondary branches per plant, pods per plant, shelling percentage, harvest index, SLA at vegetative stage and SLA at flowering stage had significant positive association with seed yield and simultaneous improvement of these characters along with seed yield is possible. Path coefficient analysis revealed that plant height, number of pods per plant and shelling percentage had showed maximum positive direct effects on seed yield per plant.

The results of multivariate analysis revealed the presence of considerable genetic divergence among the 45 genotypes studied and grouped into seven clusters as per D².
analysis and also in case of cluster analysis. The grouping of genotypes into clusters was at random, which suggested that geographical isolation might not be the only factor causing genetic diversity. Out of 21 characters studied, the character seed yield per plant contributed maximum towards divergence followed by grain protein content, relative water content at flowering stage, relative water content at vegetative stage, number of secondary branches per plant and specific leaf weight at flowering stage.

Based on the inter-cluster distances among the groups, it was suggested to attempt crosses between cluster VI (SURYA, LRG-69, JSA 66, LRG-73 and TAT 9629) and cluster VII (11969) which had maximum inter cluster distance to obtain better heterotic and desirable segregants. Principal component analysis identified seven principal components (PCs) which explained 78.0% of the variability.

Agglomerative cluster analysis revealed that crosses can be attempted between clusters II (SKNP 0528, 11960, ARCC V2, LRG-56 and 11969) and cluster VII (JSA 66, LRG-50, TAT 9629, LRG-73, SURYA and LRG-69) which had wide genetic distance to obtain maximum heterosis.

The genotypes LRG-69, JSA-66, LRG-73, TAT 9629 and 11969 showed maximum inter-cluster distance and wide genetic distance in all the three divergence methods with each other. So they can be exploited in hybridization programme for identification of desirable segregants.
GENETICS AND PLANT BREEDING

Author : CHARUMATHI, M.

Title of the thesis : STUDIES ON SELECTION INDICES IN SUGAR CANE (Saccharum officinarum L.)

Major Advisor : Dr. N. VARADARAJULU NAIDU

Degree : Ph. D.

College : S.V. AGRICULTURAL COLLEGE, TIRUPATI

Accession Number : D 8977

The present investigation was carried out to study variability, genetic parameters, character associations, repeatability, selection indices and to identify potential genotypes at seedling and clonal generations in sugarcane (Saccharum officinarum L.). The field experiment was laid out at Regional Agricultural Research Station, Anakapalle from 2007-08 to 2009-10.

Analysis of variance revealed existence of variation among the genotypes for number of green leaves, leaf area index at 60 DAP, shoot population at 90, 120, 180, 240 DAP, NMC at 300 DAP, single cane weight, cane length, cane volume, NMC per plot, cane yield and sugar yield at all the three stages of evaluation viz., seedling, first and second clonal generations.

Based on the mean data in seedling nursery, the cross combinations viz., CoC 90063 x CoA 7602 and CoC 90063 x Co 94008 for number of canes per clump, cane volume and cane yield; ISH 100 x C81615, Co85002GC and CoC90063 x CoA7602 for single cane weight and cane diameter; 81V 48 x ISH 69 and CoC 671 x CoT 8201 for HR brix per cent were identified as the best. The clones viz., 2008A15, 2008A74, 2008A104, 2008A112, 2008A113, 2008A120, 2008A160, 2008A171, 2008A187, 2008A234, 2008A236, 2008A241, 2008A357, 2008A380, 2008A387, 2008A427, 2008A444, 2008A465 and 2008A470 were identified as the best clones based on higher mean values for shoot population at 120 DAP, NMC at 300 DAP, NMC at harvest, cane diameter, single cane weight, sugar yield and cane yield in both the clonal stages.

Moderate estimates of GCV and PCV coupled with higher heritability and GAM recorded in seedling nursery for number of millable canes, single cane weight, cane yield and cane volume indicated the importance of additive gene action. Low estimates of GCV and PCV coupled with high heritability and low GAM for cane length, cane diameter and HR brix per cent indicated the operation of non-additive gene action for the above characters.
Moderate GCV and PCV coupled with high heritability and genetic advance over mean for cane volume, NMC per plot and CCS yield indicated the importance of additive gene action in the governance of the characters. Simple selection procedures may help in bringing genetic improvement in these characters. Low to moderate values of GCV and PCV along with low to moderate estimates of heritability and GAM for the characters viz., number of green leaves at 60 DAP and 120 DAP, leaf area index at 60 DAP and 120 DAP, brix per cent, sucrose percent, purity per cent and cane diameter suggested the operation of non additive gene action in the inheritance of characters. Low to moderate estimates of GCV and PCV coupled with moderate to high estimates of heritability and GAM for CCS per cent, shoot population at 90, 120, 180, 240 DAP and NMC at 300 DAP, single cane weight, cane length and cane yield indicated the importance of both additive and non additive gene action in the inheritance of the above characters. The differential pattern of gene action for the characters in seedling and clonal generations could be due to differences in sample size estimation procedures and environmental variation.

The magnitude of genotypic correlations were higher than phenotypic correlations indicating the greater influence of genotype than environment. Positive and significant association among yield components viz., single cane weight, cane length and cane diameter was observed in seedling nursery. Associations of yield components viz., NMC, single cane weight, cane length, cane diameter with cane yield were significant in both the clonal generations. Juice quality parameters viz., brix, sucrose, CCS and purity per cent had significant positive correlation with cane yield in first clonal generation but positive non significant association in second clonal generation. Number of millable canes, single cane weight, cane length, cane diameter, cane yield and juice quality parameters had positive and significant correlation with sugar yield in both the clonal generations suggesting that simultaneous selection can be made for both yield and juice quality characters. Negative correlations of number of green leaves with leaf area index in both the clonal generations indicated that optimum leaf area index is required for realizing higher yields.

Repeatability of associations at seedling and two clonal generations revealed that single cane weight and NMC had consistence positive and significant association with cane yield. Similar trend was observed in clonal generations for shoot population at 120 DAP, NMC, single cane weight, cane length and cane diameter with cane and sugar yield. Juice quality characters viz., brix, sucrose CCS and purity per cent were found to have significant effect on sugar yield. Intense selection for these characters may lead to spectacular improvement in cane and sugar yield owing to strong associations among themselves. Number of millable canes per clump, single cane weight and cane volume had higher positive direct effect on cane yield in seedling nursery. Higher positive direct effects of NMC, single cane weight, brix per cent, CCS per cent and NMC, single cane weight, cane length, cane diameter and sucrose per cent on cane yield in first and second clonal stages and number of green leaves, leaf area index, shoot population at 120 DAP, cane length, cane diameter and sucrose per cent on sugar yield suggested that direct selection for these characters may be rewarding in bringing improvement in cane and sugar yields at clonal generations. Indirect positive effects of shoot population at 120
DAP and brix per cent on cane yield and NMC, single cane weight and brix per cent on sugar yield in both the clonal stages were noticed.

Weighing coefficient values were found high for single cane weight at all the three stages of evaluation. Higher selection criterion values were noted for the best cross combinations *viz.*, 86A146 x Co 86011, 81V48 x CoT 8201, 87A380 x Co 87268, 86A146 x CoH 107, Co 8371 x 89V74, 87A298 x Co 94008, 81V48 x CoA7602, CoC 85061 x MS 6847, 87A298 x 89V74 and 81V48 x Co 94008.

Genetic advance and relative efficiency values increased linearly with simultaneous inclusion of characters. A combination of 13 characters *viz.*, cane yield, sugar yield, number of green leaves, leaf area index, shoot population at 120 DAP, NMC, single cane weight, cane length, cane diameter, brix, sucrose, CCS and purity per cent resulted in high genetic advance and relative efficiency over a combination of 10, 11 and 12 characters in both the clonal generations suggesting that selection may be effective when simultaneous selection is made based on component characters. Hence, multi-trait selection may be useful in bringing improvement in cane yield and sugar yields.

The present investigation was undertaken to identify the effective restorers and maintainers among the gall midge resistant lines, based on the results parents were selected and mated in Line x Tester mating design to study the combining ability, magnitude of heterosis and to assess the stability of experimental hybrids for single plant yield and yield contributing characters in Telangana region of Andhra Pradesh. Further, an attempt was made to understand the inheritance pattern of fertility restoration for four crosses.

Out of 120 lines screened for restorer and maintainer reaction 22 lines exhibited very high spikelet fertility (>80%), 18 lines exhibited partial fertility (60 to 80%), 35 lines resulted low fertility (10 to 60%) and 45 lines recorded complete sterility/very low fertility (<10%). From the above results, 13 R lines were identified as male parents and crossed with five CMS lines in Line x Tester mating design resulting in 65 hybrids. The 18 parents, 65 hybrids and six checks viz., KRH-2, DRRH-2, PA-6201 Jaya, IR-64 and TN1 were evaluated for gall midge resistance, combining ability, heterosis and stability of the hybrids at three locations viz., Kunaram (Karimnagar District), Warangal and Kampasagar (Nalgonda District) of Telangana region of Andhra Pradesh during Kharif, 2009.

The reaction of genotypes towards the gallmidge at three locations is different; the incidence recorded was more at Warangal, followed by Kampasagar and Kunaram. This may be due to the different biotypes existing at three locations. The R lines used are taken from RARS, Jagtial, which may be resistant to gallmidge biotype 3, due to existence of different biotypes of gallmidge at Warangal as well as at Kampasagar, the incidence percentage varied. However, some hybrids exhibited resistance reaction at all the three locations indicating the resistance of hybrids to different biotypes. Among the gallmidge resistant hybrids based on per se performance, the top five hybrids identified are, APMS 6A x JGL 11111, APMS 6A x JGL 8292, IR 58025A x JGL 16284, IR 68897A x JGL 16284 and APMS 6A x JGL 13515. Out of five hybrids 4 are of medium duration and one is of short duration type.
Segregation pattern for spikelet fertility in F\textsubscript{2} generation of four crosses were studied, the results revealed that the F\textsubscript{2} populations of all the four crosses viz., APMS 6A x JGL 11110-2, APMS 6A x JGL 11110-1, APMS 6A x JGL 17211 and APMS 6A x JGL 16284 exhibited a segregating ratio of 15:1 indicating duplicate dominant epistasis.

On the whole based on the overall performance, among the testers APMS 8A and APMS 6A, among the lines JGL 11110-2, JGL 11110-1, JGL 11111, JGL 8605 and JGL 8292, among hybrids APMS 8A x JGL11110-1, APMS 8A x JGL 11110-2, APMS 6A X JGL 11110-1, APMS 6A x JGL 11111, APMS 6A x JGL8605 and APMS 6A X JGL 8292 are found to be the best in the present investigation.

The overall study of sca effects of different traits, in the present investigation reveals that sca effects of per se performance of the crosses were not closely related. The crosses with high per se performance need not be the one with high sca effects and vice versa. The reason ascribed is due to positive interaction between nuclear and cytoplasmic genes appear to be important that the interaction between nuclear genes alone. It is evident from the different studies, the predominance of non-additive gene action over the additive component, which is ideal for exploitation through heterosis breeding.

Out of 65 hybrids tested for single plant yield, 61 hybrids are categorized under group (I) i.e. stable over three environments; the other 4 hybrids are included in groups (II), which were unstable. The 100% of the parents, 94% of the crosses 100% of the checks exhibited the stability over three environments, for the important character single plant yield.

Keeping in view of the above facts, by considering all the factors like, per se performance, sca effect, standard heterosis over PA 6201 and KRH-2, average heterosis, heterobeltiosis, stability, duration, grain type, LB ratio, the most promising hybrids identified were APMS 8A x JGL 11110-2, APMS 6A x JGL 11111 and APMS 6A x JGL 8292.

The hybrid APMS 8A x JGL 11110-2 recorded highest single plant yield of 31.22 gm/plant, high sca effect, and significant standard heterosis over check KRH-2 (23.15) with 136 days duration. This hybrid is stable over locations for grain yield, with medium slender grain type, with LB ratio of 3.5, but this was showing susceptibility reaction to gallmidge at Warangal.

The hybrid APMS 6A x JGL 11111 was the most promising gallmidge resistant hybrid identified. The duration of APMS 6A x JGL 11111 was 126 days, which recorded the yield of 28.65 gm/plant, significant sca effect, significant standard heterosis over KRH-2 (15.52). This hybrid was stable over three locations for grain yield per plant, with medium slender grain type, having LB ratio of 3.19.

Another gallmidge resistant hybrid identified was APMS 6A x JGL 8292 with 128 days duration, 26.32 gm/plant grain yield and significant standard heterosis (5.42) over check KRH-2. This hybrid is stable over three locations for grain yield, with medium slender grain type, having LB ratio of 2.89.
GENETICS AND PLANT BREEDING

Author : DHANA LAKSHMI, P.
Title of the thesis : GENETIC DIVERGENCE IN DESI COTTON (Gossypium arboreum L.)
Major Advisor : Dr. J.S.V. SAMBA MURTHY
Degree : M.Sc. (Ag.)
College : AGRICULTURAL COLLEGE, BAPATLA
Accession Number : D 9060

The present investigation was carried out during kharif, 2010-11 at Students’ Farm, Agricultural College, Bapatla, Guntur, Andhra Pradesh with 57 genotypes of cotton (Gossypium arboreum L.) to know the extent of genetic variability, heritability, genetic advance as per cent of mean, character association, the magnitude of direct and indirect effects of yield component traits on seed cotton yield and genetic divergence based on 23 characters viz., plant height (cm), days to 50% flowering, number of monopodia per plant, number of sympodia per plant, relative water content (%), specific leaf weight (mg/cm²), C.G.R at peak flowering (g/m²/day), C.G.R at boll formation (g/m²/day), C.G.R at maturity (g/m²/day), boll weight (g), number of bolls per plant, number of seeds per boll, seed index (g), lint index (g), ginning out-turn (%), 2.5% span length (mm), maturity coefficient, uniformity ratio (%), fibre elongation (%), micronaire (10-6 g/in), bundle strength (g/tex), lint yield per plant (g) and seed cotton yield per plant (g).

The genotypic coefficient of variation for all the characters studied was lesser than the phenotypic coefficients of variation indicating different levels of interaction with the environment. Wide variability was recorded for number of monopodia per plant, relative water content and C.G.R at maturity. High heritability coupled with high genetic advance as per cent of mean was observed for plant height, number of monopodia per plant, number of sympodia per plant, relative water content, specific leaf weight, C.G.R at peak flowering, C.G.R at boll formation, C.G.R at maturity, boll weight, number of bolls per plant and lint index indicating the predominance of additive gene action and hence, direct selection maybe rewarding. High heritability coupled with moderate genetic advance was observed for number of seeds per boll, seed index, ginning out-turn, 2.5% span length and bundle strength, revealing the role of both additive and non-additive gene action. The other traits viz., days to 50% flowering, maturity coefficient, uniformity ratio, fibre elongation and micronaire showed higher heritability with low genetic advance indicating the preponderance of non-additive gene action.

Correlation studies indicated significant positive association of days to 50% flowering, C.G.R at boll formation, number of bolls per plant and lint yield per plant with seed cotton yield per plant.
The path analysis revealed direct positive effect of boll weight and number of bolls per plant on seed cotton yield per plant. However, a true relationship existed between number of bolls per plant and boll weight with seed cotton yield per plant. So, improvement of seed cotton yield may be aimed through improvement in number of bolls per plant and boll weight by adopting restriction selection model without sacrificing fibre quality.

The results of multivariate analysis revealed considerable divergence among fiftyseven genotypes studied. These genotypes were grouped into eight clusters both in case of D2 analysis and also in Ward’s minimum variance method. Clustering pattern suggested that geographical distance may not be the only factor causing genetic divergence among the genotypes studied.

By Mahalanobis’ D2 statistic, it was noted that relative water content, specific leaf weight, plant height, C.G.R at maturity, boll weight, maturity coefficient and lint index contributed maximum towards divergence. Based on inter-cluster distance among the groups, crosses may be effected between genotypes belonging to cluster IV (RG 630) and cluster VIII (IC 412441) followed by cluster VII (DLSA 17) and cluster VIII (IC 412441).

In principal component method, first 7 principal components altogether explained 80.158% of the total variability. The significant factors loaded in PC1 viz., maturity coefficient, seed cotton yield per plant, plant height, number of bolls per plant, number of monopodia per plant, number of sympodia per plant, fibre elongation, specific leaf weight, seed index and ginning out-turn contributed maximum towards divergence. PCA analysis revealed that the genotypes RG 630, DLSA 17, IC 412441 and AKA-5 showed maximum divergence.

Agglomerative cluster analysis revealed wide genetic distance between cluster I (RBAV 22, RBAV 28, RG 638, IC 439871, IC 439860, RG 625 and IC 412609) and cluster VIII (IC 412717, PKV DH-1, IC 412441, RG 608, IC 412309, LD 327, AKA-7).

The above studies indicated maximum divergence among RG 630, DLSA 17, IC412441 and AKA-5 genotypes which may be better exploited through heterosis breeding or isolation of superior recombinants in segregating progenies.
GENETICS AND PLANT BREEDING

Author : ESWARI, K.B.

Title of the thesis : “GENETICS OF FIBER CHARACTERS, YIELD AND ITS COMPONENTS IN INTRA AND INTER SPECIFIC HYBRIDS OF ALLO-TETRAPLOID COTTONS (Gossypium spp. Linn.)”

Major Advisor : Dr. M.V. BRAHMESWARA RAO

Degree : Ph. D.

College : COLLEGE OF AGRICULTURE, RAJENDRANAGAR

Accession Number : D 8866

The present investigation was carried out at College Farm, College of Agriculture, Rajendranagar, Hyderabad during kharif, 2007-08 and 2008-09 to study the combining ability and heterosis for quality and yield characters. Further, an attempt was made to trace out best parents and crosses for future breeding programmes and also to know the gene action controlling the traits through generation mean analysis for designing appropriate breeding strategy.

In this direction, seven lines and four testers were crossed in L x T design to generate 28 hybrids and evaluated with check NHH 44 to know the combining ability of parents and crosses. Since L x T design does not provide comprehensive picture on gene action governing the traits, the generation mean analysis through joint scaling test was done in four crosses for eleven characters.

High PCV and GCV were recorded for number of monopodia per plant and seed cotton yield per plant and moderate estimates were observed for number of bolls per plant, boll weight. High heritability estimates coupled with high genetic advance were observed for number of bolls per plant, boll weight and seed cotton yield per plant. Estimates of components of variance and their ratios ($\sigma^2_{gca} / \sigma^2_{sca}$) indicated the preponderance of non-additive gene action for days to 50 % flowering, number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight and seed cotton yield per plant, whereas additive gene action was observed for the fiber quality traits viz., 2.5 % span length, uniformity ratio, micronaire value and bundle strength.

Based on $gca$ effects the lines, CPD 420 and among the testers, HAG 1055 were identified as best general combiners for yield which were also observed to be good combiners for one or other fibre quality characters. The crosses involving the lines L 604, LK 861 and MCU 17 among the testers were identified as best combiners for earliness. Based on $sca$ effects, the intraspecific crosses, Galama x MCU 17 ($G.hirsutum$ x $G.hirsutum$) and CPD 420 x HAG 1055 ($G.hirsutum$ x $G.hirsutum$) were identified as
best specific combiners for yield. For fiber quality traits, both inter and intra specific cross combinations ie, CPD 420 x HAG 1055 (*G.hirsutum* x *G.hirsutum*) and Galama X Suvin (*G.hirsutum* x *G.babadense*) exhibited positive *sca* effects for bundle strength. Correlation studies revealed significant association in desired direction with yield for bollweight and bundle strength under study (except for ginning percentage, uniformity ratio). Bundle strength was noticed as highly significant contributor to the yield. Path matrix revealed that number of bolls, boll weight and 2.5 % span length was found to have maximum direct positive effect on seed cotton yield.

Generation mean analysis through joint scaling tests deciphered that simple additive dominance model exhibited lack of good fit for all the traits in four crosses studied, indicating the role of non-allelic interactions. Dominance and epistatic interactions played a major role in the inheritance of yield and fibre quality characters in cotton. It can be categorically stated that reciprocal recurrent selection or diallel selective mating system are the need of the hour to modify the genetic architecture of cotton for attaining higher yields with desirable fibre properties.

In the present study, it is concluded that intraspecific cross CPD 420 x HAG 1055 were identified as promising heterotic hybrid for seed cotton yield and boll number. An interspecific cross Galama x Suvin were identified as early maturing along with high bundle strength and seed cotton yield. Hence, reciprocal recurrent selection or diallel mating systems are the breeding strategies for the improvement of yield and fiber quality traits in cotton.
The present investigation has been undertaken in rice to carry out the combining ability analysis and to estimate heterosis, heterobeltiosis and standard heterosis as well as to understand nature of gene action. Four lines and four testers were selected and crossed in Line x Tester fashion during kharif, 2010. The resulting 16 crosses along with parents and a standard check viz., Sugandha Samba were evaluated in Randomized Block Design replicated thrice during rabi, 2010-11 at Rice Section, Agriculture Research Institute, Rajendranagar, Hyderabad.

The combining ability analysis revealed importance of both additive and non-additive gene actions in governing the characters but non-additive gene action was found predominant. Non-additive gene action primarily governed hulling recovery, milling recovery, head rice recovery, kernel length after cooking, kernel breadth after cooking, kernel elongation ratio, volume expansion ratio, water uptake, aroma, alkali spreading value and protein content and grain yield plant⁻¹. Additive gene action was important for kernel length, kernel breadth, Length/Breadth ratio.

Among the parents Yamini, Pusa-1121 and BM-71 were good combiners for physical quality characters viz., kernel length and L/B ratio. Yamini and Pusa – 1121 contributed maximum favourable genes for cooking quality attributes viz., kernel length after cooking, volume expansion ratio and aroma. For chemical quality characters viz., alkali spreading value and protein MTU-1010 was identified as potential parent in imparting its superior qualities to the progenies. Yamini contributed maximum favourable genes for grain yield. These parental lines had desirable per se and therefore are identified for component breeding to improve these traits. Multiple crossing among these to pool the genes in improving rice grain quality is suggested.

The estimates of heterosis, heterobeltiosis and standard heterosis were variable among the crosses. Heterosis in desirable direction was recorded for important quality attributes viz., head rice recovery (22.16%), kernel length (10.28%), L/B ratio (12.84%), kernel elongation ratio (14.17%), volume expansion ratio (22.10%), aroma (35.21%) and
grain yield (89.25%). Some of these heterotic crosses have turned out to be best specific crosses. Ranbir Basmati x MTU-1081 (milling percentage), RNR-2354 x MTU-1081 (head rice recovery), Pusa-1121 x BM-71 (kernel length), RNR-2354 x MTU-1081 (kernel breadth), Pusa-1121 x MTU-1081 (kernel length after cooking), Ranbir Basmati x Sye-632003 (kernel breadth after cooking), Pusa-1121 x MTU-1081 (kernel elongation ratio), Pusa-1121 x MTU-1081 (volume expansion ratio), RNR-2354 x Sye-632003, Yamini x MTU-1081 (water uptake), Yamini x Sye-632003, Pusa-1121 x MTU-1081 (aroma), Pusa-1121 x BM-71, Ranbir Basmati x MTU-1081 (alkali spreading value and protein) were the best specific crosses and had desirable per se and therefore these can be used in recombination breeding to spot true breeding progenies.

Considering the yield and grain quality parameters the top yielding specific crosses viz., Ranbir Basmati x Sye-632003, Yamini x Sye-632003, RNR-2354 x MTU-1081 and Pusa-1121 x MTU-1010 were also found to be the best specific crosses which have performed exceedingly well for yield and quality parameters.
The present investigation was carried out during kharif 2010 at Agricultural College Farm, Bapatla with 40 genotypes of cotton (*Gossypium hirsutum* L.) to study variability, heritability, genetic advance as per cent of mean, genetic divergence, character association and the magnitude of direct and indirect effects of 20 yield component traits with seed cotton yield plant-1 viz., plant height, days to 50% flowering, number of sympodia plant-1, number of bolls plant-1, boll weight (g), seed index (g), lint index (g), ginning out-turn (%), 2.5% span length (mm), micronaire (10-6 g/in), bundle strength (g/tex), uniformity ratio, fibre elongation (%), crop growth rate at 60-120 days (g/m2/day), relative water content at 60 DAS (%), relative water content at 120 DAS (%), specific leaf weight at 60 DAS (mg/cm2), specific leaf weight at 120 DAS (mg/cm2), leaf area index at 120 DAS, harvest index and seed cotton yield plant-1 (g).

The genotypic coefficients of variation for all the characters studied were lesser than the phenotypic coefficients of variation indicating the masking effect of the environment. Moderate to high variability and high heritability coupled with high genetic advance as per cent of mean was observed for plant height, number of sympodia plant-1, boll weight, ginning out-turn, CGR at 60-120 days, LAI at 120 DAS and seed cotton yield plant-1 indicating the predominance of additive gene action and hence, direct phenotypic selection may be useful with respect to these traits.

Correlation and path analysis indicated that number of bolls plant-1, boll weight, lint index, ginning out-turn and harvest index had positive significant and positive direct effect with seed cotton yield plant-1 indicating the use of these attributes in selection to evolve high yielding varieties of upland cotton.

The results of multivariate analysis indicated the presence of considerable genetic divergence among the 40 genotypes studied. The 40 genotypes were grouped into 8 clusters in case of D2 analysis and 7 clusters through Ward’s minimum variance
method. This analysis clearly indicated that the genetic diversity and geographical diversity were not related.

By Mahalanobis’ $D^2$ statistic, it could be inferred that CGR at 60-120 days, number of bolls plant$^{-1}$, boll weight, LAI at 120 DAS and seed cotton yield plant$^{-1}$ contributed maximum towards genetic divergence. Based on intra and inter-cluster distance among the groups, it is suggested to make crosses between the genotypes of the clusters IV (NA-1584) and VI (TCH-1218) or IV (NA-1584) and VIII (TCH-1599) after confirming their general combining ability for evolving transgressive segregants for seed cotton yield and yield components.

Principal component analysis identified eight principal components (PCs), which contributed 83.40 per cent of cumulative variance. The significant factors which contributed maximum genetic divergence in PC$_1$ were ginning out-turn, seed index, lint index, CGR at 60-120 days, RWC at 60 DAS, SLW at 120 DAS and harvest index.

Agglomerative cluster analysis revealed that wide genetic distance exists between the genotypes of clusters III (CSH-17, GSHY-01/1338, Pee Dee-0113, CNH-7-947, Khandwa-2, GJHV-302, and SFA-5) and IV (JK-206-2, TCH-1218) indicating their usefulness in the breeding programmes for seed cotton yield improvement.

The genotypes TCH-1218, NA-1584, GSHY-01/1338, and CSH-17 showed maximum inter-cluster distance in Mahalanobis’ $D^2$ analysis, principal component analysis and cluster analysis. So they can be exploited for the development of heterotic hybrids in future breeding programmes.
Eight parents and 28 F1 cross combinations of urdbean were evaluated in a RBD with three replications during rabi, 2010 so as to identify the best parental genotypes and cross combinations with higher seed yield. The per se performance of parents revealed that LBG 770 was a superior parent for seed yield per plant, clusters per plant and plant height. High PCV and GCV values were observed for harvest index, seed yield per plant and plant height in indicating that there is a greater scope for improvement of these characters through selection. High heritability coupled with high GAM was recorded for plant height, number of primary branches, number of clusters, number of pods, seed yield per plant and harvest index and are likely under the control of additive gene action. Hence, simple selection may be practiced to improve these traits.

The top four heterobeltiotic crosses observed for seed yield per plant were PBG 107 x LBG 749, LBG 17 x LBG 770, LBG 17 x LBG 749 and LBG 20 x LBG 749 which were emerged out as best specific combinations also and could be utilized for obtaining transgressive productive segregants in their advanced generations. Estimates of component variance revealed predominance of non-additive gene action for all the traits except plant height, pod length and number of seeds per pod. Hence, to capitalize the non-additive gene action, biparental mating, crossing inter se among the superior selects followed by progeny selection could be advocated for genetic improvement of traits in the later generations of superior cross combinations.

The character association analysis in parental generation revealed the presence of highly significant positive association of pods per plant and clusters per plant with seed yield per plant. Similarly, in F1 generation days to maturity, days to 50% flowering, pods per cluster and 100 seed weight displayed highly significant positive association with seed yield. These characters also exhibited strong and positive association among themselves. Path coefficient analysis revealed that in parents, number of seeds per pod, harvest index and number of pods per plant exerted high positive direct effect on seed yield per plant via plant height and days to maturity. Similarly in F1 generation, the high positive direct effect on seed yield was shown by number of seeds per pod, number of
pods per plant and harvest index *via* plant height and 100 seed weight. Hence these characters may be given due emphasis in formulating selection indices in order to augment the identified superior genotypes in urdbean.
In vitro response of sugarcane pre-release varieties, 2005T16 and 2005T50 was assessed in the present investigation for direct organogenesis, multiplication, shooting, rooting and on different hormonal combinations and concentrations and hardening on different combinations of substrates from shoot tip and young leaf roll explants. Shoot tip responded well but leaf rolls did not establish in all the treatments.

Different combinations and concentrations of BAP, IAA, Kinetin and NAA were studied for establishment of axillary shoots. Among the various treatments evaluated MS medium supplemented with 3 mg l-1 BAP, 2 mg l-1 IAA and 2 mg l-1 Kinetin was found to be the best for axillary shoot establishment in 2005T16. Whereas, MS medium supplemented with 2 mg l-1 BAP, 1 mg l-1 IAA and 3 mg l-1 Kinetin was the best for establishment of axillary shoots in 2005T50.

Among the various treatments evaluated for multiple shoot induction MS medium supplemented with 3 mg l-1 BAP, 2 mg l-1 IAA and 2 mg l-1 Kinetin was found to be the best by recording the highest multiple shoot induction in 2005T16. MS medium supplemented with 3 mg l-1 BAP, 1 mg l-1 NAA and 3 mg l-1 Kinetin had recorded the highest multiple shoot induction of in 2005T50.

In case of root induction studies half MS medium supplemented with 6 mg l-1 NAA was proved to be the successful one than other treatments in both the varieties by recording highest rooting frequency. NAA was found to be better for root induction than IBA used alone or in combination with other hormones.

Acclimatization and hardening of plantlets was studied using various substrates. Vermicompost : Soil : Sand (1:1:1) was found to be the most suitable medium for acclimatization and hardening in case of both 2005T16 and 2005T50 with the highest survival percentage.
The present investigation was carried out to study the variability, heritability, genetic advance as per cent of mean, character association, path coefficient analysis and stability analyses among 10 sesamum (*Sesamum indicum* L.) genotypes in 6 environments resulting from six sowing dates. The data were recorded on 9 quantitative characters (Plant height, days to 50% flowering, number of primaries, number of secondaries, number of capsules per plant, number of seeds per capsule, 1000 seed weight, oil content and seed yield per plant).

The analysis of variance indicated significant differences among the genotypes for all characters in all six environments studied.

Variability was studied for all the characters and indicated that seed yield per plant, number of primaries and number of secondaries showed high variability and further improvement of these traits will be helpful in improvement of seed yield.

The genotypic coefficients of variation for all the characters studied were lesser than the phenotypic coefficients of variation indicating the masking effect of the environment. High heritability coupled with high genetic advance as per cent of mean was observed for number of capsules per plant, number of seeds per capsule, seed yield per plant, number of primaries and number of secondaries.

Correlation study indicated that number capsules per plant, number of seeds per capsule and 1000 seed weight had significant positive association with seed yield per plant in all environments and selection may be exercised on these traits to improve seed yield.

The path analysis indicated that number of capsules per plant, number of seeds per capsule, 1000 seed weight and plant height had positive direct effects on seed yield per plant as correlation of these parameters was positive and significant, direct selection through these characters for improvement in seed yield per plant should be highly rewarding.
In pooled analysis of variance for stability the genotypes, environments, genotype-environment interaction, environment (linear) and pooled deviations showed significant differences for most of the characters studied.

According to Eberhart and Russell regression method, the genotypes, YLM 106 (number of seeds per capsule and number of capsules per plant), YLM 82 (number of seeds per capsule, oil content and 1000 seed weight), YLM 17 (seed yield per plant) and Madhavi (1000 seed weight and oil content) showed stable performance over environments.

According to AMMI analysis, the genotypes (Madhavi, YLM 17, YLM 66 and YLM 80) are stable for seed yield per plant because their IPCA-1 score is nearer to zero.

The study of different stability parameters indicated the importance and convenience of stability parameters like Wricke’s (1962) ecovalence, mean variance due to genotype-environment interaction of ranks, as these methods gave similar results in spotting the stable genotypes to that of the deviation from regression ($S_2d$) of Eberhart and Russell (1966) whose calculation is cumbersome.
An investigation was carried out during kharif (monsoon) season of 2010-11 at ICRISAT, Patancheru, Hyderabad, to study (i) relative mid-parent heterosis, heterobeltiosis, and standard heterosis in medium duration disease resistant pigeonpea hybrids, (ii) inbreeding depression from F1 to F2 generations for important economic traits, and (iii) genetics of fertility restoration. A total of 22 hybrids were synthesized by hand pollinating five CMS-lines with 14 restorers during 2009 kharif season. The F1 plants of each hybrid were selfed to obtain F2 seeds. Genetics of fertility restoration was studied by using F1, F2, and BC1F1 data in four crosses.

Hybrid ICPH 2671 showed higher negative heterosis indicating exploitable hybrid vigour for earliness. For maturity, six hybrids ICPH 2671, ICPH 3461, ICPH 3762, ICPH 3763, ICPH 4022, and ICPH 4024 exhibited significant negative heterosis. For plant height ICPH 2671 (11.35%), ICPH 3933 (23.94%), and ICPH 3759 (8.28%) showed significant positive heterosis over mid parent. Hybrids ICPH 2671, ICPH 2751, and ICPH 3759 expressed positive heterosis for number of primary branches. Hybrids ICPH 2671 and ICPH 3933 showed significant positive heterosis over mid and better parents for pod clusters. A considerable amount of heterosis for number of pods plant-1 ranged from -38.40 to 113.46%, -21.88 to 120.47% and -24.44 to 149.19% over better, mid and standard parent, respectively. Five hybrids ICPH 2671, ICPH 2740, ICPH3359, ICPH 3477, and ICPH 4017 exhibited higher positive heterosis at all the three bases of estimation. Hybrids ICPH 3477 and ICPH 3758 had significant positive heterosis over better and mid parents for seed size. Wide range of positive and negative heterosis was observed for seed yield, hybrid ICPH 2671 (148.94-208.44%) exhibited the high heterosis in seed yield followed by ICPH 2740 (49.89-121.45%), ICPH 3477 (48.54-119.45%), ICPH 3491 (50.99-134.17%), ICPH 4017 (55.82-184.90%), and ICPH 4022 (127.23-155.64%) at different levels of heterosis, respectively.

There was no significant inbreeding depression for days to flower and maturity and plant height. In case of number of pod cluster plant-1, inbreeding depression ranged from -64.50% (ICPH 3494) to 68.44% (ICPH 4012). For number of pods plant-1 ICPH 2671, ICPH 2740, ICPH 3359, ICPH 3461, ICPH 3758, ICPH 3933, ICPH 4012, and
ICPH 4017 exhibited high heterosis and inbreeding depression. Seventeen out of 22 hybrids, demonstrated significant inbreeding depression for seeds pod-1. For 100-seed weight, significant inbreeding depression was found in ICPH 3359 (19.61%). For seed yield plant-1, 14 hybrids showed 44.69 to 73.28% inbreeding depression. These results indicated the predominance of non-additive gene action. For plot yield, 12 hybrids exhibited positive heterosis and inbreeding depression ranging from 7.64 to 52.33%.

The results on inbreeding depression suggested that the genes affecting yield showed both additive and non-additive gene action.

The fertility restoration in pigeonpea hybrids appeared to be governed by two genes with epistatic interaction. ICPH 2671 and ICPH 2740 which have the same restorers but different male sterile lines segregated in the ratio of 12:3:1 in F2 and 2:1:1 in BC1 generation showing digenic dominant epistatic interaction, respectively. ICPH 3359 showed a segregation ratio of 9:6:1 and 1:2:1 in F2 and BC1 generation indicating two major genes governing fertility restoration showing epistasis with incomplete dominance while ICPH 4012 segregated in the ratio of 9:3:4 and 1:1:2 in F2 and BC1 generations for pollen fertility/sterility.
The study was carried out during kharif 2010-11 at Regional Agricultural Research station, Lam Farm, Guntur with 54 hybrids along with their 15 parents (6 lines and 9 testers) to know the genetic variability, heritability, genetic advance, correlation and the magnitude of direct and indirect effects, combining ability and standard heterosis.

The data were recorded on 14 economically important characters viz., number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight (g), seed index (g), lint index (g), ginning out-turn (%), 2.5% span length (mm), micronaire value (10-6 g/inch), bundle strength (g/tex), uniformity ratio, fibre elongation (%), harvest index and seed cotton yield per plant (g).

The analysis of variance revealed significant differences among the genotypes for all the characters studied indicating that the material used in the present investigation possessed sufficient variability. High heritability coupled with high genetic advance as per cent mean was observed for number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight, seed index, lint index, micronaire, harvest index and seed cotton yield per plant indicating the operation of additive gene action with little influence of environment.

The character association analysis revealed that number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight, seed index, 2.5% span length, fibre elongation and harvest index were found to have significant positive association with seed cotton yield per plant.

Further, the path analysis indicated that number of monopodia per plant, number of bolls per plant, boll weight, seed index, ginning out turn, 2.5% span length,
micronaire, uniformity ratio, fibre elongation and harvest index showed direct positive effects on seed cotton yield per plant.

The ratio of general combining ability variance to specific combining ability variance indicated the preponderance of non-additive gene action for most of the characters studied. The lines, ACH 703 E, RFS 3438, 0892 B and REBA B 50 and the testers, RHCB 001, DB 11, TCB 108, CCB 6 and BRAZIL were identified as good general combiners based on overall gca effects. The crosses 0892B X CCB 5, CNH 120 MB X RHCB 001 and RFS 3438 X SUVIN showed positive and significant specific combining ability effects for seed cotton yield per plant along with few fibre quality characteristics. Significant positive standard heterosis compared to check was observed for seed cotton yield in two crosses viz., 0892 B X CCB 5 and 0892 B X DB 11.

Thus in the present study the cross, 0892B X CCB 5 was identified as promising hybrid for high seed cotton yield per plant based on overall performance i.e., per se performance, sca effects and standard heterosis. But incase hybrids with good fibre quality characteristics CNH 120 MB X DB 11 is superior to the above hybrids and the seed cotton yield is also on par with the check. These hybrid can be exploited for commercial cultivation after thorough testing in different environments for its superiority and stability.
The present investigation was carried out separately during two consecutive seasons of 2008-2009, namely *kharif* 2008 and *rabi* 2009 at Agricultural College Farm, Bapatla, with 18 Indian and 34 exotic genotypes of Italian millet *Setaria italica* (L.) Beauv procured from collections maintained at All India Co-ordinated Small Millets Improvement Project (AICSMIP), Bengaluru. Nature and extent of variability, heritability, genetic advance, selection indices, character association and the magnitude of direct and indirect effects of yield components on yield were studied for thirteen characters *viz.*, days to 50% flowering, plant height, days to maturity, number of productive tillers per plant, flag leaf area, ear length, ear weight, straw weight, 1000 grain weight, carotene, crude protein percent, calcium content and grain yield per plant.

The analysis of variance indicated significant differences among Indian and exotic genotypes for all the characters during *kharif* 2008 and *rabi* 2009 indicating substantial variability among the two groups of genotypes during both the seasons.

The study of Indian genotypes during *kharif* 2008 revealed positive significant correlation of days to 50% flowering, plant height, number of productive tillers per plant, flag leaf area, ear length, ear weight, straw weight and protein content with grain yield per plant and improvement of grain yield may be possible if these traits are considered in the selection programme.

The study of Indian genotypes during *rabi* 2009 revealed positive significant correlation of days to 50% flowering, plant height, days to maturity, number of productive tillers per plant, ear weight, straw weight and 1000 grain weight with grain yield per plant and improvement of grain yield may be possible if the above traits are considered in the selection programme.

The study of exotic genotypes during *kharif* 2008 revealed positive significant correlation of days to 50% flowering, plant height, days to maturity, number of productive tillers per plant, ear length, ear weight and straw weight with grain yield per
plant and improvement of grain yield may be possible if these traits are considered in the selection programme.

The study of exotic genotypes during *rabi* 2009 revealed positive significant correlation of days to 50% flowering, plant height, days to maturity, number of productive tillers, flag leaf area, ear length, ear weight, straw weight and 1000 grain weight with grain yield per plant and improvement of grain yield may be possible if these traits are considered in the selection programme. The association of protein content and calcium content with grain yield is negative in all the four groups, while with carotene is negative in both Indian and exotic groups during *kharif* only. Simultaneous improvement of these two traits is not possible so we have to strike a balance among the attributes to find out an acceptable level of the characters under improvement. The study of Indian genotypes indicated that direct selection based on the traits, number of productive tillers per plant and ear weight during *kharif* where as in *rabi* days to maturity and ear weight are effective as the association and direct effects were positive for these traits. The study of exotic genotypes indicated that direct selection based on the characters, number productive tillers per plant during *kharif* where as in *rabi* ear weight and straw weight are effective as the association and direct effects were positive for these traits during both the seasons. The results of classical selection indices indicated that in Indian genotypes GS 448, GS 444, GS 442, and GS 449 for *kharif* and GS 440, GS 450, GS 451 and GS 448 for *rabi* are to be preferred. In case of Exotic group of genotypes, GS 462, GS 489 and GS 488 for *kharif* and GS 462, GS 463 and GS 458 for *rabi* are to be favoured. In general, the indices, which include more than one character, gave high genetic advance in all the four groups suggesting the utility of selection index for simultaneous improvement of several characters. Studies on genetic advance and relative efficiencies of indices indicated that in Indian genotypes, eight characters *i.e.* grain yield per plant, days to 50% flowering, plant height, number of productive tillers per plant, ear length, ear weight, crude protein content and calcium content during *kharif* where as nine characters *i.e.* grain yield per plant, days to 50% flowering, plant height, number of productive tillers per plant, ear length, ear weight, 1000 grain weight, crude protein content and calcium content during *rabi* together formed efficient selection indices and these traits may be given due weightage for simultaneous improvement in the respective groups.

In case of exotic genotypes, eight characters *i.e.* grain yield per plant, days to 50% flowering, plant height, number of productive tillers per plant, ear weight, carotene, 1000 grain weight and crude protein content during *kharif* where as nine characters *i.e.* grain yield per plant, days to 50% flowering, plant height, number of productive tillers per plant, ear length, ear weight, 1000 grain weight, crude protein content and calcium content during *rabi* together formed efficient selection indices and these traits may be useful for simultaneous improvement in the respective groups. It was observed that inclusion of characters one by one in the function gave fluctuating changes in the value of genetic advance and relative efficiencies over yield in all the four groups.

The restricted selection indices indicated that by restricting the quality parameters both in Indian and exotic genotypes the genetic enhancement of grain yield per plant can be improved both in *kharif* and *rabi* seasons. So while aiming for genetic enhancement of
yield, we have to strike a balance between yield and quality parameters as they constitute staple food of poor people.

The study of general selection indices in the four groups indicated that character behavior differed widely in all the four groups and suggested that separate selection models should be made for each group. However, in the study of the pool with Indian kharif group and Indian rabi group the prime importance should be given to number of productive tillers per plant, ear length, 1000 grain weight and ear weight while making selection. The study of pool with Indian kharif group and exotic kharif group revealed that prime importance should be given to number of productive tillers per plant, ear length and straw weight while making selection. The study of pool with Indian rabi group and exotic kharif group indicated that prime importance should be given to ear weight, number of productive tillers per plant and ear length while making selection. The study of pool with exotic kharif group and exotic rabi disclosed that prime importance should be given to ear weight, number of productive tillers per plant and ear length while making selection. When both Indian and exotic genotypes were considered together major emphasis should be given to number of productive tillers per plant, ear weight, ear length and plant height during both kharif and rabi seasons.

Thus, the present study revealed that the major emphasis should be laid on selection process with increased number productive tillers per plant coupled with more ear weight and ear length while aiming for improvement of Indian and exotic genotypes of Italian millet [Setaria italica (L.) Beauv.]
Rice (Oryza sativa L.) is the most important staple food grain for more than half of the world’s human population. Among various quality traits, aroma is one of the most attractive quality traits. The Indian aromatic rices greatly vary in grain quality including strength of aroma, length/breadth ratio and cooked kernel elongation ratio. These constitute an important source of genetic variation for utilization in breeding of high yielding aromatic rice varieties and hybrids.

The present study was undertaken with the objective to analyse the genetic diversity of aromatic short grain rice varieties. The study also intended to identify some genotype specific markers. Out of the total 55 SSR markers tested, 27 were found to be polymorphic which dispersed throughout 12 chromosomes were used to assess the extent of genetic diversity across 96 short grain aromatic rice genotypes.

A total of 83 alleles were detected across 96 ASG rice genotypes by 27 polymorphic SSR markers. The number of alleles generated per locus by each marker was ranged from 2 (RM577, HRM16592, RM267, RM505 and RM 23899 on chromosome 1, 4, 5, 7 and 9 respectively) to 5 (RM276 on chromosome 6), with an average of 3.07 number of alleles per locus.

Polymorphism information content (PIC) values among the SSR loci tested was ranged from 0.066 (RM505 on chromosome 7) to 0.721 (RM276 on chromosome 6) with an average of 0.54 per locus.

The cluster analysis performed by using UPGMA based on similarity co-efficient resolved 96 ASG rice genotypes into two major clusters with 74% dissimilarity. Cluster I consisted of 60 genotypes which showed 73% dissimilarity and was further subdivided into five subclusters viz IA, IB, IC, ID and IE which consisted of 19, 18, 2, 19 and 2 accessions respectively. Cluster II consists of 36 genotypes which revealed 69% dissimilarity which was again subgrouped into four sub-clusters namely IIA, IIB, IIC, and IID where each subgroup consisted of 3, 19, 8 and 6 accessions respectively. Out of 27 polymorphic SSR markers, four SSR markers were identified as genotype specific
markers, namely RM577 on chromosome 1, RM505 on chromosome 7, RM89 and RM22866 on chromosome 8.
The present investigation was carried out during kharif 2010, at Agricultural College Farm, Bapatla, with seventy six genotypes of Rice (Oryza sativa L.) to obtain information on the nature and extent of variability, heritability, genetic advance, character association, the magnitude of direct and indirect effects of yield components on yield and to formulate a selection indices based on seventeen characters.

The analysis of variance indicated significant differences among all the seventy six genotypes for all the characters studied.

Considerable amount of variability was observed for all the seventeen characters viz., days to 50% flowering, plant height, ear bearing tillers plant-1, filled grains panicle-1, panicle length, test weight, grain yield plant-1, milling percentage, hulling percentage, head rice recovery percentage, grain length, grain breadth, L/B ratio, kernel length after cooking, protein percentage, amylose content, and alkali digestion value.

High heritability coupled with high genetic advance was observed for plant height, ear bearing tillers plant-1, panicle length, filled grains panicle-1, grain yield plant-1, head rice recovery percentage, grain breadth, L/B ratio, kernel length after cooking, protein percentage and alkali digestion value indicating the predominance of additive gene action in controlling these characters. Hence selection pressure could be effective on these traits for improving yield. Both additive and non additive gene actions were involved in controlling the characters like milling percentage and hulling percentage.

Correlation studies revealed positive significant association of ear bearing tillers plant-1 and filled grains panicle-1 with grain yield plant-1. Hence, selection for these traits is useful in obtaining simultaneous improvement of the associated characters resulting in increased yield in rice.

Results of path coefficient analysis revealed that ear bearing tillers plant-1 and filled grains panicle-1 could serve as important criteria for a sound selection programme,
since these traits posses a positive direct effect on grain yield plant-1 at both phenotypic and genotypic level.

Selection indices were constructed adopting discriminant function which indicated that the maximum genetic advance and relative efficiency can be obtained when grain yield was included as one of the component character. The function including the nine characters viz., grain yield plant-1, days to 50% flowering, plant height, ear bearing tillers plant-1, panicle length, filled grains panicle-1, milling percentage, head rice recovery percentage, L/B ratio recorded highest genetic advance with a high relative efficiency over grain yield plant-1.

In restricted selection indices, a highest genetic advance value was recorded by filled grains panicle-1, when each character was restricted separately.
The experimental material comprising of 28 crosses generated by 8 × 8 half diallel in F1 and F2 generations and the parents was evaluated for sixteen yield, yield attributes and foliar disease resistant traits over two seasons, *kharif* 2009 and *rabi* 2009-10 at Regional Agricultural Research Station, Tirupati to study combining ability, nature of gene action and inter-relationships between yield and resistance parameters which will be useful in planning breeding programmes and selection procedures to evolve high yielding foliar disease resistant genotypes with desirable pod and kernel traits. Combining ability analysis of *kharif* 2009, *rabi* 2009-10 and pooled data revealed that ICG (FDRS) 79 was the best combiner for days to 50% flowering, days to maturity, number of primary branches per plant, number of secondary branches per plant, number of leaves per plant at harvest, percentage of leaves affected by foliar diseases per plant, number of mature pods per plant, kernel weight per plant, LLS and rust severities, harvest index and pod yield per plant; GPBD 4 was identified as the next best combiner for the traits, percentage of leaves affected by foliar diseases per plant and LLS and rust severities; Tirupati 1, Narayani, Kadiri 6 and TLG 45 were found to be good combiners for early flowering and early maturity. TCGS 876 was found to be best combiner for the number of primary branches per plant during both the seasons. While TCGS 876 × ICG (FDRS) 79, TLG 45 × GPBD 4 and TLG 45 × ICG (FDRS) 79, TPT 25 × GPBD 4, TPT 25 × Kadiri 6 and TCGS 876 × GPBD 4 were found to be promising cross combinations for pod yield, other yield attributes and for foliar disease resistance traits.

Variability studies indicated that most of the traits except days to flowering and maturity, shelling out-turn and sound mature kernel percentage are highly influenced by additive genetic variance. The best heterotic crosses identified for pod yield per plant were TPT 25 × GPBD 4, Kadiri 6 × TLG 45 and Narayani × Kadiri 6 during *rabi* 2009-10 and TPT 25 × ICG (FDRS) 79, TLG 45 × GPBD 4, TLG 45 × ICG (FDRS) 79 and TCGS 876 × ICG (FDRS) 79 during *kharif* 2009.

Correlation and path coefficient analysis revealed that days to maturity, number of primary and secondary branches per plant, number of mature pods per plant and kernel
weight per plant had significant positive association with pod yield per plant indicating the scope for concurrent improvement of these traits.

Through SSR analysis, the profiles of two primer pairs, pPGPseq 5D% and pPGPseq 1B09 were found to be distinct different in resistant and susceptible genotypes for LLS and rust. This was further confirmed through bulk segregant analysis of F2 generation material of Narayani × GPBD 4 cross involving susceptible and resistant parents to LLS and rust.
GENETICS AND PLANT BREEDING

Author : MURALI KRISHNA, K.
Title of the thesis : GENETIC ANALYSIS FOR RESISTANCE TO POST FLOWERING STALK ROT IN MAIZE (Zea mays L.)
Major Advisor : Dr. R. SAi KUMAR
Degree : Ph. D.
College : COLLEGE OF AGRICULTURE, RAJENDRANAGAR
Accession Number : D 9092

Ten selected maize parental lines comprising six resistant and four susceptible were crossed in diallel fashion (excluding reciprocals). Forty five crosses along with parents were studied for heterosis, nature of gene action, genetic parameters for yield and yield components at two locations viz., Rajendranagar and Karimnagar and generation mean analysis for yield at both the locations and for post flowering stalk rot (PFSR) resistance at Rajendranagar.

Non additive gene action primarily governed resistance to PFSR. Six parents viz., BML-6, BML-7, BML-10, BML-13, CM-119 and BPPTI-34 recorded low per se performance and were good combiners for resistance. Two crosses; BML-6 x BML-10 and BML-7 x BML-13, exhibited highest heterosis and both the parents are good combiners for resistance and therefore, can be used to identify true breeding lines with resistance to PFSR. The heterotic cross combinations viz., BML-7 x CM-131, BML-13 x BPPTI-44, CM-119 x CM-131, CM-119 x BPPTI-44 were resultant of non-additive gene action and can be recommended for cultivation in PFSR endemic areas. PFSR disease exhibited negative correlation with yield. The path analysis revealed positive direct effect and positive indirect effect through ear height and kernel rows.

The cross, BML-13 x CM-131 can be best used in developing resistant varieties as additive and additive x additive epistatic interactions were significant. The crosses; BML-7 x BPPTI-35, BML-10 x BML-13 and BML-13 x BPPTI-38 can be utilized for heterosis breeding as the dominant variance was significant and of higher magnitude. The ‘l’ and ‘h’ components had opposite sign for most of the crosses indicating duplicate gene action.

The genotypic differences were significant for all the characters except days to maturity at both the locations. Non additive gene action was found to be preponderant for all the characters in the present investigation. The hybrids, in general were tall and high yielding, compared to the parents. High level of heterosis was observed for grain yield per plant followed by number of kernels per ear and number of kernels per row.

The parental lines, BML-13, BPPTI-35 for days to 50 per cent tasseling, 50 per cent silking, CM-119 for plant height, CM-131 for ear height, BML-6 for ear girth, CM-119 and CM-131 for kernel rows were the best combiners with significant gca effects at
both the locations. The inbred lines, BML-6 and BML-7 at Rajendranagar and BPPTI-38 at Karimnagar for ear length, 100 kernel weight and grain yield per plant were best specific combiners with highly significant gca effects. The parental lines BML-6 at Rajendranagar and BPPTI-35 at Karimnagar were good combiners for kernels per row.

The hybrids, BPPTI-38 x BPPTI-44 at Rajendranagar, BML-7 x BPPTI-44 at Karimnagar exhibited significant sca effects for days to 50 per cent tasseling and 50 per cent silking. BML-6 x BPPTI-44 at Rajendranagar, BML-13 x BPPTI-38 at Karimnagar recorded significant sca effects in desired direction for plant height. The crosses; BML-10 x BPPTI-34 for ear height, ear girth, BML-13 x BPPTI-44 for ear length, kernels per row, grain yield per plant, BML-6 x BML-10 for kernels per ear, number of kernel rows, ear girth, grain yield per plant recorded significant sca effects at both the locations. The crosses; BML-7 x BPPTI-38 and BML-10 x BPPTI-44 recorded higher per se and significant sca effects for grain yield per plant at both the locations.

Estimates of heterosis, heterobeltiosis and standard heterosis were variable among crosses in desirable direction. The hybrids, BML-6 x BPPTI-34, CM-119 x BPPTI-35 and BPPTI-34 x BPPTI-44 for earliness, BML-7 x BPPTI-38 for ear length, ear girth exhibited significance for heterosis and standard heterosis in the desirable direction at both the locations. The crosses; BML-7 x CM-131 at Rajendranagar and BML-13 x BPPTI-38 at Karimnagar for plant height, BML-6 x BML-10 for number of kernels per ear and number of kernel rows at both the locations exhibited significant standard heterosis. The hybrid, CM-131 x BPPTI-35 at Rajendranagar and BML-6 x BPPTI-35 at Karimnagar exhibited highest per se and were heterotic with a mean value of 41.50 kernels per row.

For grain yield per plant, the crosses; BML-7 x BPPTI-38 (Resistant x Susceptible) and BML-6 x BPPTI-35 (RxS) had higher grain yield per se and recorded significant positive standard heterosis of 76.42 and 50.5 and 23.73 and 53.60 at Rajendranagar and Karimnagar respectively. In crosses; BML-7 x BPPTI-38 at Rajendranagar, heterosis for grain yield was accompanied by significant standard heterosis in plant height, ear length and number of kernel rows while at Karimnagar, it was accompanied by ear length and 100 kernel weight.

Plant height, ear height, ear length, ear girth, number of kernels per ear, number of kernels per row and 100 kernel weight had revealed significant positive association with grain yield per plant at both the locations. Days to maturity and post flowering stalk rot resistance showed significant negative association with grain yield per plant at Rajendranagar. 100 kernel weight, number of kernels per row, number of kernels per ear and ear girth, at Rajendranagar, while ear girth, number of kernels per ear, number of kernel rows and number of kernels per row at Karimnagar directly influenced grain yield per plant.

In the generation mean analysis, considering both the locations, the cross combinations viz., BML-6 x BPPTI-35, and CM131 x BPPTI-35 can be exploited to spot true breeding and high yielding segregants from future generations as they exhibited significant positive additive and additive x additive epistatic interactions, while BML-7 x BML-10 and BML-7 x CM-119 can be utilised in heterosis breeding as they possessed
significant ‘$h$’ effects. For most of the crosses, the sign of ‘$l$’ and ‘$h$’ components were in opposite direction indicating duplicate type of gene action.

The hybrids, BML-7 x BPPTI-38 and BML-7- x CM-131 at Rajendranagar while, BML-13 x BPPTI-38 and BML-6 x BPPTI-35 at Karimnagar were found to be superior as they possessed higher *per se*, significant positive combining ability and standard heterosis for yield and most of the yield contributing characters and were also found to be insulated with resistance to PFSR disease at Rajendranagar.
The present investigation was carried out to study the combining ability, heterosis, association for grain iron and zinc content and identifying the regions associated with iron and zinc content in the F2 mapping population at Directorate of Rice Research, Rajendranagar, Hyderabad. Six lines viz., RP Bio 226, Swarna, MTU 1010, IR 64, PR 116 and Mandya Vijaya were crossed (Line × Tester design) with eight testers viz., Chittimutyalu, Ranbir Basmati, Madhukar, Jalmagna, Type 3, Suraksha, Jalpriya and BR 2655 and the resultant 48 F1s along with parents were evaluated for combining ability and heterosis. The analysis of variance for combining ability revealed that significant differences in parents and hybrids indicating the existence of wider variability in the material studied. The ratio of GCA to SCA variances revealed that non-additive gene action was predominant in inheritance of all characters studied. The gca effects of the parents revealed that the lines viz., MTU 1010 and PR 116 and testers viz., Madhukar, Jalmagna, Jalpriya and BR 2655 were found to be promising general combiners for grain yield and its components. None of the parents recorded significant positive gca effects, hence no parents found to be general combiners for grain iron content. Chittimutyalu, Madhukar, PR 116, IR 64 and RP Bio 226 found to be good general combiners for grain zinc content. Based on significant sca effects in the analysis, ten hybrids were identified as promising specific combiners for grain yield and other characters. Mandya Vijaya × Jalmagna, PR 116 × Chittimutyalu, PR 116 × Suraksha, Swarna × Ranbir Basmati and Mandya Vijaya × Type 3 were had good specific combiners for grain zinc content.

Based on heterosis studies MTU-1010 × Jalmagna, PR116 × BR-2655, MTU-1010 × Madhukar hybrids were found high heterotic for grain yield. MTU-1010 × Jalmagna hybrid exhibited significant positive heterosis for panicle length, number of tillers, number of productive tillers per plant, test-weight, number of grains per panicle, grain length, grain breadth and negative significant heterosis in desirable direction for days to 50 per cent flowering and days to maturity. IR64 × Chittimutyalu and PR 116 × Chittimutyalu found to be good heterotic hybrids for grain iron and zinc content.
The association studies revealed grain yield had significant positive correlation with productive tillers per plant, test-weight and number of grains per plant. Grain iron and zinc content had no correlation with grain yield. Grain iron had significant positive correlation with grain zinc content. From path analysis productive tillers per plant and grains per panicle had high direct effect on grain yield. Selection has to be made on these characters to get higher yield.

Identification of regions associated with iron and zinc content in the grain found that, only three markers SC120, SC128 and SC129 were found associated with the traits. The SC129 showed highest significant variation with both zinc and iron at the tune of $R^2 = 13.09\%$ and $R^2 = 19.51\%$ respectively.

Further study has to be made under this to know the genetics involved in the controlling of these traits. The association could be made more stringent by further analysis of more number of lines and using more number of markers.
The present investigation on characterization in pigeonpea advanced lines was carried out during kharif, 2010-11 at Regional Agricultural Research Station, Lam, Guntur with 49 genotypes of pigeonpea [Cajanus cajan (L.)Millsp.]

The genotypes were characterized for 15 morphological characters viz., anthocyanin colouration of hypocotyls, plant branching pattern, plant growth habit, stem colour, leaf shape, pubescence on lower surface of the leaf, flower colour, pattern of streaks on petal, pod colour, pod surface stickiness, pod waxiness, pod constriction, seed colour, seed colour pattern and seed shape as per DUS guidelines of pigeonpea and for 13 quantitative characters.

The mean variability, heritability, genetic advance as per cent of mean, genetic divergence, character association and the magnitude of direct and indirect effects of yield component traits with seed yield per plant were studied for 13 characters viz., plant height (cm), days to 50% flowering, days to maturity, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, pod length (cm), number of seeds per pod, shelling percentage (%), 100 seed weight (g), seed yield per plant (g), grain protein content (%) and harvest index.

The genotypic coefficients of variation for all the characters studied were lesser than the phenotypic coefficients of variation indicating the modifying effect of the environment in association with the characters at genotypic level. High PCV coupled with high GCV was observed for the traits viz., number of primary branches per plant, number of secondary branches per plant and number of pods per plant indicating the presence of wider variability for these traits in the population studied. High heritability coupled with high genetic advance as per cent of mean was observed for plant height, number of primary branches per plant, number of secondary branches per plant, number of pods per plant and seed
yield per plant which indicates the operation of additive gene action in inheritance of these traits.

Correlation studies indicated that days to 50% flowering, number of pods per plant and harvest index had significant positive association with seed yield per plant. Path coefficient analysis revealed that plant height, number of pods per plant, shelling percentage and harvest index had positive direct effects on seed yield per plant together with strong positive correlation on seed yield per plant revealing their true relationship. So improvement in seed yield is possible by taking number of pods per plant and harvest index characters in theselection scheme.

The results of multivariate analysis revealed that considerable genetic divergence was existed among the 49 genotypes studied and grouped into 4 clusters as per D2 analysis and 8 clusters in case of cluster analysis grouping of genotypes was at random, which suggested that geographical isolation might not be the only factor causing genetic diversity.

By Mahalanobis’ D2 statistic, it could be inferred that the trait number of primary branches per plant contributed maximum towards divergence followed by days to 50% flowering, seed yield per plant and grain protein content. Based on the intra and inter-cluster distances among the clusters, suggestions were made to attempt crosses to obtain new desirable recombinants between the genotypes of cluster III and II followed by cluster II and IV.

Principal component analysis indicated first five principal components (PCs), contributed 75.04 per cent of cumulative variance. The first principal component explained 31.71% of total variability and was characterized by plant height, number of primary branches per plant, number of secondary branches per plant and shelling percentage.

Agglomerative cluster analysis showed that wide genetic distance exists between clusters II and III followed by clusters I and II. Therefore, for hybridization programme, selection of parents from these clusters will produce superior segregants. Dendrogram obtained by cluster analysis showed the subgrouping of genotypes within the cluster which is not possible through D2 analysis.

The genotypes LRG-97, LRG-61, BRG-2 and BDN 2010 showed maximum inter-cluster distance and wide genetic distance in all the three divergence methods. So they can be exploited in hybridization programme for identification of desirable segregants.
The present investigation on “Effect of cytoplasm on stalk traits and sugar content in sweet sorghum (Sorghum bicolor (L.) Moench) hybrids” was carried out with two sets of diverse alloplasmic isonuclear A-lines with A1, A2, A3 and A4 cytoplasms. These 8 male sterile lines were crossed to 8 sweet stalk genotypes used as testers through line × tester mating design during Rabi, 2009-2010 resulting in 64 hybrids. Hybrids along with the parents (lines, testers) and three standard checks were grown and evaluated in Randomized Block Design with three replications during Kharif, 2010 at Directorate of Sorghum Research, Rajendranagar, Hyderabad. Observations were recorded in respect of eleven characters viz., days to 50% flowering, days to maturity, plant height (cm), stem girth (cm), nodes, total biomass (t ha⁻¹), fresh stalk yield (t ha⁻¹), juice yield (l ha⁻¹), juice extraction (%), brix (%) and fertility reaction in hybrids. Recorded data was then subjected to statistical analysis.

The analysis of variance of parents and hybrids indicated the existence of sufficient variation in the material studied. The mean performance of parents, hybrids and crosses indicated that the hybrids which flowered early were also early maturing. The tester which was promising for plant height IS 6962 also recorded higher gca effects. The testers which were promising for fresh stalk yield were also superior in juice yield indicating the close association of stalk yield with juice yield.

In the present study, wherein the effect of cytoplasm on total biomass, fresh stalk yield, juice yield and brix was studied, the results revealed presence of significant cytoplasmic differences in hybrid mean performance. The data revealed that in A4 cytoplasm, total biomass, fresh stalk yield and juice yield was significantly higher than A1, A2 and A3 cytoplasms. A4 cytoplasm was found to be a useful secondary CMS system for production of hybrids where biomass is important. For brix, it was found that there
were no significant differences among the four cytoplasms. But when each hybrid was analyzed independently, differences among the cytoplasms of the same hybrid were detected for most of hybrids for all the four traits. Such cytoplasmic differences in some of the isonuclear hybrids were attributed due to the interaction of cytoplasm with the nuclear genes of A-lines and of R-lines in these hybrids.

The fertility restoration revealed that A1 cytoplasmic hybrids were fully fertile when compared to A2 cytoplasmic hybrids. Fertility status of A4 cytoplasmic source hybrids was in between A2 and A3. The order of sterility in the diverse cytoplasms increased from A1 → A2 → A4 → A3.

The analysis of variance for combining ability revealed the significance of mean squares due to parents and parents vs. crosses for all the traits. Diversity was found among the pollinator parents for all the traits and diversity among the lines for days to 50% flowering, days to maturity, nodes and brix. The variance due to gca was larger than variance due to sca for all the characters except stem girth and total biomass indicating predominance of additive gene action.

The testers SSV 84, IS 6962 and RSSV 9 recorded highly significant and positive gca effects for stem girth, total biomass, fresh stalk and juice yields. Testers IS 6962, NSSV 352 and RSSV 9 were considered as good general combiners for brix. It was interesting to note that IS 6962 and RSSV 9 were also promising for stem girth and stalk traits.

Sca effects indicated that a number of hybrid combinations gave significantly higher sca effects for many of the characters studied. It is evident that crosses involving either both or at least one high gca parent produced hybrids with high sca effects. The cross USA 16 x IS 6922 showed positive and significant sca effects apart from high mean performance for important characters like total biomass, fresh stalk yield and juice yield and may be commercially exploited as high biomass yielding sweet sorghum hybrid. Apart from this, the other promising hybrids like USA 17 x SSV 84 and USA 19 x SSV 84 in this study would be recommended for further testing across many locations in the targeted environments.
A study comprising of 28 crosses derived from a 8 X 8 half diallel was carried out at Agricultural Research Station, Kadiri during rabi 2008 and kharif 2009 seasons. The data recorded on yield, physiological and confectionery traits (eighteen characters) were subjected to combining ability analysis, heterosis, genetic parameters, character association and path co-efficient analysis.

Among parents K 1375 was found as a promising genotype for pod yield, kernel yield, oil percent, SMK percent, shelling percent, early maturity as well as for physiological traits i.e., high SCMR, low SLA at 30, 60 and 90 DAS and high RWC. The other promising parents identified were K 1271 for kernel yield, SMK percent, shelling percent and early flowering habit, ICGV 86564 and ICGV 99073 for pod yield, kernel yield per plant, HKW and haulm yield per plant, ICGV 99073 for high oil content and RWC and ICGV 86564 for low SLA at 30, 60, and 90 DAS during both the seasons.

Among F1s crosses K 1375 X K 1319 exhibited superiority for pod yield, kernel yield per plant, high SCMR and low SLA at 30, 60 and 90 DAS in both the seasons. Further, four more crosses viz., K 1375 X (3X155-005), K 1375 X K 1510, K 1375 X ICGV 00350 and 3 X 155-005 X ICGV 86564 was found promising for SCMR and low SLA values at 30, 60 and 90 DAS and shelling percent in both the seasons (rabi 2008 and kharif 2009). For oil content the parent K 1510 and five crosses viz., K 1375 X ICGV 99073, K 1375 X ICGV 00350, K 1510 X ICGV 86564 and K 1510 X ICGV 99073 and K 1510 X ICGV 00350 were found promising during both the seasons (rabi 2008 and kharif 2009). The F1 of cross the ICGV 86564 X ICGV 99073 recorded high per se values for pod yield, kernel yield, haulm yield per plant and hundred kernel weight while ICGV 86564 X ICGV 00350 recorded high mean values for relative water content, haulm yield per plant and hundred kernel weight. The F1 of cross the K 1271 X ICGV 99073
recorded high mean values for kernel yield and pod yield per plant and also it has expressed very early flowering and maturity.

Among F2 populations K 1271 X K 1510 exhibited high \textit{per se} performance for pod yield, kernel yield, haulm yield per plant, shelling percent and oil percent. Two F2s viz., K 1319 X ICGV 86564 and (3X155-005) X ICGV 86564 recorded the high mean values for pod yield, kernel yield and haulm yield per plant.

The estimates of genetic variance components in F1 generation of 28 crosses revealed additive gene action for hundred kernel weight and oil percent and non additive gene action for SCMR, SLA at 30, 60 DAS, RWC, harvest index, days to maturity, haulm yield per plant, sound mature kernel, kernel yield and pod yield per plant in both the seasons (\textit{rabi} 2008 and \textit{kharif} 2009).

Among the parents best general combiners identified for the respective traits were K 1375 for pod yield, kernel yield per plant, shelling percent and oil percent, SCMR, SLA at 30,60 and 90 DAS, ICGV 99073 for pod yield, kernel yield, haulm yield per plant, oil percent and hundred kernel weight while K 1271 for days to 1st, 50\% flowering and maturity, K 1510 for oil percent and ICGV 86564 for hundred kernel weight were adjudged as the best general combiners.

The \textit{sca} effects of crosses indicated K 1375 X K 1319 to be the good specific combiner for pod yield, kernel yield and haulm yield per plant, ICGV 86564 X ICGV 99073 for pod yield, haulm yield and hundred kernel weight, (3X155-005) X ICGV 99073 for low SLA at 30, 60 and 90 DAS, two F1 crosses viz., ICGV 86564 X ICGV 00350 and ICGV 99073 X ICGV 00350 for hundred kernel weight and RWC and K 1271 X ICGV 99073 for early days to 1st, 50\% flowering and early maturity.

The best heterotic combinations identified over standard parent (K 1375) were K1271 X ICGV 99073 and K 1375 X K 1319 for pod yield, kernel yield, early flowering and early maturity, 3 X 155-005 X ICGV 99073 for low SLA at 30, 60 and 90 DAS, ICGV 86564 X ICGV 99073 for haulm yield per plant and K 1319 X (3 X 155-005) for early maturity. High magnitude of heterosis was observed in the crosses of high X low potential combinations for most of the traits. In majority of the crosses the dominance and epistasis type of gene effects were implicated in the expression of the heterosis hence these crosses could be further utilized in the isolation of superior high yielding transgressive segregants in their later generations.

High heritability coupled with high genetic advance as percent of mean was found for pod yield per plant, kernel yield per plant, haulms yield per plant, hundred kernel weight, SLA at 60 and 90 DAS indicating that it would be rewarding to lay due emphasis on the selection of these characters for rapid improvement of pod yield potential in groundnut.

The character associations in parents, F1 and F2 generation of 28 crosses indicated significant positive correlation of kernel yield, haulm yield per plant, harvest
index and HKW with pod yield per plant in both the seasons. Very high positive direct effects on pod yield per plant were exerted by kernel yield, haulm yield, SCMR at 60 DAS, SLA at 30 and 90 DAS and SMK percent indicating that these traits were the important yield determinants and could be included in formulating selection indices for identification of high yielding genotypes in groundnut.
The present investigation was carried out during *rabi* 2007-08 at Andhra Pradesh Rice Research Station, Maruteru with 40 New Plant Type genotypes of rice (*Oryza sativa* L.) which were developed by APRRI, Maruteru to study mean, variability, heritability, genetic advance as per cent of mean, correlation, path coefficient analysis and genetic divergence for the following eleven morphological characters *viz.*., plant height (cm), days to 50% flowering, productive tillers/hill, panicle length (cm), fertile grains/panicle, test weight (g), L/B ratio, protein content (%), leaf nitrogen content at harvest (%), harvest index and grain yield/plant (g) and three physiological characters *viz.*., leaf area index at the time of days to 50% flowering, relative growth rate from panicle initiation to maturity and total biomass/plant.

Analysis of variance indicated that there were significant differences among the genotypes for all the characters studied except for test weight, L/B ratio and leaf nitrogen content at harvest.

The characters such as fertile grains/panicle, grain protein, leaf nitrogen at harvest, leaf area index at days to 50% flowering (DFF), harvest index and grain yield per plant showed high heritability coupled with high genetic advance as per cent of mean indicating predominance of additive gene action.

Character association studies revealed positive and significant association of grain yield per plant with productive tillers per hill, fertile grains per panicle, relative growth rate at 60-90 days after transplanting, total biomass per plant and harvest index.

The results of path coefficient analysis revealed that productive tillers/hill, fertile grains per panicle, relative growth rate at 60-90 days after transplanting, total biomass per plant and harvest index exhibited high positive direct effect coupled with positive significant correlation with grain yield per plant.
Results of multivariate analysis and principal component analysis indicated the presence of considerable genetic divergence among the 40 genotypes that were studied. Based on the $D^2$ analysis, the genotypes were grouped into six clusters by Tocher’s method and into seven clusters in cluster analysis proving the fact that there was no parallelism between genetic diversity and geographical distribution. In $D^2$ analysis protein content contributed maximum towards diversity.

Principal component analysis delivered four principal components which contributed 93.672 cumulative variance. Population with high PC$_1$ values was characterized by high loading values of grain protein, leaf area index at days to 50% flowering (DFF) and grain yield per plant. Whereas, population with high PC$_2$ values was characterized by total biomass per plant, harvest index and days to 50% flowering.

Agglomerative hierarchical clustering by Ward’s minimum variance method revealed high genetic diversity between cluster I and VII followed by cluster II and VII and cluster V and VII which could probably give birth to superior progenies.
The evaluation of combining ability and heterosis in a study involving eight parents and 15 F1 hybrids of pigeonpea revealed that the lines ICPL-15225 and LRG-41, the testers ICPL-8863 and ICPL-87119 and among the crosses, ICPL-15225 X ICPL-8863, ICPL-15225 X ICPL-87119 and LRG-41 X PRG-158 showed high mean performance for seed yield. Analysis of genetic parameters revealed higher phenotypic and genotypic coefficient of variation, heritability, genetic advance as per cent of mean for pods per plant, 100-seed weight, harvest index, phenol content, seed yield per plant, primary and secondary branches per plant in parents and for pods per plant and seed yield per plant in crosses indicating that simple selection could be practiced for improving these characters.

The expression of heterosis was most evident for pods per plant, seed yield per plant, phenol content, days to flowering, days to maturity, harvest index, seed protein and SCMR at vegetative phase. Significant heterosis, heterobeltiosis, standard heterosis were recorded in the crosses viz., ICPL-15225 X ICPL-8863, LRG-41 X PRG-158, LRG-41 X ICPL-8863, LRG-41 X ICPL-87119 and ICPL-15225 X ICPL-87119 for most of the characters. The parents LRG-41 and ICPL-15225 were found to be good general combiners for harvest index, pods per plant and seed yield per plant, ICPL-2376 and ICPL-8863 for seed protein, phenol content and earliness, ICPL-7035 for seeds per pod, pod length, 100-seed weight and SCMR at vegetative phase, LRG-41 for plant height and branches per plant. Based on sca effects, per se performance, heterosis, ICPL-15225 X ICPL-8863, ICPL-15225 X ICPL-87119 and LRG-41 X PRG-158 were identified as the best specific crosses for hybrid breeding programme, while the crosses ICPL-15225 X PRG-158 and LRG-41 X ICPL-8863 were identified for advancing through recombination breeding programme.

Character association studies indicated that the character pods per plant had significant positive correlation with seed yield per plant and also intercorrelations were observed among seeds per pod, pod length and 100-seed weight. Path coefficient analysis revealed the high positive direct influence of pods per plant on seed yield and it also had
positive indirect effects on seed yield via all the characters except 100-seed weight and SCMR at vegetative phase in both parents and crosses. Hence, selection for pods per plant is suggested for the improvement of seed yield per plant in pigeonpea.
An investigation was carried out during Kharif 2010 involving eleven parents, 30 F1 hybrids and three checks at three locations viz., Hyderabad, Rahuri and Coimbatore during Kharif 2010 to know the heterosis, combining ability and G × E interactions in sweet sorghum.

The results indicated higher amount of variability among the parental material and the F1 hybrids. Based on mean performance the females, RS 1220B followed by NSS 10B, the males, CSV 19SS followed by SSV 84 and RSSV 120 and the hybrids NSS 1007A × CSV 19SS, RS 1220A × RSSV 120, NSS 8A × CSV 19SS, NSS 1016A × CSV 19SS, RS 1220A × CSV 19SS, RS 1220A × SSV 74 and RS 1220A × RSSV 76 were found to be superior for ethanol yield and its component traits.

Among female lines RS 1220B and among males (testers) CSV 19SS and SSV 74 were good general combiner for total biomass, fresh stalk yield, juice yield and ethanol yield. Hence, these parents can be utilized in hybridization programmes.

The $sca$ effects revealed NSS 1007A × CSV 19SS, NSS 10A × CSV 19SS, NSS 8A × CSV 19SS and NSS 8A × RSSV 120 were found for commercial exploitation. The parents, SSV 84 and RSSV 120 and the hybrids viz., NSS 1007A × CSV 19SS and NSS 8A × SSV 84 were identified as stable hybrids for total biomass, juice yield and ethanol yield.

From the variability studies it was evident that in parents the simple directional selection would be helpful for the characters plant height, fresh stalk yield and grain yield. Critical analysis of character association and path analysis suggested that importance in selection programmes should be given for the traits viz., plant height, total sugar index, juice yield and fresh stalk yield in parents while brix percent, fresh stalk yield and juice yield in hybrids which resulted in high positive correlation with ethanol yield for improvement of ethanol yield in genotypes.
The present investigation has been undertaken in sweet corn to carry out the combining ability analysis and to estimate heterosis as well as to understand nature of gene action, genetic parameters, character association of yield and yield contributing characters. Eight divergent parents were selected and crossed in diallel fashion excluding reciprocals during Kharif, 2010. The resulting 28 crosses along with parents and a standard check Sugar 75 and Madhuri were evaluated in Randomized Block Design replicated thrice, during Rabi, 2010-11 at Agricultural Research Institute, Rajendranagar, Hyderabad. The data were collected on days to 50 per cent tasseling, days to 50 per cent silking, days to maturity, plant height, ear height, ear length, ear girth, number of kernel rows per ear, number of kernels per row, green cob yield, 100 kernel (dry) weight and seed yield (wet) per plant, green fodder yield and sugar content in percentage.

The combining ability analysis revealed importance of both additive and non-additive gene actions in governing the characters but non-additive gene action was found predominant. Among the parental lines, 6122-1 and 6100-2 were good general combiners for earliness viz., days to 50 per cent tasseling, days to 50 per cent silking and days to maturity and the parents 6100 and 6100-2 for seed yield (wet) per plant. The parental lines 6100, 6100-2 and 6104 contributed maximum favourable genes. Considering all the characters, the parents 6100, 6100-2 and 6122-1 can be given status of good combiners.

The hybrids, 6104 x 6100, 6127 x 6100 and 6122-1 x 6100-2 were the good specific combiners for seed yield (wet) per plant. Hence, these crosses could be advanced further for isolation of transgressive segregants and also to develop good inbred lines.

Estimates of heterosis, heterobeltiosis and standard heterosis were variable among crosses in desirable direction and some of them turned out to be best specific crosses. The cross combinations 6127 x 6100 (20.09%) and 6104 x 6100 (19.65%) for seed yield (wet) per plant were found to be superior to the standard check Madhuri. The hybrids 6072-3 x
6069, 6072-3 x 6100-2, 6069 x 6122-1, 6122-1 x 6127, 6072-3 x 6127 and 6104 x 6082 performed well over standard Madhuri for sugar content in kernel. But none of the character (except sugar content in some hybrids like 6072-3 x 6069, 6072-3 x 6100-2 and 6069 x 6122-1) was significant when compared with standard check Sugar 75.

Character association among seed yield (wet) per plant and yield contributing characters exhibited that 100 seed (dry) weight, number of kernels per row, number of kernel rows per ear, ear girth, ear length, plant height, green cob yield and ear height had significant and positive correlations with grain yield.

Path coefficient analysis had shown direct positive relationship of number of kernels per ear, ear height, ear length, 100 seed (dry) weight (phenotypic), number of kernels per row and green cob yield with grain yield. The indirect effect of these characters on grain yield influenced more by green cob yield and number of kernels per row.

The identified four superior cross combinations (6104 x 6100, 6127 x 6100, 6100 x 6100-2 and 6122-1 x 6100-2) in the present investigation, based on heterosis and combining ability, which performed well for seed yield (wet) per plant and yield contributing characters may be used as single cross hybrids after evaluation in multi location trials.
GENETICS AND PLANT BREEDING

Author : Saidu Bazi Noor Basha

Title of the thesis : GENTIC DIVERGENCE BASED ON METRIC AND PHYSIOLOGICAL TRAITS IN UPLAND COTTON

(Gossypium hirsutum L.)

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College : AGRICULTURAL COLLEGE, BAPATLA

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The present investigation was carried out during kharif 2009-10 at Regional Agricultural Research Station, Lam farm, Guntur with 70 genotypes of cotton (Gossypium hirsutum L.) to know the extent of genetic variability, heritability, genetic advance as per cent of mean, character association, the magnitude of direct and indirect effects of yield component traits on seed cotton yield and genetic divergence based on 19 characters viz., number of sympodia per plant, number of bolls per plant, boll weight (g), seed index (g), lint index (g), ginning out-turn (%), 2.5% span length (mm), micronaire ($10^{-6}$ g/in), bundle strength (g/tex), uniformity ratio, fibre elongation (%), crop growth rate at 60-120 days (g/m$^2$/day), relative water content at 60 DAS (%), relative water content at 120 DAS (%), specific leaf weight at 60 DAS (mg/cm$^2$), specific leaf weight at 120 DAS (mg/cm$^2$), leaf area index at 120 DAS, harvest index and seed cotton yield per plant (g).

The genotypic coefficient of variation for all the characters studied was lesser than the phenotypic coefficient of variation indicating different levels of interaction of each character with environment. High variability was recorded for number of bolls per plant, crop growth rate at 60-120 days and leaf area index at 120 DAS. High heritability and high genetic advance as per cent of mean was observed for the characters viz., number of bolls per plant, boll weight, seed index, lint index, 2.5% span length, micronaire, CGR at 60-120 days, LAI at 120 DAS and seed cotton yield per plant indicating the predominance of additive gene action and hence, direct phenotypic selection may be useful with respect to these traits.

Correlation studies indicated significant positive association of number of bolls per plant, boll weight, seed index, lint index, CGR at 60-120 days and harvest index with seed cotton yield per plant.
The path coefficient analysis revealed that number of bolls per plant and boll weight exerted direct positive effect on seed cotton yield per plant. Selection based on these attributes may be helpful in evolving high yielding varieties of upland cotton. The results of multivariate analysis indicated presence of considerable divergence among seventy genotypes studied which were grouped into nine clusters in case of $D^2$ analysis and in Ward’s minimum variance method. Clustering pattern suggested that geographical distance may not be the only factor causing genetic divergence among genotypes studied.

By Mahalanobis’ $D^2$ analysis, it was noted that boll weight, CGR at 60-120 days and ginning out-turn contributed maximum towards divergence. Based on inter-cluster distance among the groups, it is suggested to make crosses between the genotypes of cluster VII (AK 32) and cluster VIII (L 387) or between genotypes falling under cluster VII (AK 32) and cluster IX (HLS 329) for generating desirable segregants.

In principal component method, first 7 principal components explained 75.365% of the variability. The significant factors loaded in $PC_1$ towards maximum divergence were number of bolls per plant, lint index, micronaire, boll weight, CGR at 60-120 days, seed cotton yield per plant and SLW at 60 DAS. 2D and 3D graphs showed wide divergence between L 741, AET 5, CCH-05-2, CSH-01, CNO-12 and HLS 329 signifying their usefulness in cotton breeding to develop high heterotic combinations.

Agglomerative cluster analysis revealed wide genetic distance between cluster III (HLS 272, HLS72, MCU 11, CCH 18, CSH-01, K 3902) and VII (4085, L 606, B4 Empire, SA 1104, JK 344, ARB 8901, AC 88, CNH 7-94-3, AET 5, CPD 431, CPD 420, DS 28, NA 1678, BWR 39, HLS 329). Therefore, selection of parents from these clusters for hybridization may help in developing heterotic hybrid combinations.

The genotypes HLS 329, HLS 272, AET 5 and CSH-01 showed maximum inter-cluster distance in all the three divergence methods. So they can be exploited for the development of heterotic hybrids in the future breeding programmes.
Eight parents and 28 F1 cross combinations of maize were evaluated in a RBD with three replications during rabi, 2010-2011 so as to identify the best parental genotypes and cross combinations with higher grain yield. Based on both per se performance and gca effects, the inbred lines CM 209, CM 149 and BML 15 were recognized as the best general combiners for most of the traits and hence, could be used in crossing programme for obtaining transgressive segregants for yield and yield components. The highly significant sca effects in addition to high per se performance were identified for most of the traits in the crosses viz., CM 149 x BML 6 (cob length, cob girth, grain yield per plant and 100-seed weight) and CM 132 x BML 7 (days to 50 per cent tasseling and days to 50 per cent silking). These cross combinations showing high sca effects besides high per se performance for yield and yield components could be utilized in recombinant breeding programme. The estimates of components of variance revealed predominance of non-additive gene action for all the traits. In such cases where non-additive gene action played a predominant role in association with additive component, the recurrent selection and reciprocal recurrent selection can be used to exploitsimultaneously both the components.

The estimates of heterosis obtained in hybrid combinations revealed considerable genetic divergence among eight parents. The cross combinations CM 149 x BML 6 and CM 148 x BML 15, which recorded high heterobeltiosis for most of the traits could be utilized in heterosis breeding programme to exploit heterotic vigour. Further, based on highly significant heterobeltiosis, standard heterosis and sca effects for grain yield per plant, the promising cross combinations were CM 149 x BML 6, CM 149 x BML 15, CM 148 x BML 15 and CM 133 x BML 7.
Correlation analysis revealed that, number of kernels per row followed by cob length, cob girth and 100-seed weight exhibited maximum positive association with grain yield per plant. Further, the inter-se association among these traits was also highly significant and positive. Path coefficient analysis revealed that, cob length followed by cob girth, number of kernels per row and 100-seed weight exerted highest positive direct effects on grain yield per plant. Hence these characters may be given due emphasis in formulating selection indices in order to evolve high yielding genotypes in maize.
Powdery mildew is a serious disease of sesame (Sesamum indicum L.). It occurs in epidemics under heavy rainfall conditions followed by low night temperatures and high humid conditions. Powdery mildew causes yield loss of 25 to 50% depending upon the severity. Classical breeding for incorporation of resistance using backcrossing is difficult because consistent disease reaction in the field is hard to achieve due to environmental factors. Identification of molecular markers linked to powdery mildew resistant gene(s) is one approach to improve selection for resistant cultivars. The objective of this study was to identify the mode of inheritance of disease resistance and to use microsatellite (SSR) markers to identify markers linked to resistance gene(s) and map gene(s) resistance to powdery mildew. In the present study Swetha til, a high yielding popular white seeded variety but susceptible to powdery mildew and BB3-8 accession of Sesamum mulayanum resistant to powdery mildew from RARS, Jagtial were selected as parents for hybridization. F1 was developed by crossing the resistant parent (BB3-8 accession of Sesamum mulayanum) and the susceptible parent (Swetha til) during Late summer, 2009. F1 was selfed during Kharif 2010 to generate F2. Four populations including P1, P2, F1, F2 were sown during Late summer, 2010 to screen powdery mildew under field conditions. The F1 of the cross between Swetha til and BB3-8 accession of Sesamum mulayanum exhibited susceptible reaction to the disease suggesting resistance to be governed by recessive gene. On screening of 104 plants of F2 population, the plants segregated into 61 susceptible and 43 resistant plants. Chi-square analysis showed the observed ratio to confirm the expected ratio of 9:7 ratio (susceptible: resistant) and the resistance to disease was governed by two pairs of recessive genes contributed by Sesamum mulayanum. The two parents were screened for parental polymorphism using 300 sesame microsatellite markers, of which 240 showed clear amplification pattern and 24 markers exhibited polymorphism (10%) and the same were used for genotyping. DNA
from 104 F2 progenies were collected for genotyping with 24 Polymorphic SSR primers. Molecular linkage map was constructed with SSR markers SM10 178 and SM10 176 using the MAPMAKER/EXP version 3.0. Both the markers were mapped to one and the same linkage group at a distance of 14.2 cM. These two markers were found to be linked to the powdery mildew resistance gene.

GENETICS AND PLANT BREEDING

Author : SUDARSHAN PATIL, K.

Title of the thesis : “STUDIES ON GENETIC DIVERSITY ASSESSMENT IN SORGHUM (Sorghum bicolor L. Moench) GENOTYPES AND HYBRID PURITY TEST EMPLOYING SSR MARKERS”

Major Advisor : Dr. J. SURESH

Degree : M.Sc. (Ag.)

College : COLLEGE OF AGRICULTURE, RAJENDRANAGAR

Accession Number : D 8869

In the present investigation, forty six genotypes of sorghum and three F1 hybrids were evaluated for genetic diversity and hybrid purity test respectively by employing morphological and SSR markers. The experiment was laid out in randomized block design for genetic diversity assessment with three replications and 400 plants of each of three hybrids for Grow-out test were grown at experimental field of Directorate of Sorghum Research (DSR), Rajendranagar, Hyderabad during Rabi 2010.

Studies of genetic variability revealed high phenotypic and genotypic coefficients of variation, heritability and genetic advance as percent mean for the traits viz., peduncle length, plant height, panicle weight and number of primary branches per panicle indicating simple selection can be practiced for improvement of these characters.

Morphological divergence by Euclidian method indicated the existence of significant diversity among genotypes which were grouped into thirteen clusters. Peduncle length, plant height and panicle weight at maturity contributed maximum towards genetic diversity. The Cluster XII recorded higher mean value for days to 50% flowering, plant height, total number of leaves, panicle weight, number of primary branches, grain yield per panicle and test weight. Clusters I and Cluster III were recorded considerably lower mean value for days to fifty per cent flowering and higher mean value for panicle weight, grain yield, plant height at maturity, number of primary branches per panicle and test weight. Hence crosses between genotypes selected from these clusters may be useful to develop early varieties with increased number of branches per panicle and grain yield.
Analysis for molecular diversity was carried out employing SSR markers. Among the 42 SSRs employed, 32 were polymorphic. The PIC value ranges from 0.02 to 0.74. Cluster analysis revealed a dendrogram with range of 0.53 to 0.95 similarity indicating considerable amount of diversity among the genotypes. Cluster I consists of 1 genotype with 48% dissimilarity. Cluster II consists of 22 genotypes revealed 42% dissimilarity which is sub grouped into 6 sub-clusters viz., IIA, IIB, IIC, IID, IIE and IIF. Cluster III consists of 23 genotypes which revealed 40% of dissimilarity which is again sub grouped into 3 sub-clusters namely IIIA, IIIB and IIIC.

Cluster IIA consisted of 3 genotypes with genetic dissimilarity of only 14% with the rest of genotypes of cluster II. Cluster IIB, IIC and IID consisted of 5, 3 and 3 genotypes with a genetic dissimilarity of 35%, 16% and 21% respectively. Similarly, genotypes of cluster IIIE and IIIF recorded 34% and 37% of dissimilarity respectively. Cluster III which was subgrouped into three clusters. Solitary cluster IIIA showed genetic dissimilarity of 39% and remaining two clusters IIIB and IIIC both recorded 33% of genetic dissimilarity.

Both molecular and morphological analysis gave quite similar results but Molecular marker (SSR) more informative and could group the genotypes into different clusters. Both can be complimentary for assessment of diversity and genotype identification.

A total of 42 genomic SSRs analyzed with five parental lines of three commercial hybrids. Nine markers showed polymorphism between the parents. The markers Xtxp 10, Xtxp 15, Xtxp 145, Xtxp 343, Xtxp 312, msbCIR 238, msbCIR 286, Xgap 10 and SbAGB 02 markers found to be specific for parental lines of CSH 9, CSH 13 and CSH 14 hybrids. Genetic purity assessment with molecular markers showed 2-3% more efficiency in detecting impurities in commercial hybrids as compared to Grow-out test.

Results of GOT and molecular data were effective in assessment of genetic purity. In addition, this SSR marker-based genetic purity testing would save the cost of hybrid seed storage for a whole season and the cost incurred on GOT. This assay can be used by the public and private seed companies for accurate and reliable detection of off-types in commercial sorghum hybrid seed lots for ensuring the supply of good quality seeds to the market.
Generations mean analysis was carried out to estimate the nature and magnitude of gene effects for sugar yield and its component traits in sweet sorghum \([\text{Sorghum bicolor (L.) Moench}]\). Six basic generations, namely P1, P2, F1, F2, BC1P1, BC1P2 of four crosses involving seven diverse parents were evaluated in rainy seasons 2009 and 2010. The means of all six generations in all the crosses indicated higher F1 means than midparent and better parent values in majority of the characters. F1 means were higher than mid-parental values and/or comparable to better parent mean values in respect of all the traits in both seasons except days to 50 per cent flowering which indicated presence of both partial and over dominance. The F2 means were lesser than the F1 means. The means of backcross populations tended towards their respective parents.

Scaling and joint scaling tests revealed inadequacy of simple additive-dominance model to explain the observed variation of all the traits in both seasons, providing an evidence for the presence of epistasis in all the crosses. The six generation mean analysis in all the four crosses indicated significance of both additive and dominance gene effects. While, all the traits showed significance of one or more interaction types (additive × additive \([i]\) or additive × dominance \([j]\) or dominance × dominance \([l]\)). Based on the signs of \([h]\) and \([l]\) components, duplicate type (opposite sign) of gene interaction has been reported in the inheritance of traits studied in all the four crosses with a few exceptions.

High degree of heterosis coupled with high magnitude of inbreeding depression was reported for sugar yield and its important component characters indicating the operation of the non-additive gene action. Consistency in the performance of the hybrids
over the crosses and seasons was observed or all the traits. Minimum number of effective factors influencing a trait in F2 population ranged between one and ten.

Genetic variability studies in F2 population of four crosses revealed wide range of variability for majority of the traits under study. The skewness and kurtosis indicated the presence of both complementary and duplicate type of interaction in the inheritance of characters. However, majority exhibited platykurtic and positively skewed distribution suggesting the involvement of relatively large number of segregating genes having decreasing effects and dominance based complementary type of interaction. Higher per cent of GCV and PCV were observed for all the traits. The estimates of heritability and genetic advance as per cent of mean was observed to be high for all the traits.

Correlation coefficient studies revealed significant positive correlation of all component characters with sugar yield. Path analysis revealed high positive direct effect of juice weight which was consistent over the seasons and crosses. The selection indices formulated in F2 generation of one of the crosses indicated, the three character combination including plant height, juice weight and Brix% manifesting maximum relative efficiency coupled with genetic advance.
GENETICS AND PLANT BREEDING

Author : SURESH, RENTAPALLI.

Title of the thesis : GENETIC DIVERGENCE IN PIGEONPEA 
[Cajanus cajan (L.) Millsp.]

Major Advisor : Dr. B. GOVINDA RAO

Degree : M.Sc. (Ag.)

College : AGRICULTURAL COLLEGE, BAPATLA

Accession Number : D 9066

An investigation on genetic divergence in pigeonpea [Cajanus cajan (L.) Millsp.] was carried out during kharif 2010-11 at Regional Agricultural Research Station, Lam, Guntur with 41 genotypes to elicit the information on nature and extent of the genetic variability, heritability, genetic advance, character association, path analysis and genetic divergence. Observations were recorded on thirteen characters viz., plant height (cm), days to 50% flowering, days to maturity, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, pod length (cm), number of seeds per pod, shelling percentage, 100 seed weight (g), seed yield per plant (g), grain protein content (%) and harvest index.

The genotypic coefficients of variation for all the characters studied were lesser than the phenotypic coefficients of variation indicating the effect of the environment. High genetic variability coupled with high heritability and genetic advance as per cent of mean was observed for number of primary branches per plant, number of secondary branches per plant, number of pods per plant, seed yield per plant and grain protein content indicating the role of additive genes in governing the inheritance of these traits.

The correlation study indicated that the plant height, number of secondary branches per plant, numbers of pods per plant, number of seeds per pod and harvest index had significant positive association with seed yield and simultaneous improvement of these characters along with seed yield is possible.

Path coefficient analysis revealed that harvest index, number of primary branches per plant and 100 seed weight had positive direct effects on seed yield per plant.
The results of multivariate analysis revealed the presence of considerable genetic divergence among the 41 genotypes studied and grouped into six clusters as per D2 analysis and seven clusters in case of cluster analysis. The grouping of genotypes into clusters was at random indicating that geographical isolation might not be the only factor causing genetic diversity. Out of 13 characters studied, number of pods per plant contributed maximum towards divergence followed by grain protein content, plant height, days to 50% flowering, seed yield per plant and number of primary branches per plant.

Based on the inter-cluster distances among the groups, suggestions were made to attempt crosses between clusters IV (JKM144, PERENNIAL 1, MAHANANDI 2, LOCAL 2003-1, LOCAL 2002-3, LRG 30, JSA72-3, SM 1, WRG 53, GM 1, WRG 150, SM 30, TT 02 and BSMR 737) and VI (SM 13 and WRG 47) which had maximum inter-cluster distance to obtain better heterotic and desirable segregants. Principal component analysis identified five principal components (PCs) which explained 83.54% of the variability.

Agglomerative cluster analysis revealed that crosses can be attempted between clusters III (JKM 144, PERENNIAL 1 and MAHANANDI 2) and cluster VII (SM 13 and WRG 47) which had wide genetic distance to obtain maximum heterosis.

The genotypes SM 13, SM 114, PERENNIAL 1 and TT 02 showed maximum inter-cluster distance and wide genetic distance with each other in all the three divergence methods. So they can be exploited in hybridization programme for identification of desirable segregants.
The present investigation was carried out during *kharif* 2010-11 at Agricultural College Farm, Bapatla, with 40 genotypes of cotton (*Gossypium hirsutum* L.).

The variability, genetic divergence, character association and the magnitude of direct and indirect effects of yield component traits with seed cotton yield were studied along with morphological characterization of the lines using IBPGR descriptors. The data were recorded on 27 morphological characters, *viz.*, stem pigmentation, stem hairiness, leaf shape, leaf lobe number, leaf size, leaf colour, leaf pubescence, leaf appearance, leaf gossypol glands, leaf nectaries, leafpetiole pigmentation, type of bract, number of serrations of bract, sepal pigmentation, petal colour, petal spot, position of stigma, filament colouration, anther colour, boll bearing habit, boll size, boll colour, boll shape, boll surface, boll prominence of tip, boll opening and plant habit, and 15 quantitative characters *viz.*, days to 50% flowering, plant height (cm), number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight (g), ginning out-turn (%), seed index (g), lint index (g), 2.5% span length (mm), micronaire (10-6 g/in), bundle strength (g/tex), uniformity ratio, fibre elongation (%) and seed cotton yield per plant (g).

IBPGR descriptors data revealed that variability was present for thirteen characters out of twenty seven descriptors studied and they can be exploited for varietal identification and IPR protection along with crop improvement programmes.

The analysis of variance revealed significant differences among the genotypes for all the characters studied indicating the data generated from the diverse material will yield reliable information.
The genotypic coefficients of variation for all the characters studied were lesser than the phenotypic coefficients of variation indicating the masking effects of the environment. The characters viz., number of sympodia plant-1, number of bolls per plant, boll weight and seed cotton yield per plant exhibited moderate phenotypic coefficient of variation. Moderate heritability coupled with moderate genetic advance was noted for number of sympodia plant-1, number of bolls per plant and seed cotton yield per plant. This indicates the presence of non-additive gene action and further improvement of these traits would be possible through heterosis breeding rather than simple selection.

The correlation and path coefficient analyses together indicated that plant height, number of sympodia plant-1, number of bolls plant-1 and seed index had significant positive and positive direct effects on seed cotton yield per plant indicating the existence of true relationship between these characters and their exploitation in selection programmes.

The results of multivariate analysis revealed that the distribution of 40 genotypes into seven clusters in case of D2 analysis and agglomerative cluster analysis. The distribution of genotypes into these clusters was at random indicating genetic diversity and geographical diversity were not related. Mahalanobis’ D2 statistic indicated that the characters, fibre elongation, seed index, number of monopodia plant-1, boll weight, lint index, micronaire, ginning out-turn, 2.5% span length, seed cotton yield per plant and uniformity ratio contributed maximum towards genetic divergence.

Based on the inter-cluster distances among the groups suggestions were made to attempt crosses after confirming the general combining ability of the genotypes from the clusters IV (KH-11, RAH-101) and VII (COP-420) which had maximum inter-cluster distance (276.846) to obtain better heterotic and desirable segregants.

In the principal component method, first 5 principal components explained 78.35% of the variability. The first component was characterized by the high loading values of plant height, boll weight, days to 50% flowering, seed cotton yield per plant, number of bolls per plant, ginning out-turn and fiber elongation in assessing the genetic diversity. Agglomerative cluster analysis revealed crosses can be attempted between the clusters III (KH-11, RAH-101) and VII (COP-420) which had maximum inter-cluster distance to obtain desirable segregants.

The genotypes KH-11 and RAH-101, and COP-420 showed maximum inter-cluster distance and wide genetic distance in multivariate analysis. These genotypes can be exploited in hybridization programme for identification of desirable segregants.
GENETICS AND PLANT BREEDING

Author : TUSHARA, M.
Title of the thesis AND
STUDIES ON GENETIC DIVERGENCE IN MEDIUM
AND LONG DURATION RICE (Oryza sativa L.) GENOTYPES.
Major Advisor : Dr. V. SATYANARAYANA RAO
Degree : M.Sc. (Ag.)
College : AGRICULTURAL COLLEGE, BAPATLA
Accession Number : D 9063

The present investigation was carried out to study the variability, heritability, genetic advance, correlation, path coefficients and genetic divergence among 19 medium duration and 34 long duration genotypes of rice (Oryza Sativa L.) for 21 characters.

The analysis of variance revealed significant differences among the genotypes for all the characters studied indicating that the data generated from the above diverse material shall represent wide variability. The genotypic coefficients of variation for all the characters studied were lesser than the phenotypic coefficients of variation indicating the modifying effect of the environment in association with the characters at genotypic level. High PCV coupled with high GCV observed for plant height, total tillers per plant, ear bearing tillers per plant, panicle length, filled grains per panicle, grain width, flag leaf length, test weight, grain yield per plant, kernel length, kernel breadth, water uptake and alkali digestion value in medium duration genotypes and plant height, total tillers per plant, ear bearing tillers per plant, filled grains per panicle, flag leaf length, test weight, grain yield per plant, kernel length, kernel breadth, water uptake and alkali digestion value in long duration genotypes. High heritability coupled with high genetic advance as per cent of mean was observed same for the characters in medium and long duration genotypes like plant height, tillers per plant, ear bearing tillers per plant, filled grains per panicle, flag leaf length, test weight, grain yield per plant, kernel length, kernel breadth, water uptake and alkali digestion value along with panicle length and grain width in medium duration genotypes indicating the operation of additive gene action in the inheritance of these traits and improvement of these

The correlation studies revealed that selection may be exercised on characters like filled grains per panicle, flag leaf length, protein percentage and hulling percentage in
medium duration genotypes and tillers per plant, ear bearing tillers per plant, days to 50% flowering, filled grains per panicle, alkali digestion value and hulling percentage in long duration genotypes to improve the grain yield.

The path coefficient analysis indicated that in medium duration genotypes selection can be practiced for plant height, filled grains per panicle, grain width, kernel length, water uptake, alkali digestion value and milling percentage, whereas, in long duration genotypes, it may be beneficial to exercise selection on ear bearing tillers per plant, filled grains per panicle, grain width, flag leaf length, kernel breadth, alkali digestion value, hulling percentage and milling percentage.

Based on D2 analysis the medium and long duration genotypes were grouped into five and seven clusters respectively. Protein percentage, alkali digestion value, amylose content, grain length, grain width, water uptake, days to 50% flowering, test weight, kernel breadth, tillers per plant, filled grains per panicle and kernel length after cooking in medium duration genotypes and alkali digestion value, amylose content, kernel length after cooking, test weight, water uptake, ear bearing tillers per plant, hulling percentage, filled grains per panicle, flag leaf length, grain yield per plant and kernel breadth in long duration genotypes showed maximum contribution towards genetic divergence. Based on the divergence studies crosses may be made between the genotypes of cluster II (394,398,404,390,405 and 400) and V (391) having the distance 902.211 followed by cluster III (393,395 and 396) and cluster V (391) having the distance 677.984 in medium duration genotypes and cluster II (2478,2495,2441,1768 and 2482) and VII (407) having the distance 1530.228 followed by cluster IV(409,413,402,2445,403 and 412) and cluster VII (407) having the distance 1505.682 in long duration genotypes to obtain transgressive recombinants in rice for yield and quality traits.

The principal component analysis identified seven principal components. Out of which PC1 contributed maximum to the variance. Characters viz., ear bearing tillers per plant, days to 50% flowering, kernel length and plant height in medium duration genotypes and grain yield per plant, ear bearing tillers per plant, water uptake and filled grains per panicle in long duration genotypes explained the maximum variance. Genotypes like 393, 395, 397 and 405 in medium duration and 415, 2441, 3291 and 401 in long duration scattered distantly in 2D and 3D plots showing their maximum divergence and these genotypes can be utilized in breeding programmes for exploitation ofheterosis.

Hierarchial cluster analysis grouped the medium and long duration genotypes in to five and six clusters respectively. Maximum divergence was observed between clusters I (392,401,407,394 and 395) and V (400,405 and 390) (3053.238) followed by clusters II (396, 406 and 391) and V (400,405 and 390) (2308.768) in medium duration genotypes and cluster II (409, 413, 402 and 2445) and cluster VI (407 and 411) (4137.445) followed by cluster III (2441, 3291, 2482, 1768, 412, 2478 and 2495) and cluster VI (407 and 411)(3563.630) in long duration genotypes.
GENETICS AND PLANT BREEDING

Author: VENKATA SUBBAIAH, P.
Title of the thesis: HETEROSIS AND COMBINING ABILITY STUDIES ON CMS BASED RICE (Oryza sativa L.) HYBRIDS FOR YIELD AND YIELD COMPONENTS
Major Advisor: Dr. M. REDDI SEKHar
Degree: M.Sc. (Ag.)
College: S.V. AGRICULTURAL COLLEGE, TIRUPATI
Accession Number: D 8969

The experimental material used in the study consisted of sixteen parents and 48 F1 hybrid combinations of rice which were evaluated in wet land farm of S.V. Agricultural College, Tirupati during rabi, 2010 so as to identify the best parental genotypes and cross combinations which will improve seed yield.

The analysis of variance revealed the existence of significant differences among the genotypes for all the twenty five traits studied. The per se performance of parents revealed that among lines APMS 6A recorded high per se performance for grain yield per plant followed by harvest index, plant height, hulling percentage, milling percentage, head rice recovery, water uptake and amylose content whereas among testers BPT 5204 recorded high per se performance for grain yield per plant followed by harvest index and plant height. Among 48 crosses, IR 58025A x MTU 5249 recorded the high per se performance for grain yield per plant and total number of productive tillers per plant.

Estimates of heterosis obtained in hybrid combinations revealed considerable genetic divergence among sixteen parents. Combining ability analysis revealed significant gca and sca mean squares for all the traits studied indicating the influence of both additive and non-additive gene action in them. The estimates of genetic variance revealed predominance of non-additive gene action for all the traits except total number of productive tillers per plant. The predominance of additive gene action was observed in the gene action of total number of productive tillers per plant. In order to capitalize the non-additive gene action observed in most of the traits, biparental mating (or) crossing...
Among the superior selects followed by pedigree method of breeding is advocated further improvement of traits.

The hybrid APMS 6A x MTU 1061 displayed high heterosis for 200-kernel test weight and head rice recovery whereas IR 58025A x MTU 2716 displayed high heterosis for kernel breadth, water uptake and kernel L/B ratio. The best two hybrids identified for most of the characters based on gca effects were IR 58025A x MTU 5249 and APMS 6A x MTU 4870. The good general combiners identified for both grain yield and quality characters were IR 58025A, APMS 6A, MTU 1010 and MTU 1001 and could be utilized in hybridization programme for further genetic improvement of traits.

A perusal of character association indicated significant positive association of harvest index and total number of productive tillers per plant with grain yield per plant in case of both parents and F1 generation. Gel consistency and volume expansion ratio displayed significant positive character association with grain yield per plant in case of parents and kernel L/B ratio after cooking in case of hybrids. Total number of productive tillers per plant, harvest index and head rice recovery revealed highly significant and positive association with grain yield in hybrids. These characters also exhibited strong and positive association among themselves.

Path coefficient analysis revealed that in case of both parents and hybrids, harvest index exerted the highest positive direct effect on seed yield per plant followed by total number of productive tillers per plant, days to 50% flowering and plant height. Hence, these characters should be given due emphasis in formulating selection criterion for genetic improvement of grain yield per plant in the present genetic material.

A study on genetic parameters revealed high GCV and PCV for harvest index, total number of productive tillers per plant and gelatinization temperature in parents and for total number of productive tillers per plant, number of grains per panicle, gelatinization temperature and amylose content in hybrids. High heritability coupled with high genetic advance as per cent of mean were recorded for gelatinization temperature, harvest index, total number of productive tillers per plant, number of grains per panicle, kernel length, kernel L/B ratio and grain yield in case of parents and for gelatinization temperature, amylose content, total number of productive tillers per plant, number of grains per panicle and harvest index in case of hybrids indicating the additive gene effects in the genetic control of these traits and can be improved by simple selection in the present breeding material.
The present investigation was carried out at Agricultural College Students’ Farm, Bapatla, Andhra Pradesh during kharif 2010-11 with 84 intrahirsutum cotton (Gossypium hirsutum L.) hybrids derived from 19 parents (12 lines and 7 testers) which were developed from new heterotic gene pools through line x tester fashion along with two checks. Information on genetic variability, heritability, genetic advance as per cent of mean, correlation and the magnitude of direct and indirect effects, combining ability and standard heterosis was generated.

The data was recorded on twenty one characters viz., plant height (cm), days to 50% flowering, number of monopodia per plant, number of sympodia per plant, relative water content (%), specific leaf weight (mg/cm2), crop growth rate at peak flowering stage (g/m2/day), crop growth rate at boll formation stage (g/m2/day), crop growth rate at maturity stage (g/m2/day), number of bolls per plant, boll weight (g), ginning out-turn (%), seed index (g), lint index (g), 2.5% span length (mm), micronaire value (10-6 g/inch), bundle strength (g/tex), uniformity ratio, fibre elongation (%), lint yield per plant (g) and seed cotton yield per plant (g).

The analysis of variance revealed that there were significant differences existed among the hybrids for all the characters. The genetic variability studies indicated that the material used in the present study possessed sufficient variability which gives ample scope for improvement through selection procedures. High heritability accompanied by high genetic advance was observed in case of plant height, number of monopodia, number of sympodia, relative water content, specific leaf weight, crop growth rate at peak flowering stage, crop growth rate at boll formation stage, crop growth rate at maturity
stage, boll weight, seed index and lint index indicating the role of additive gene action in the inheritance of these traits and directional selection could be rewarding.

The correlation and path analysis revealed that lint yield per plant had high positive direct effect coupled with high significant positive correlation. The other important traits identified were boll weight and number of sympodia per plant but they exerted direct effects at lower magnitude. Majority of the traits studied exerted prominent positive indirect effects via lint yield per plant. Further it was also observed that important fibre quality parameters like ginning out-turn, 2.5% span length and bundle strength showed undesirable association with the above traits and also among themselves. So care should be exercised in simultaneous improvement of these traits without sacrificing fibre quality, since the cotton is valued for its lint.

Estimates of variance due to \( gca \) and \( sca \) and their ratios revealed the importance of non-additive gene action for all the traits studied. Non-additive component may be exploited through heterosis breeding. It also helps in varietal adaptability. Among the 19 parents involved, the lines RAC 99152 followed by RAH 178-4, NAWAB and RAH 97-612 and in testers SC 68 followed by SC 7-IPS and SC 40 were identified as potential general combiners for important yield component traits. These parents may be utilized in further breeding programmes for varietal improvement.

Combining ability studies revealed that, it is not possible to find a definite trend for all the traits in hybrids based on \( gca \) effect of parents and \( sca \) effect of resultant hybrids. Most crosses with high \( sca \) effect involved parents either with high × low, low × high or low × low combiners with a few exceptions of high × high general combiners. These hybrids are likely to produce desirable transgressive segregants which may be studied through biparental mating or diallel selective mating system or any other form of recurrent selection.

Based on \emph{per se} performance, high \( sca \) effect and standard heterosis, the top specific cross combinations identified for seed cotton yield and other component traits were RAH 370 × SC 31 and RAH 178 × SC 40. This suggested the possibility of direct utilization of these hybrids for commercial exploitation after thorough testing over larger number of diversified environments and seasons. The progeny of these crosses may be further advanced to isolate superior segregants in further generations or pedigree breeding to combine not only seed cotton yield but also fibre quality of the derived lines.
An experiment entitled was conducted at Students Farm and Post Harvest Technology laboratory, College of Agriculture, Rajendranagar, Hyderabad, Andhra Pradesh during the period from April to December 2007 and 2008.

The effect of organic manures and biofertilizers on growth, yield and quality of gherkin was studied. Growth attributes of gherkin like vine length, number of branches per vine, internodal length and node at which first female flower appeared were increased with the application of RDF and vermicompost 18 t ha\(^{-1}\). The yield attributes like highest number of female flowers, number of fruits per vine, grade wise number of fruits per vine (‘A’, ‘B’ and ‘C’ grades), small sized fruits and lowest number of unmarketable (‘D’ grade) fruits per vine were observed with the above treatments. The early appearance of female flowers and highest fruit set percentage were recorded with RDF which was on par with vermicompost at varied dosages (18, 14 and 10 t ha\(^{-1}\)) along with biofertilizers. Application of RDF was proved to be superior in recording higher A, B, C grade fruit yields, total fruit yield per vine and quality which was on par with vermicompost @ 18 t ha\(^{-1}\)+ biofertilizers. While significantly highest marketable, total fruit yield per hectare and highest nutrient uptake were recorded with RDF and lowest with control.

The fruits were stored in polythene bags of different gauges and ventilations under two conditions of storage. PLW per cent of the fruits increased with ventilation and decreased with gauge. Spoilage was delayed and shelf life was extended for four days at room temperature and ten days at low temperature compared to control. Fruits packed in unventilated polythene bags under both gauges and storage conditions resulted in anaerobic respiration and tended to produce off-odours and off-flavours. Fruits stored in 0.25 per cent ventilated polythene bags irrespective of gauges was found to be promising under room temperature with a maximum shelf life of 7.17 days with 100 gauge and 7.00 days with 200 gauge. Under low temperature fruits packed in 100 gauge polythene bag with 0.25 per cent ventilation were free from spoilage and retained good quality with a maximum shelf life of 19.17 days.

The studies on the effect of various chemicals on the shelf life and quality of gherkin revealed that chemical treatments extended shelf life for two days compared to
control (untreated fruits packed in 100 gauge polythene bag with 0.25 per cent ventilation). Among the chemical treatments, BA at 50 ppm was proved to be promising in reducing the PLW, spoilage percentage, better retention of the quality parameters like, TSS, titrable acidity, total sugars, ascorbic acid and higher organoleptic score with maximum shelf life of 21.66 days.

The studies on the effect of gamma irradiation and shelf life of gherkin revealed that irradiation at 0.2 kGy recorded lower PLW and per cent of spoilage. The shelf life was extended for 4 days when compared to control (BA 50 ppm treated fruits packed in 100 gauge polythene bag with 0.25 per cent ventilation without irradiation). The fruits of 0.2 kGy were free from spoilage and retained good quality (TSS, titrable acidity, total sugars and ascorbic acid) and higher organoleptic score with a maximum shelf life of 25.50 days.

Fruits preserved in 12 per cent brine was found to be organoleptically superior in terms of colour, flavour, texture and overall acceptability. Decrease in salt concentrations reduced acceptability of fruits.

In conclusion, fruits receiving recommended dose of fertilizers enhanced growth, yield attributes, yield and quality parameters which was on par with vermicompost 18 t ha⁻¹ in combination with biofertilizers. Combined effect of 0.2 kGy gamma irradiation, BA 50 ppm and 100 gauge polythene bag with 0.25 per cent ventilation stored at 10°C was beneficial in extending the shelf life for 25.50 days. Preserving gherkins in 12 per cent brine registered highest organoleptic score and rendered the product stable for 3 months.
The present investigation was undertaken to study the diversity among 48
genotypes, heterosis, combining abilities, character association and effect of growth
regulators on sex expression of ridge gourd during 2008-09 at Vegetable Research
Station, A.R.I Rajendranagar, Hyderabad.

During summer, 2008 Forty-eight genotypes of ridge gourd were evaluated for
genetic diversity. Analysis of variance revealed significant differences among the
genotypes for all the 14 characters studied. Based on Mahalanobis D² analysis the 48
genotypes were grouped into ten clusters. The pattern of distribution of genotypes into
various clusters revealed that there was no relationship between geographical distribution
and genetic diversity. Greater genetic divergence was in clusters IV, VI and cluster IX
suggested exploitation of these clusters by intermating the genotypes in a definite
breeding design to explore the fullest range of heterosis and to realize good recombinant
lines. Based on genetic divergence studies, the genotypes Chitrada from cluster–IX, RG
-152, RG-157, LA-54, VRRG-36 and LA-76 from cluster–IV, and LA-30 from cluster-VII
and Satputia from cluster–VI were selected for hybridization programme as they
were expected to produce high heterotic crosses.

The differences between values of PCV and GCV were less for all traits. This
suggests that the traits were less influenced by environmental interaction. High PCV and
GCV estimates were observed for the traits viz., fruit yield per plant, sex ratio, staminate
flowers per plant, pistillate flowers per plant, fruit length fruits per plant and fruits yield
per plant. This implies that maximum variability is exists in the genotypes for aforesaid
traits and there is good scope for improvement of these characters through simple
selection programme. Moderate PCV and GCV values were observed for the characters
like node of first female flower appearance and fruit weight. The character which
exhibited low estimates of PCV and GCV were days to fruit harvestable maturity from
anthesis, days to first staminate flower appearance, days to first pistillate flower
appearance, days to 50% flowering and fruit diameter. Genotypes expressing least
variability for these characters could be utilised in the hybridization for obtaining high
heterosis as well as better segregation in later generations for selection. High heritability
estimates were recorded for all the fourteen characters and high GA as per cent mean
values were recorded for all the characters except days to fruit harvestable maturity from
anthesis. This indicate that the traits were under the influence of additive gene action and simple selection process based on phenotypic performance of these traits would be effective and the desirable gene can be pyramid in the genotypes

Eight parents were crossed in diallel manner in all possible combinations excluding reciprocals. Thus total number of 28 F1 hybrids, their parents along with a check Malika was evaluated for heterosis and combining abilities during kharif, 2008.

Analysis of variance for all the traits studied indicated that highly significant differences existed among the parents and hybrids. Per se performance of the parents for fourteen traits revealed that among 8 parents involved, Chitrada showed superiority for yield, Satputia for sex ratio, node of first female flower appearance and number of fruits per plant, LA-76 for fruit length and fruit weight. In case of hybrids RG-152 x VRRG-36, VRRG-36 x Satputia registered higher mean values for fruit yield per plant.

The sca variances were higher than gca variances for all the characters except for vine length and node at which first female flower appearance, suggesting the predominant role of non-additive gene action in control of these traits. The parents LA-54 for nine characters, LA-76 for eight characters, RG-157, RG-152 and Satputia for seven characters respectively, LA-30 for six and VRRG-36 and chitrada for five characters respectively exhibited significant gca effects for the traits studied. LA-54 and LA-76 for fruit yield, fruits per plant, fruit diameter and fruit weight, Satputia for narrow sex ratio, pistillate flowers per plant and fruits per plant, while LA-30 for, fruits per plant and yield. Hence use of these lines in any breeding programme would be desirable. Among the crosses VRRG-36 x Satputia, RG152 X VRRG -36, RG-152 x LA-54, Chitrada x VRRG-36, LA-76x VRRG-36, RG-152 x LA-54, Chitrada x VRRG-36, LA-76 x VRRG-36 had recorded highly significant sca effects for yield and yield attributes.

Heterotic vigour over standard parent was exhibited by majority of hybrids for vine length, node at which first female flower appearance, days to fruit, fruits per plant and fruit yield. Crosses RG-152 x VRRG-36, LA-30 x Satputia and VRRG -36 x Satputia had exhibited significant standard heterosis for yield and yield contributing traits.

Based on the present study, it can be emphasized that RG-152 x VRRG-36, LA-30 x Satputia and VRRG -36 x Satputia are with the desirable sca effects, heterosis and per se performance for fruit yield and other important yield attributes. These hybrids may be further tested over locations, seasons and years and recommended for commercial release.

The character association studies revealed that fruit yield per vine was significantly and positively correlated with vine length, days to 50% flowering, number of staminate flowers per plant, number of pistillate flowers per plant, node at which the first female appearance, fruit length, fruit weight, number of fruits per plant and negatively correlated with days to first staminate flower appearance, days to first pistillate flower appearance, sex ratio and fruit diameter and thus these characters were identified as component characters on which selection can be relied upon for genetic improvement of ridge gourd. Path analysis elucidated positive association of number of fruits, fruit weight and fruit length, days to first staminate flower appearance, staminate flowers, days to 50% flowering at both levels with yield was due to its positive direct
effect on yield. This suggested that direct selection based on these traits will be rewarding for yield improvement.

Effect of growth regulators (TIBA, Ethrel, MH and NAA) at 100 and 200 ppm concentrations were studied on ridge gourd variety Pusa Nasdar during summer, 2009. Foliar application of these growth regulators at 4th and 6th leaf stage revealed that among the growth regulators, Ethrel at 100 ppm and NAA 200 ppm caused maximum suppression of male flowers while increase the number of female flowers and yield per vine. While, M.H has reduced sex ratio but not contributed for yield per vine. Therefore foliar application Ethrel 100 ppm and NAA 200 ppm on ridge gourd would result in increased yield.
An experiment was conducted at College of Agriculture, Rajendranagar, in collaboration with Grape Research Station, Rajendranagar, Hyderabad from October 2006 to April 2008. Thirteen varieties (8 coloured and 5 white) were evaluated for performance of the growth, yield, wine production and quality.

The objectives of experiment was to study the varietal performance of different grape varieties in respect of their growth and yield and to study the wine recovery and quality parameters from different wine grape varieties. Further, the effect of blending of different grape varieties on the quality of wine was also studied.

Varieties differed significantly with respect to their growth and yield characteristics. Among the varieties, Athens and Shiraz recorded significantly higher pruning weight while minimum was noticed in Zinfandel. Cv. Pusa Navrang took minimum number of days for bud break after winter pruning, while Ruby Red took maximum number of days. The number of canes and cane diameter differed distinctly, among the varieties studied, Shiraz recorded higher number of canes followed by Chenin Blanc and lower in Thompson Seedless. Thicker canes was produced by the Cv. Italia followed by Thompson Seedless and thinner in Zinfandel. Days taken for 50% flowering varied significantly ranging from minimum of 25.36 days in the variety Pusa Navrang to maximum of 44.37 days in Thompson Seedless.

Different varieties tested exhibited significant variation in yield parameters (no. of bunches, bunch weight, bunch length, number of berries, hundred berry weight and berry diameter). The variety Chenin Blanc recorded higher number of bunches per vine (113.78) and Thompson Seedless (37.26) recorded lower number of bunches, where as heavier bunches were produced by the variety Italia (331.61 g) followed by Thompson Seedless and lighter bunches in the variety Cabernet Sauvignon (88.06 g). The variety Italia besides having lower number of bunches and higher bunch weight showed maximum diameter of berry (17.9 mm) and higher berry weight (414.21 g per 100 berries). The variety Chenin Blanc (16.81 kg/vine) recorded maximum yield and it was minimum with Sauvignon Blanc (4.51 kg/vine). Heat unit requirement in different cultivars of grape varied from 1726.25 degree days to 2207.46 degree days with maximum being in case of Italia and minimum in Pusa Navrang.
With respect to the physico-chemical properties of juice, Chenin Blanc (78.38\%) followed by Pusa Navrang showed the highest juice content. Total soluble solids was highest in Shiraz (21.95 °B) and minimum in Italia (15.43 °B). Chenin Blanc recorded maximum titrable acidity content (0.85 \%) and minimum by Ruby Red (0.38 \%). There was a reduction in the TSS, titrable acidity, sugars, tannins, phenols and flavonoids in wine after aging. Among the varieties studied, Shiraz showed minimum TSS content in wine after aging and maximum was observed in Italia. The volatile acidity of all the varieties was within the range of the International standards (0.011 to 0.063\%). The total phenols, tannin and flavonoid contents of wine showed a wide variation in which coloured varieties recorded higher content than the white ones. Alcohol content of wine varied from 8.78 to 12.25 \%. The variety Shiraz recorded higher content of alcohol followed by Chenin Blanc and Cabernet Sauvignon and minimum recorded in Italia. 

Organoleptic evaluation of wine samples showed a significant variation among the varieties. Based on the average score, wine made from Cvs. Shiraz, Chenin Blanc and Cabernet Sauvignon were graded as Good, while Cv. Italia showed ordinary quality.

Blending is an useful technique to overcome defects in varieties and improve the quality of wine from varieties which are deficient in colour or chemical composition. The bio chemical properties of juice revealed that TSS of the juice varied from 16.46 °B to 21.46 °B and T7 has recorded maximum TSS which was significantly superior to the rest of the cultivars closely followed by T1 while minimum content was observed with T24. Maximum titrable acidity was recorded with T12 (1.66 \%) and minimum titrable acidity was observed with T3 (0.64\%). 

Wine prepared from different blends showed wide variations in the bio-chemical properties of wine. Decrease in the TSS and titrable acidity, and sugars was observed after fermentation in all the treatments and among them, T7 showed minimum content of TSS, total and reducing sugars and highest was recorded with T21. Volatile acidity, sugars, total phenols and flavonoids were found to decrease after aging in all the treatments while alcohol content was found to increase in wine upon aging. The volatile acid content of wine in the treatments after aging varied from 0.017 to 0.046 \% with minimum in the treatment T13 and maximum in T22 and were within the range of International standards. Treatments blended with 3:1 ratio recorded maximum content than 2:1 ratio. Wine produced from the blends of Italia with Ruby Red showed higher content of volatile acidity. Alcohol content of blended wine after aging varied from 7.99 to 11.87 \% with highest content being recorded by T7 while least content was recorded with the treatment T21. Tannin content of wine was maximum in T21 (0.044%) and minimum in T8 (0.007\%). Significantly maximum content of total phenols and flavonoids was recorded with T21 which was superior over the other treatments followed by T22 while minimum content was observed in T8. The white varieties blended with coloured variety Shiraz registered minimum content of total phenol and flavonoids in wine while wines blended with Ruby Red showed maximum content.

Organoleptic evaluation of wine samples after aging indicated that average score of wine blends ranged from 11.96 in T23 to 17.23 in T7. Based on the average score, wine made from blended varieties were graded as Good (T7, T1, T8, T12, T4 & T13), while rest of the treatments produced fair quality wine except T23 which showed ordinary quality.
Studies on “Standardization of Agro-techniques for Ashwagandha (Withania somnifera Dunal.)” in coastal districts of Andhra Pradesh” was conducted at College of Horticulture, Venkataramanagudem, West Godavari district, Andhra Pradesh during late kharif seasons of 2009-10 and 2010-11. The studies include five experiments. The first experiment was on “Effect of seed rate on growth and yield of Ashwagandha (Withania somnifera Dunal.)” with treatments T₁: 6 kg of seed ha⁻¹, T₂: 8 kg of seed ha⁻¹, T₃: 10 kg of seed ha⁻¹ and T₄: 12 kg of seed ha⁻¹. The experiment was laid out in a randomized block design with five replications. Among different seed rates, 12 kg of seed ha⁻¹ had recorded highest plant height with longer roots, higher fresh and dry root yield and seed yield and was on par with seed rate of 10 kg of ha⁻¹. The growth attributes viz., leaf area, number of branches per plant and root attributes like root girth, primary roots, secondary roots recorded higher at seed rate of 6 kg of seed ha⁻¹ and was on par with 8 kg of seed ha⁻¹. Higher gross income was obtained with the seed rate at 12 Kg ha⁻¹. Further the seed rate at 6 Kg ha⁻¹ was observed with lower dry root yield resulting in lower net income and BCR. The seed rate at 12 Kg ha⁻¹ had recorded the maximum BCR followed by 10 Kg ha⁻¹ seed rate.

Second experiment was on “Effect of spacing on growth and yield of ashwagandha (Withania somnifera Dunal.)” with treatments T₁: 30x30 cm, T₂: 30x10 cm, T₃: 20x20 cm and T₄: 20x10 cm. Plant height was highest with 20x10 cm which was on par with 30x10 cm. The leaf area and primary branches per plant was recorded highest with 30x30 cm spacing resulted in higher root girth, primary and secondary roots. The treatment 20x10 cm recorded highest root length, fresh root yield, dry root yield and seed yield which was on par with 30x10 cm. Higher gross income was observed with 20x10 cm spacing. Further lower dry root yield was observed at 30x30 cm resulting in lowest net income and BCR. The spacing 30x10 cm had recorded the maximum BCR followed 20x10 cm.

Third experiment was on “Influence of biofertilizers in combination with graded levels of P₂O₅ on growth and yield of ashwagandha (Withania somnifera Dunal)” with treatments T₁: P₂O₅ @ 30 kg ha⁻¹, T₂: P₂O₅ @ 40 kg ha⁻¹, T₃: P₂O₅ @ 50 kg ha⁻¹, T₄:
Azatobactor + P₂O₅ @ 30 kg ha⁻¹, T₅:  Azatobactor + P₂O₅ @ 40 kg ha⁻¹, T₆: Azatobactor + P₂O₅ @ 50 kg ha⁻¹, T₇: Phosphobacteria + P₂O₅ @ 30 kg ha⁻¹, T₈: Phosphobacteria + P₂O₅ @ 40 kg ha⁻¹, T₉: Phosphobacteria + P₂O₅ @ 50 kg ha⁻¹, T₁₀: Azatobactor, T₁₁: Phosphobacteria and T₁₂: Control. The maximum plant height, leaf area, leaf area index and primary branches per plant on par was recorded with Azatobactor + P₂O₅ @ 50 kg ha⁻¹ was on par with Azatobactor + P₂O₅ @ 40 kg ha⁻¹. The other yield and yield attributes viz., root length, root diameter, fresh root yield, dry root yield and seed yields recorded maximum with Azatobactor + P₂O₅ @ 50 kg ha⁻¹ was on par with Azatobactor + P₂O₅ @ 40 kg ha⁻¹ and found significantly superior to other treatments. Among the treatments, application of Azatobactor + P₂O₅ @ 50 kg ha⁻¹ resulted in higher N, P and K uptake and was on par with Azatobactor + P₂O₅ @ 40 kg ha⁻¹. The application of biofertilizers alone (Azatobactor and Phosphobacteria) had resulted in low values for growth, yield and nutrient uptake and was on par with P₂O₅ @ 30 kg ha⁻¹. Higher gross income was obtained with, Azatobactor + P₂O₅ @ 50 kg ha⁻¹ compared to Azatobactor + P₂O₅ @ 40 kg ha⁻¹ owing to higher yield. Further the control treatment recorded lowest dry root yield resulting in lower net income and BCR. The treatment, Azatobactor + P₂O₅ @ 50 kg ha⁻¹ had recorded the maximum BCR followed by Azatobactor + P₂O₅ @ 40 kg ha⁻¹.

The fourth experiment was on “Effect of time of harvesting on root yield and quality of ashwagandha (Withania somnifera Dunal.) with five treatments T₁: 120 days after sowing; T₂: 135 days after sowing, T₃: 150 days after sowing, T₄: 165 days after sowing and T₅: 180 days after sowing. Among different treatments, crop harvesting on 180 days after sowing recorded the highest root length, root girth, dry root weight and higher alkaloid content in roots. The roots obtained at maturity stage, i.e., 180 DAS yielded higher per cent of ‘A’ grade roots, which was on par with roots harvested at 165 DAS. The crop harvested on 120 days after sowing recorded lower values for above parameters.

The fifth experiment was on “Effect of time of harvesting on quality of ashwagandha (Withania somnifera Dunal.) during storage” with five treatments viz., storage of roots for 65 DAH, 90 DAH and 135 DAH harvested at 120 days after sowing (T₁), 135 days after sowing (T₂), 150 days after sowing (T₃), 165 days after sowing (T₄) and 180 days after sowing (T₅).with five treatments T₁: 120 days after sowing, T₂: 135 days after sowing, T₃: 150 days after sowing, T₄: 165 days after sowing and T₅: 180 days after sowing. The studies revealed that as the storage period advances, there was a reduction in the root quality characters like root girth, root weight and total alkaloid content. The dry root weight (g plant⁻¹) was reduced during storage irrespective of harvesting stage. The reduction in girth was almost linear upto 135 days of storage. The loss in weight was maximum in the stored roots harvested at 180 DAS after 135 storage. As the storage period advances, the moisture content of the stored roots increased irrespective of stage of harvest. The total alkaloid content (%) was degraded during storage irrespective of stage of harvest.
Survey conducted in sunflower growing areas of Anantapur, Kurnool, Mahabubnagar districts during 2009-10 and 2010-11 kharif seasons and Nizamabad district during 2009-10 and 2010-11 rabi seasons revealed natural occurrence of Sunflower Necrosis Disease (SND) in different mandals with overall average incidence of 4.66 per cent of SND during two consecutive seasons. Symptoms of the disease varied with different cultivars grown under field conditions. Higher incidence of SND was observed in Mahabubnagar (5.34 per cent) followed by Anantapur (4.66 per cent), Kurnool (4.64 per cent) and Nizamabad (3.97 per cent) districts over two years. None of the cultivars (Sunbred-275, GK-2002, SH-177, SH-3322, Jwalamukhi, Kaveri-618, Leader, Advanta-8699, 64-S-99 and P-Gold) grown in these areas were free from the disease.

Irrespective of locations surveyed in the four districts, 10-13 per cent incidence of SND was observed in sunflower cvs. Sunbred-275, GK-2002 and P-Gold, while, 4-9 per cent incidence of the disease was recorded in cvs. SH-177, SH-3322, 64-S-99, Jwalamukhi, Advanta-8699 and Leader during two consecutive seasons. However, the severity of the disease varied with the cultivars.

Occurrence of thrips fauna was recorded in all sunflower growing areas of four districts surveyed. Population of thrips was comparatively higher in Mahabubnagar (4.48 thrips/plant) followed by Anantapur (3.85 thrips/plant), Nizamabad (3.65 thrips/plant) and Kurnool (3.46 thrips/plant). Four species, viz., Frankliniella schultzei (Trybom), Scirtothrips dorsalis (Hood), Thrips palmi (Karny) and Megalurothrips usitatus (Bagnall) were identified in the present study. Of these, T. palmi was found to be more prevalent in all the areas surveyed. Infestation of M. usitatus was observed during flower head formation stage, while infestation of other three species during vegetative growth stage of the ten common weed species found in and around the surveyed sunflower fields, Parthenium hysterophorus was more predominant and found in all the fields followed by Euphorbia geniculata, Achyranthus aspera, Commelina bengalensis, Abutilon indicum, Acanthospermum hispidum, Ageratum conyzoides, Malvstrum coromandelianum, Digeria arvensis and Trianthema portulacastrum in four districts of A.P. during two consecutive years.

Symptoms of the disease varied depending on the cultivars. The characteristic symptoms of SND include chlorotic spots, mosaic, necrosis of leaves, stem and bracts, twisting of flower
head leading to partial or complete sterility of the head with chaffy seeds in susceptible sunflower cultivars. Similar type of symptoms were also observed in sap inoculated sunflower plants. Severity of the disease also varied with the cultivars.

The virus causing SND had a wide host range infecting members of six families. Four (Asteraceae), three (Chenopodiaceae), four (Cucurbitaceae), two (Malvaceae), thirteen (Leguminosae) and seven (Solanaceae) plant species produced visible symptoms of the disease on sap inoculation. However, sunflower necrosis virus failed to infect *Raphanus sativus* cv. Pusa Himani of Cruciferae and *Sesamum indicum* cv. local of Pedaliaceae family.

No seed transmission was recorded with the seeds of sunflower cultivars (Morden, DRSF-108, KBSH-1, KBSH-41, KBSH-44, KBSH-53, Sunbred-275, DRSH-1, ASF-107 and RSF-101) collected from SND infected plants in grow-out tests. However, reduction in germination percentage from seeds of diseased plants was noticed as compared to healthy seeds.

The method used for purification yielded concentrated preparation of the virus. Electron microscopy of negatively stained, purified and leaf dip preparations revealed the presence of typical isometric virus particles measuring 27-35 nm in diameter. Based on symptomatology, transmission, host range, serology and electron microscopy, the virus causing SND in major sunflower growing areas has been identified as an isolate of Tobacco Streak Virus (TSV) of *Ilar* virus group.

Of the 35 common weed species collected from in and around the sunflower fields, tested for their susceptibility, natural infection of SND was detected in twelve weed species viz., *D. arvensis*, *A. aspera*, *Lagasca mollis*, *P. hysterophorus*, *A. hispidum*, *A. conyzoides*, *C. bengalensis*, *E. geniculata*, *Phyllanthus niruri*, *M. coromandelianum*, *A. indicum* and *Physalis minima* by back inoculation on assay host, cowpea cv. C-152 and further confirmed by DAC-ELISA using polyclonal antiserum of TSV.

Under artificial inoculated conditions, of the twelve weed species tested for their reaction to SND, *A. conyzoides*, *Gomphrena globosa* and *P. minima* produced both local and systemic symptoms. Whereas, three weed species viz., *Amaranthus viridis*, *P. hysterophorus* and *T. portulacastrum* were symptomlessly infected.

Studies on the effect of different dates of sowing of sunflower cv. Morden on thrips population and SND incidence revealed that thrips infestation was high in June sown crop followed by July sown crop. The disease incidence was more in July sown crop and less in November and December sown crop. Thrips population was at peak level in the initial stages of crop growth and declined gradually at senescence stage. Various weather parameters affected thrips population and incidence of SND. Maximum temperature had significant positive impact on thrips population, while significant negative correlations were found with relative humidity (I and II) and rainfall. Incidence of SND was positively correlated with relative humidity and rainfall.

Disease severity had definite effect on yield and yield attributes of sunflower cv. Morden. With the increase in disease severity, there was corresponding decrease in yield and yield attributes. Maximum reduction in yield and yield attributes was recorded when the disease
severity was > 50 per cent followed by 11-50 per cent and < 10 per cent severity level.

The sunflower plants became increasingly resistant with the age to the SND infection as maximum (100 per cent) infection was recorded in 10 day old plants as against 35 per cent infection in 30 day old plants under artificial inoculated conditions.

Twenty R lines, 12 each of CMS A & B lines, 100 germplasm lines and 12 cultivars of sunflower were evaluated against SND under artificial inoculated conditions using a six point scale (0-5). Highly susceptible reaction was shown by all R lines and CMS lines tested. Of the hundred germplasm lines screened, 8, 23 and 69 lines were moderately susceptible, susceptible and highly susceptible, respectively. Of the 12 sunflower cultivars screened, 5 and 7 cultivars exhibited highly susceptible and susceptible reaction, respectively.

An integrated disease management strategy was worked out against SND at field level for two consecutive years during kharif season. Of the 15 treatments evaluated, seed treatment with thiomethoxam (4g/kg seeds), three sprays of thiomethoxam (0.05 per cent) at 15, 30 and 45 days and three rows of border crop (sorghum) followed by seed treatment with imidacloprid (5g/kg seeds), three sprays of imidacloprid (0.05 per cent) at 15, 30 and 45 days with three rows of border crop (sorghum) were found best in not only reducing the disease incidence and thrips population, but also increasing the yield and yield attributes of sunflower cv. Morden.

Economics of different treatments revealed that, maximum incremental benefit cost ratio (IBCR) was obtained with the seed treatment alone with imidacloprid (5g/kg seed) followed by seed treatment with thiomethoxam (4 g/kg seed) at the time of sowing compared with other treatments. Based on IBCR, the next best treatments in the management of SND were bordering of sunflower crop with sorghum and seed treatment with imidacloprid or thiomethoxamat the time of sowing.

Reverse Transcription- Polymerase Chain Reaction (RT-PCR) of RNA extracts of eight SND infected sunflower samples collected two each from Andhra Pradesh, Maharashtra, Karnataka and Tamil Nadu using primers specific to the coat protein gene of TSV did not show any variation. Infectivity assay of the eight virus isolates of SND collected from various locations on cowpea cv. C-152 and N. tabacum cv. Samsun showed no variation in symptom expression.
Isolation of the causal organism of chilli fruit rot from the diseased chilli fruits and identification of the organism as *Colletotrichum capsici* (Syd) Butler & Bisby, evaluation of different inoculation methods, relationship between ripening stage of the chilli fruit and chilli fruit rot infection, relationship between inoculum concentration of the pathogen and chilli fruit rot infection, effect of temperature, light and relative humidity on the infection of chilli fruit rot by *C. capsici*, and effect of leaf/bulb extracts and biocontrol agents on growth and spore germination of *C. capsici* and on chilli fruit rot development were studied.

Hypodermic injection method of *C. capsici* was found to be the best in producing the largest sized lesions and per cent disease index compared to other methods. Fully ripened red stage chilli fruits were most susceptible to chilli fruit rot, producing highest lesion size and per cent disease index (PDI), when inoculated artificially. Inoculum concentration of $10^6$ conidia/ml of *C. capsici* was the most effective producing highest lesion size and per cent disease index (PDI). The infection of chilli fruits was the highest when the inoculated chilli fruits were incubated at temperature of $25^\circ$C. Temperature beyond and below $25^\circ$C caused significant reduction in both lesion size and per cent disease index (PDI). When the inoculated chilli fruits were incubated under 18 h light followed by continuous darkness for 6 h highest infection of chilli fruits were recorded. Incubation of inoculated chilli fruits at 95 per cent relative humidity resulted in the highest infection.

Bulb extract of *Allium sativum* followed by leaf extracts of *Calotropis gigantean* were found to be the most effective in inhibiting the radial growth and spore germination of *C. capsici*. The leaf extract of *Azadirachta indica* followed by the extracts of *A. sativum* and *C. gigantean* were found to be the most effective in inhibiting the chilli fruit rot development. *Trichoderma harzianum* isolate 4 followed by *T. longibrachiatum* isolate 1 were found to be the most effective in inhibiting the radial growth and spore germination of *C. capsici*.

*T. harzianum* isolate 3 followed by *T. virens* isolate 6 were found to be the most effective in inhibiting the chilli fruit rot development.
Groundnut is an important oil-seed crop of tropical and sub-tropical regions of the world. Among the fungal diseases aflatoxin contamination due to invasion by *A. flavus* is potentially very destructive with respect to export of groundnut and its products. In the present study an integrated management package was formulated against *A. flavus* in groundnut using biocontrol agent.

The pathogen is a saprophyte or facultative parasite and produce green colored conidia on artificial medium. Five types of aflatoxins have been reported *viz.*, B₁, B₂, G₁, G₂ and M, among them aflatoxin B₁ (AFB₁) is more carcinogenic and occur more commonly.

The pathogen was isolated from rhizosphere soil of groundnut by serial dilution technique and identified as *A. flavus*.

Fourteen isolates of antagonistic mycoflora were isolated from groundnut rhizosphere soil, geocarposphere, root endophyte and seed endophyte by using serial dilution technique. The antagonistic mycoflora were identified as *Trichoderma* isolates and designated from T₁ to T₁₄.

*In vitro* screening of *Trichoderma* isolates (T₃, T₅, T₇, T₈, T₁₁ and T₁₄) against *A. flavus* by dual culture indicated that native *Trichoderma* isolate T₇ was found to be significantly superior over others in inhibiting the growth of *A. flavus* to the extent of 70.36 per cent, besides the isolate T₇ performed well at high temperatures (37°C) compared to other isolates.

The efficacy of potential antagonistic *Trichoderma* isolate -7 (T₇), was tested in pot culture against *A.flavus* in groundnut. The results revealed that treatment under irrigated condition possess low level of *A.flavus* population and having maximum population of *Trichoderma* when compared to drought and was found to be effective in reducing the per cent seed infection and also aflatoxin content.

*Trichoderma* isolates T₃, T₅, T₇, T₈, T₁₁ and T₁₄ differing in their antagonistic activity were selected for Molecular Characterization by RAPD and ITS-PCR.

The RAPD banding pattern reflected the genetic diversity among the isolates with the formation of two main clusters. The potential *Trichoderma* isolate T₇ a separate group within the
cluster II. Amplified ITS region of rDNA with universal primers ITS-1 and ITS-4 produced 600 bp which confirmed that all the isolates were *Trichoderma.*
Maize (Zea mays L.) is one of the most important cereal crops in the world agricultural economy as food, feed and industrial product. In India, maize is grown in almost all the states. It is mainly utilized for direct human consumption and livestock/poultry feed. During the last few years, there has been a progressive escalation in its demand for the value-added products, like glucose, sorbitol, dextrose, starch-based products and oil. The productivity of the crop in India is 1.8 t ha⁻¹, which is quite low as compared to the yield levels in other major maize growing countries of the world and the decline is due to biotic and abiotic stresses. Of the biotic stresses, the diseases caused by fungi, bacteria and viruses are of economic importance. Among the fungal diseases, banded leaf and sheath blight caused by R. solani f.sp. sasaki (Khun.) has become major constraint resulting in yield losses year after year. A detailed study was carried out on the biological control of this disease, isolating rhizosphere and phylloplane microflora, in vitro screening of native microflora and commercial formulations of fungal and bacterial biocontrol agents, in vitro compatibility of potential biocontrol agents with commonly used fungicides and herbicides and seed and soil treatment with fungicides and biocontrol agents against banded leaf and sheath blight disease under field conditions.

Native microflora was isolated from rhizosphere and phylloplane of maize plants (Hybrid 30V92) by serial dilution technique. All native isolates were evaluated in vitro against R. solani by following dual culture technique. Among native microflora Trichoderma harzianum, Fluorescent Pseudomonad sp. and phylloplane bacterial isolate-1 were found to be best and were compared with commercial formulations (T. viride, Bacillus subtilis and Pseudomonas fluorescens). Among all native isolates and commercial bioagents T. harzianum (Native) was found to be the best among all the isolates tested in inhibiting the growth of test pathogen (R. solani). T. harzianum (Native) was found to be less sensitive to pyraclostrobin at recommended and half recommended dosages in comparison with other fungicides and herbicides tested.

The efficacy of seed and soil treatments with fungicides and commercial biocontrol agents tested in field conditions against the pathogen. Seed treatment with carbendazim and seed treatment with T. viride were found to be superior by recording least per cent disease severity index and per cent disease incidence compared to other treatments. Seed treatment with P. fluorescens (Commercial) recorded highest plant height, fresh and dry weights.
The investigation entitled “Effect of Bio-Regulators on Growth, Dry Matter Production and Yield in Rice Fallow Maize (Zea mays L.)” was undertaken at the Agricultural College Farm, Bapatla during Rabi 2010-11. The treatments comprised of foliar spray of brassinosteroids @ 1 ppm, thiourea @ 1000 ppm and kinetin @ 10 ppm and their combinations at vegetative stage and silking stage.

Application of brassinosteroid + thiourea + kinetin at vegetative stage resulted in an increase in plant height (25.02 %). Bioregulators spray had no influence on the flowering in maize and the number of days for flowering reduced in some treatments but not significant. By spraying of bioregulators brassinosteroid + thiourea + kinetin at silking stage resulted in increase in leaf area, LAI and SLW at the rate of 11.48, 11.47 and 13.64 % respectively. Brassinosteroid + thiourea + kinetin at silking stage resulted in higher total dry matter which showed an increase of 14.73 per cent over control, indicating its positive impact in accumulating dry matter, where as brassinosteroid + thiourea + kinetin spray at silking stage recorded 12.7 % increase in total dry matter.

The results indicated that foliar sprays enhanced growth and development in rice fallow maize and particularly in the combined spray treatments, physiological parameters like AGR, CGR, RGR and NAR increased with the increment in the leaf area and dry matter production.

Biochemical parameters like membrane thermo stability index, chlorophyll stability index, and total sugars increased with foliar spray of bioregulators. The high total chlorophyll content was observed in the brassinosteroid + thiourea + kinetin spray at silking stage. Kinetin spray recorded least membrane injury (15.69 %) compared to remaining treatments. Foliar spray of bioregulators significantly increased the yield and yield attributes. The grain yield per ha, test weight, harvest index and shelling percent recorded were high in the combination sprays of three bioregulators at silking stage. However spray of thiourea at silking stage recorded high net returns of Rs. 22889.2 and C-B ratio (1:1.53) and proved superior to the rest of the treatments.
Sunflower (Helianthus annuus L.) is one of the major oil seed crops grown in the world. In India it occupies 4th place in terms of area and production. In A.P it is grown in an area of 0.42 m ha with 0.427 mt production.

Sunflower is affected by Alternaria helianthi (Hansf) Tubaki and Nishihara, causing Alternaria leaf spot an important disease with yield losses ranging from 60 to 80 per cent. Earlier reports indicated the development of resistance by the pathogen to different fungicides due to continuous and indiscriminate usage. Hence, in the present study, an attempt was made to isolate native potential antagonists against A.helianthi and to evaluate their efficiency in combinations with different fungicides in vivo conditions.

The Pathogen was isolated from infected plant showing typical Alternaria symptoms viz., circular, dark brown to black lesions with concentric rings that resemble a target pattern, purified and identified as Alternaria helianthi.

A total of 24 antagonistic microflora (4 fungi and 20 bacteria) were obtained from phylloplane and leaf endophyte of sunflower using serial dilution method. Most of the bacterial isolates were found to be effective in inhibiting the growth of A.helianthi in dual culture as well as in culture filtrate experiment, but at varying degrees. Among the 4 fungal isolates, one was identified as Trichoderma sps. (FP1). All the fungal antagonists overgrew the pathogen, A.helianthi in dual culture technique. Among the twenty bacterial isolates, the endophyte isolate, BE8 showed the highest inhibition (62.42%) against A.helianthi in culture filtrate technique. It is followed by BE10 showing inhibition (61.12%) which is followed by BP1 showing inhibition (58.87%).

Sensitivity of A.helianthi to different fungicides viz., carbendazim + mancozeb (0.3%), mancozeb (0.25%), iprodione (0.2%), propiconazole (0.1%), hexaconazole (0.2%), copper hydroxide (0.3%), cymoxanil (0.15%) was assessed in poisoned food technique. Propiconazole showed the highest rate of inhibition (88.12%) followed by cymoxanil (87.62%).
Compatibility of the potential bacterial antagonist BE8 with the above fungicides was evaluated using spectrophotometric method. The bacterial isolate, BE8 was highly compatible with propiconazole followed by cymoxanil and iprodione. Since the tested bacterial isolate BE8 shown highest degree of compatibility with propiconazole, propiconazole was selected as the effective fungicide. The *in vitro* experimental results (Plate 14) revealed that volatile metabolites produced by antagonistic bacteria BE8 and BE10 inhibited the mycelia growth of *Alternaria helianthi* up to the extent of 47.60% and 24.35% over the control on the 10th day of incubation under *in vitro*.

The efficacy of potential antagonist BE8 alone and in combination with propiconazole (0.1%) was assessed in pot culture. The integrated treatment T6, of BE8 and the fungicide, propiconazole imposed at 30 and 45 DAS, was found to be effective with leaf spot score 2, followed by the treatment T5 (leaf spot score 3). The treatment T1 was found to be least effective with leaf spot score 5.

RAPD banding profile with seven different random primers *viz.*, OPA-2, OPA-3, OPA-4, OPA-6, OPA-9, OPA-12 and OPD-3 revealed the existence of genetic variability among the isolates and were classified into 3 main clusters.

Amplification of 16S rDNA with 63F and 1387R primers which are specific to bacterial 16S rDNA produced approximately 1300 bp fragment. These results show that all the antagonistic isolates are bacteria and belong to prokaryotes.
Groundnut (Arachis hypogaea L.) is the 13th most important food crop of the world and one of the principal oilseed crops grown in India, covering nearly half of the area under oilseeds. It is the world’s 4th most important source of edible oil and 3rd most important source of vegetable protein. Groundnut seeds contain high quality edible oil (50 per cent) rich in easily digestible proteins (25 per cent) and carbohydrates (20 per cent). Being a legume, it is also valued for its N₂-fixing capacity through the root nodule bacteria and also forms an important member in many crop rotations. But its productivity is very low. Many biotic and abiotic stresses accounts for low productivity of groundnut. In recent years, seedling diseases of groundnut caused by complex soil borne fungi viz., Aspergillus niger, Rhizoctonia bataticola were prevalent in almost all the parts of country resulting in seed rot and seedling diseases.

The pathogens Aspergillus niger and Rhizoctonia bataticola were isolated from the diseased plants of groundnut which were collected from Warangal and Ananthapur districts of Andhra Pradesh. An inoculum level of 5 per cent was identified as optimum infection threshold levels of both the test pathogens i.e., Aspergillus niger and Rhizoctonia bataticola following soil infestation method with groundnut cv. TMV-2.

Native fungi and bacteria were isolated from rhizosphere and rhizoplane of groundnut plants following serial dilution plate count technique. All the native isolates along with commercial formulations were screened for their antagonistic activity against test pathogens viz., Aspergillus niger and Rhizoctonia bataticola by following dual culture technique in vitro.

Among the tested native isolates and commercial formulations, native fungal isolate Trichoderma sp. and native fluorescent pseudomonad isolate-1 were found to be superior in inhibiting both the test pathogens. Trichoderma sp. (native) inhibited the test pathogens A. niger and R. bataticola by 72.05 per cent and 69.92 per cent, respectively. While fluorescent pseudomonad native isolate-1 inhibited the test pathogens A. niger and R. bataticola by 63.67 per cent and 67.31 per cent, respectively. The potential native isolates of antagonists i.e., Trichoderma sp. and fluorescent pseudomonad isolate-1 were further used for testing their efficacy under green house studies.
Combined application of seed treatment with *Trichoderma* sp. @ 4 g kg\(^{-1}\) seed followed by soil application @ 2.5 g kg\(^{-1}\) soil along with seed treatment with fluorescent pseudomonad isolate-1 @ 10 g kg\(^{-1}\) seed followed by soil application @ 2 g kg\(^{-1}\) was found to be superior in not only increasing the plant growth parameters 40 per cent to 90 per cent, but also resulted in reduction seedling disease complex by 89.28 and 92.68 per cent and 87.61 per cent reduction in population levels of test pathogens *A. niger* and *R. bataticola* when compared to control with groundnut cv. TMV-2 in soil infested with *A. niger* and *R. bataticola* pathogen complex. The reduction of seedling disease complex resulted an increase in pod yield by 87.50 per cent when compared to inoculated control. The tested biocontrol agents were also proved to be beneficial in increasing the plant growth as indicated by an increase of 96.40 and 71.43 per cent in plant root length and shoot length, 43.19 and 58.65 per cent in root dry weight and shoot dry weight when compared to control.
PLANT PATHOLOGY

Author : KIRAN BABU, T.

Title of the thesis : EPIDEMIOLOGY, VIRULENCE DIVERSITY AND HOST-PLANT RESISTANCE IN BLAST [Magnaporthe grisea (Hebert) Barr.] OF FINGER MILLET [Eleusine coracana (L.) Gaertn.]

Major Advisor : Dr. P. NARAYAN REDDY

Degree : Ph. D.

College : COLLEGE OF AGRICULTURE, RAJENDRANAGAR

Accession Number : D 9093

Studies were conducted on blast disease of finger millet that included cultural, morphological, pathological and molecular diversity, epidemiology and identification of host-plant resistance at International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India and field trials were conducted at ICRISAT; ARS, Vizianagaram; RARS, Nandyal; ZARS, Mandya and OFRS, Naganahalli. A total of 125 blast disease specimens from finger millet, 6 from foxtail millet, 3 from rice and 5 from pearl millet were collected from major crop growing areas of India during 2008-2010. From these samples, a total of 70 monoconidial isolates of Magnaporthe grisea, 56 from finger millet, 6 from foxtail millet, 3 from rice and 5 from pearl millet were obtained. Of the 70 isolates, 15 each were from Patancheru and Vizianagaram, 13 from Nandyal, 14 from Mandya, 8 from Naganahalli and one each from Dholi, Aurangabad, Hissar, Jaipur and Solan.

In pathogenicity studies, considerable variation was found among the isolates from finger millet for leaf blast however, no significant differences were found among the isolates from foxtail millet and pearl millet. In cross-inoculation tests M. grisea isolates from finger millet failed to infect foxtail millet and pearl millet, and vice versa.

Diversity in cultural characters, such as colony colour, texture and growth pattern were noticed among the isolates, but no clear-cut groupings were observed between isolates from different hosts. The isolates that were grayish-green and sector-forming produced more spores than those having cottony and submerged growth. Variations in morphological characters, such as colony growth, size of the conidia and sporulation were observed. Variations in sporulation capacity were noticed within and between the isolates from the same location.

Sixteen finger millet mini-core accessions developed varying reaction types for leaf, neck and finger infection over 2 years of evaluation at five locations. Five selected representative isolates (one isolate/location) were evaluated for pathogenicity (leaf blast) on Finger Millet Blast Resistance Stability Nursery (FMBRSN) consisting of 28 accessions and were found highly variable for virulence, disease severity and disease reaction. Among five isolates, the isolate FMNg55 was found highly virulent and FMP1 the weakly virulent. A set of 10 putative host
differentials were identified based on field evaluation of FMBRSN accessions over 2 years at five locations and greenhouse screening. Twenty isolates (4 isolates/location) evaluated for pathogenicity on 10 host differentials, and one resistant and one susceptible check were found highly variable for virulence, disease severity and disease reaction. Among these, the isolates FMP5, FMV23, FMNg54 and FMNg55 were found highly virulent and FMV14 the weakly virulent. Based on leaf blast severity, *M. grisea* isolates were classified into four pathotype groups.

High degree of polymorphism was detected among the isolates from finger millet and foxtail millet using SSR analysis with 17 markers. The isolates were grouped on the basis of their host origins however, two isolates from finger millet and one from foxtail millet were grouped together indicating the occurrence of some genetic drift between the two populations. Based on similarity coefficient, the isolates from finger millet were classified into nine groups. The isolates from different plant parts (leaf and neck) were randomly distributed in the dendrogram. In contrast, the isolates from neck and finger samples from the same genotype/plant were clustered in one group at 90% similarity matrix. No correlation was observed between pathogenicity data and SSR data of 25 *M. grisea* isolates. Model-based population structure analysis revealed three distinct populations based on their host origin with varying levels of ancestral admixtures among the 65 isolates.

Epidemiological studies showed maximum disease development after 48 h of leaf wetness with $1 \times 10^5$ and $1 \times 10^6$ conidia ml$^{-1}$ inoculum concentration. Influence of temperature on sporulation showed that 27°C was optimum for sporulation of *M. grisea* lesions in finger millet. Maximum growth and sporulation of finger millet isolates occurred at 25°C and those of pearl millet at 30°C whereas, maximum growth of foxtail millet isolates occurred at 25°C and sporulation at 30°C.

Effective greenhouse and field screening techniques, and rating scales for neck blast (1–5 scale) and finger blast severity (%) were developed. From the resistance evaluation of 622 finger millet core collection, 402 accessions were found resistant to neck blast, 436 resistant to finger blast and 372 had combined resistance to both neck and finger blast in field under artificial inoculation at ICRISAT during the rainy season (*kharif*) 2009. Of the mini-core, 68 had combined resistance to all the three phases of blast in field during 2009 and 2010 at ICRISAT. A significant weak to moderate correlations were found between leaf blast with neck blast and finger blast whereas, significant strong positive correlation was found between neck and finger blast ratings. Of the mini-core, 58 accessions were found resistant to leaf blast in greenhouse to Patancheru isolate. These represented five basic races of finger millet that originated from 13 countries and exhibited considerable diversity for agronomic traits.

Of the mini-core, 68 accessions were resistant to both neck and finger blast at Patancheru, 57 at Vizianagaram, 56 at Naganahalli, 11 at Naganahalli and 10 at Mandya during 2009 field screening. Among the mini-core, 7 accessions were resistant to both neck and finger blast across the 5 locations during 2009. Differential reactions across the locations was evident in 60 accessions that were categorized into seven groups. The FMBRSN-2010 comprising of 28 accessions including resistant and susceptible checks was constituted and evaluated at five locations during the *kharif* 2010. Of these, 17 were resistant to all the three phases of blast at
Patancheru; 11 at Naganahalli; 10 at Vizianagaram; 8 at Mandya and 7 at Nandyal. Of the 7 resistant accessions during 2009, two were found susceptible to neck and finger blast in 2010 screening.

Analysis of weather data from five locations over two years and neck, and finger blast severity on three highly susceptible accessions did not show any significant association between blast severity and weather variables (temperature and relative humidity) however, positive association was observed with amount and frequency of rainfall.

Analysis of resistance stability (2009 and 2010) using relative variation and GGE biplot technique showed that, five accessions (IE 2589, -2911, -4497, -6337 and -7018) were most resistant to all the three phases of blast across the five locations over two years. Of the five accessions, IE 2911 was found resistant to all three phases of blast against five isolates (one representative isolate/location) under greenhouse conditions and thus appears to be the best source of stable resistance.
Alternaria alternata causing leaf blight disease on sesamum, was isolated and identified. The effect of host age on the development of the disease, survival and viability of the fungus in sesamum seeds, and antagonistic effects of Trichoderma spp. and the effect of leaf extracts on the growth and spore germination of A. alternata, effect of culture filtrate of Trichoderma spp. on the growth and spore germination of Alternaria alternata, and efficacy of leaf extract and bio-control agent and Propiconazole in the management of leaf blight of sesamum were studied.

Sesamum plants were susceptible to A. alternata at different ages. However seventy five days old plants were more susceptible. The survival and viability of A. alternata in sesamum seed was higher in seed stored for 30 days in both agar and blotter paper methods. The fungus significantly showed a reduction with increase in storage period, even though the fungus could be isolated from the seed even after 120 days.

Sesamum seeds stored in cloth bags showed more incidence of A. alternata than the seed stored in gunny bag and open heap. Sesamum seed stored at 25°C showed more colonization by A. alternata than the seed stored at 30°C, 35°C and 40°C.

The leaf extracts of Azadiracta indica followed by those of Eucalyptus tereticornis, and Calotropis procera, were found to be effective in inhibiting the growth and spore germination of A. alternata whereas the leaf extracts of Vinca rosea were least effective in reducing fungal growth and spore germination.

The biocontrol agents viz., Trichoderma virens, T. longibrachiatum, T. harzianum and T. reesei were found to be superior in inhibiting the growth and germination of A. alternata. The culture filtrate of Trichoderma virens isolate 8 was found to be the most effective in inhibiting the growth of A. alternata. T. harzianum isolate 2 was found to be the most inhibitory to spore germination. T. reesei isolate 1 was the least effective in inhibiting growth and spore germination.

In pot culture experiments under both natural and artificially inoculated conditions Propiconazole (0.1%) followed by T. harzianum isolate 2 and leaf extract of neem in combination reduced severity of Alternaria leaf blight and increased plant height and pod yield of sesamum over control.
The present investigation entitled “Physiological evaluation of maize (Zea mays L.) cultivars for terminal drought and heat tolerance in rice fallow situation” was undertaken at the Agricultural College Farm, Bapatla during rabi 2010-11 on a sandy clay loam soil in a Randomized Block Design with three replications. The treatments comprised of 15 maize hybrids Commando, Dekalb pinnacle, 30V92, Laxmi 2277, HM 7701, Victory super, NMH 666, NK 6240, Super 45, CP 808, Kaveri 50, King GK 3063, Sun 405, Eden VMH 4040 and Bisco X-92 taking 30V92 as local check.

The data on morphological, physiological and biochemical parameters recorded at vegetative (30DAE), reproductive (60DAE) and maturity (90DAE) stages. From the basic data on leaf area and total dry matter growth characteristics such as CGR, RGR, NAR, LAI, SLW and SLA were computed.

The results indicated that the maize genotypes differed significantly in respect of all morphological, physiological and biochemical characters. Cultivars Laxmi 2277, Kaveri 50 and King GK 3063 grew taller (12.11, 10.04 and 9.00 percent respectively), maintained higher leaf area (18.22, 21.80 and 15.97 percent respectively) produced higher amount of total dry matter (14.38, 14.43 and 16.78 percent respectively) and maintained higher RWC in leaves than local check.

Compared to 30V92 the cultivars CP 808, Kaveri 50, King GK 3063, Laxmi 2277 and Dekalb pinnacle require relatively shorter duration for tassel and silk initiation (52-55d), 50percent tasseling (57-60d) and silking (57-64d) and 100percent tasseling (61-64d) and silking (62-68d) than 30V92.

Kaveri 50, Laxmi 2277 and King GK 3063 showed higher LAI (24.25, 23.65 and 14.41 percent respectively) and RGR (38.81, 38.81 and 45.55 percent respectively) than 30V92. King GK 3063 recorded higher CGR (12.89percent) and both Laxmi 2277 and King GK recorded higher NAR 3063 (26.19 and 22.79 percent respectively) than 30V92.

Laxmi 2277, King GK 3063, Super 45 and CP 808 showed higher SLW, while at maturity Kaveri 50 and Super 45 showed higher than 30V92.
Compared to 30V92, the higher SLA was observed in Commando at 30DAE, Laxmi at 60DAE and Eden VMH 4040 at 90DAE and the lower SLA was observed in Laxmi 2277, Bisco X-92, Sun 405 and Dekalb pinnacle at 30DAE, Sun 405 at 60DAE, Sun 405 at 60DAE and Dekalb pinnacle at 90DAE.

The total chlorophyll content and CSI were significantly higher in Kaveri 50, Laxmi 2277 and King GK 3063. The membrane injury was less in Kaveri 50, King GK 3063 and Laxmi 2277 during the period of tasseling and silking. Kaveri 50 Laxmi 2277, King GK 3063, Sun 405, Victory super, NK 6240 and Super 45 possessed higher proline content indicating the tolerance to drought and heat than 30V92 in rice fallow situation.

Compared to 30V92, NMH 666 and Laxmi 2277 produced more number of cobs per plant; Kaveri 50, Laxmi 2277 and King GK 3063 produced more number of rows, kernels per row, kernel weight per plant, test weight, shelling percentage and harvest index. Cultivars significantly differed in respect of number of cobs per plant, number of rows per cob, number of kernels per row, kernel weight per plant, test weight. Thus the observations on yield and yield components indicated that cultivars Laxmi 2277, King GK 3063 and Kaveri 50 are better yielders in rice fallow situation than local check and other Overall, it can be concluded from the study that cultivars Laxmi 2277, Kaveri 50 and King GK 3063 performed better under rice fallow conditions than local check 30V92 and other cultivars.
India is the world's second largest producer of white rice, accounting for 80 per cent of world rice production. Rice is affected by *Sclerotium oryzae* (Cattanoe) causing stem rot an important disease with yield losses of over 18-56 per cent.

A detailed study was carried at Department of Plant Pathology, S.V Agriculture College, ANGRAU, Tirupati on isolation of the pathogen and establishment of pathogenicity of *Sclerotium oryzae*. Potential fungicidal and insecticidal compatible bacteria antagonistic to *Sclerotium oryzae* was isolated from the rice rhizosphere. The integrated disease management (IDM) of *Sclerotium oryzae* and molecular characterization of potential biocontrol agents by RAPD and 16S rDNA was carried.

The Pathogen was isolated from infected plant showing typical stem rot symptoms collected from Agricultural Research Station (ARS), ANGRAU, Nellore, Andhra Pradesh and were purified by single hyphal tip method and identified as *Sclerotium oryzae*.

Among all the fungicides that were tested propiconazole (0.10 %), hexaconazole (0.20 %), carbendazim (0.10 %), thiophanate-methyl (0.10 %) and copper oxychloride (0.25 %) showed 100 per cent inhibition of mycelial growth. Whereas the fungicide validamycin (0.20 %) gave 88.88 per cent inhibition.

Different fungicides were tested *in vitro* for compatibility with potential biocontrol agents viz., SRR-1, SRR-3 and SRR-6. Thiophanate-methyl was found to be highest compatible (95.70 %) followed by propiconazole (86.86 %), the less compatibility was recorded in case of copper oxychloride (67.98 %) with SRR-1. In case of insecticides SRR-1 was more compatible with cartap hydrochloride „Kaldane” (91.69 %) followed by acephate (83.86%) and least compatible with flubendiamide (59.38 %) gave 88.88 per cent inhibition.

The *in vitro* experimental results revealed that volatile metabolites produced by antagonistic bacteria inhibited the mycelial growth of *Sclerotium oryzae* to an extent of 100 per cent (SSR-1), 86.66 per cent (SRR-3) and 22.22 per cent (SRR-2 and SRR-6) over control after 7 days of inoculation. In the case of non-volatile test, culture filtrate of antagonistic bacteria did...
not show any inhibition on growth of *Sclerotium oryzae* over control under *in vitro*.

The efficacy of potential biocontrol agent (SRR-1) and compatible fungicide (thiophanate-methyl) was tested in pot culture against stem rot of rice. The results revealed that treatment T6 (foliar spray of antagonistic + foliar spray of fungicides at 30 DAT) was superior in reducing per cent disease incidence (16.93 %) and increasing plant growth parameters, like grain yield per hill, straw yield per hill, panicle weight, panicle length, per cent of filled grain and 1000 grain weight when compared to other treatments.

The RAPD banding profiles with random primers *viz.*, OPA-5, OPA-7, OPA-10, OPA-18 and OPD-2 reflected the genetic diversity among the antagonistic bacterial isolates with formation of two main clusters. Amplified 16S rDNA with universal primers 63F and 1387R produced approximately 1300 bp fragments as expected. The amplified product was sent for sequencing to Eurofins Genomics Private Limited, Bangalore.
PLANT PATHOLOGY

Author : MOHAMMAD RAFI, G.

Title of the thesis : DEVELOPMENT OF FUNGICIDAL RESISTANCE IN Pyricularia grisea Sacc. INDUCING RICE BLAST TO COMMONLY USED FUNGICIDE

Major Advisor : Dr. R. JAGADEESHWAR

Degree : M.Sc. (Ag.)

College : COLLEGE OF AGRICULTURE, RAJENDRANAGAR

Accession Number : D 8873

Rice blast incited by Pyricularia grisea (telemorph: Magnaporthe grisea) is one of the economically important disease of rice in Andhra Pradesh for which chemical control by fungicides viz. carbendazim, tricyclazole, kasugamycin etc. was adopted as an integrant measure to reduce its damage. Since the wide spread use of above systemic fungicides began in recent past fungicide resistance in blast pathogen has become an important problem in Southern Telangana Zone of Andhra Pradesh. keeping this in view Nine isolates (Pg1 to Pg9) of P.grisea obtained from different rice growing areas of STZ of Andhra Pradesh viz., Ranga Reddy, Mahabubnagar, Nalgonda were tested for in vitro for development of resistance to carbendazim and tricyclazole.

The isolation of P. grisea was made from the infected leaf samples of rice in oat meal agar medium by following standard tissue isolation procedure. The cultural characters among isolates of P. grisea varied with respect to colony characters like type of growth, colour of colony and colony margin. Colour varies with shades of grey, buff, black, greyish black to dark jet black colour with smooth to irregular margin and medium to good growth was observed. Pathogenecity of all the isolates of P.grisea collected was proved by spraying spore suspension of 10⁻⁴ ml⁻¹ on susceptible rice cv. HR-12. All the isolates satisfied the Koch’s postulates and hence proved to be pathogenic on rice crop.

Sensitivity of P. grisea isolates to carbendazim was individually assayed in vitro at different concentrations (0 - 2000 µg ml⁻¹) in OMA. The test revealed that of the eight isolates of tested Nalgonda isolate Pg5 recorded the lowest ED₅₀ value of 2.82 µg ml⁻¹ and MIC value of 10 µg ml⁻¹ which was nearly equal sensitive as reference isolate Pg2. Ranga Reddy isolate (Pg1) recorded the highest ED₅₀ value of 4.05 µg ml⁻¹ and MIC of this isolate was 10 µg ml⁻¹. Ranga Reddy isolate Pg3 recorded the next lowest ED₅₀ value of 2.98 µg ml⁻¹ with MIC of 10 µg ml⁻¹ followed by Mahabubnagar isolates Pg4 with ED₅₀ value of 3.32 µg ml⁻¹ and Pg5 with ED₅₀ value of 3.35 in the increasing order of their resistance. The MIC values of both Mahabubnagar isolates Pg4 and Pg5 were 10 µg ml⁻¹. Pg8 isolate was recorded the next highest ED₅₀ value of 3.6 µg ml⁻¹ with MIC of 10 µg ml⁻¹ followed by Pg6 isolate (3.43 µg ml⁻¹) and Pg7 isolate (3.39 µg ml⁻¹) in the decreasing order of their resistance. The MIC value for both Pg6 and Pg7 isolates was
The results indicate that the fungus is under high selection pressure leading to evolution of carbendazim resistant population.

Sensitivity of *P. grisea* isolates to tricyclazole were individually assayed *in vitro* at different concentrations (0 - 2000 µg ml\(^{-1}\)) of tricyclazole in OMA. The test revealed that of the eight isolates tested for their sensitivity to tricyclazole, Mahabubnagar isolate (Pg\(_5\)) recorded the highest ED\(_{50}\) value of 118.51 µg ml\(^{-1}\) and the MIC of isolate was 500 µg ml\(^{-1}\). Ranga Reddy isolate Pg\(_1\) recorded the lowest ED\(_{50}\) value of 96.10 µg ml\(^{-1}\) and MIC value of 250 µg ml\(^{-1}\) which was nearly equal sensitive as reference sensitive isolate (Pg\(_3\)). Pg\(_4\) isolate collected from Mahabubnagar district recorded the next highest ED\(_{50}\) value of 110.41 µg ml\(^{-1}\) with MIC of 250 µg ml\(^{-1}\) followed by Pg\(_9\) isolate (104.66 µg ml\(^{-1}\)) and Pg\(_8\) isolate (104.26 µg ml\(^{-1}\)) both collected from Nalgonda district in the decreasing order of their resistance. The MIC value for both Pg\(_9\) and Pg\(_8\) isolates was 250 µg ml\(^{-1}\). Isolate Pg\(_2\) recorded the next lowest ED\(_{50}\) value of 99.22 µg ml\(^{-1}\) with MIC value of 250 µg ml\(^{-1}\) followed by Mahabubnagar isolate Pg\(_6\) with ED\(_{50}\) value of 101.81 µg ml\(^{-1}\) and Nalgonda isolate (Pg\(_7\)) with ED\(_{50}\) value of 104.26 in the increasing order of their resistance. The MIC values of both Pg\(_6\) and Pg\(_7\) were 250 µg ml\(^{-1}\). The results showed that the fungus is under high selection pressure leading to evolution of tricyclazole resistant population.

Development of resistance towards carbendazim has contributed to the development of positive cross resistance to both azoxystrobin and kresoxim-methyl whereas, its resistance was unaltered to tricyclazole+mancozeb and pyraclostrobin+metiram. Similarly, development of resistance towards tricyclazole had also contributed to development of positive cross resistance towards tricyclazole+mancozeb whereas, its resistance was unaltered to other fungicides *viz.*, azoxystrobin, pyraclostrobin+metiram, and kresoxim-methyl.
PLANT PATHOLOGY

Author : OBAIAH SIGA

Title of the thesis : MOLECULAR DETECTION AND CHARACTERIZATION OF YELLOW MOSAIC VIRUS INFECTING BLACKGRAM IN ANDHRA PRADESH

Major Advisor : Dr. B. V. BHASKARA REDDY

Degree : M.Sc. (Ag.)

College : S.V. AGRICULTURAL COLLEGE, TIRUPATI

Accession Number : D 8956

The present study was carried out to identify resistance source among available germplasm, genome organization and variability that exist in YMV infecting blackgram in Andhra Pradesh with reference to YMV infecting pulses in India. A total of 56 genotypes/entries were screened and 22 entries that were showing resistance to YMV under natural field conditions were identified. In this study, four YMV infected samples were collected from Tirupati, Kurnool (Rayalaseema), Guntur and Vizianagaram (Coastal Andhra) and DNA was isolated by CTAB method. The isolated DNA was successfully amplified with coat protein gene primers (RHA-F and AC abut) and 900bp gene product was obtained. The 900bp CP gene product of four isolates was cloned, sequenced and assembled, its length was determined as 920bp. Sequence analysis of four 920bp CP gene clones consist of 115bp pre-coat protein region at 5’ end and 774bp core coat protein. The actual size of full length CP gene was determined as 889bp by analogy with other begomoviruses. The complete nucleotide sequence of 889bp of CP gene of four isolates were obtained and sequence analysis showed that YMV-TPT isolate has 100% similarity with YMV-KNL isolate, 97.2% with YMV-VZM isolate and 95.4% with YMV-GUN isolate at nucleotide level. At amino acid level, YMV-TPT isolate has 100% homology with YMV-KNL isolate, 94.5% with YMV-VZM isolate and 91.4% with YMV-GUN isolate.

A comparison of complete nucleotide sequence of coat protein gene of four isolates with 27 other geminivirus sequences available in the NCBI GenBank showed that YMV-TPT isolate has >95% homology with MYMIV isolates, and less than 80% homology with MYMV and other geminiviruses. Nucleotide sequence analysis of YMV-GUN isolate showed that it has >97% homology with MYMIV and <80% with MYMV isolates. Comparison of pre-CP gene sequences of four isolates with 27 other sequences downloaded from GenBank showed that YMV-TPT isolate shows >90 DNA homology with MYMIV isolates infecting various crops and <80 homology with other geminiviruses.

A comparison of predicted amino acid sequence of coat protein gene of four isolates with 27 other amino acid sequences available in the NCBI GenBank database indicated that YMV-TPT isolate has >91% homology with MYMIV and <66% homology with MYMV and other geminiviruses.
Phylogenetic tree based on the full length coat protein gene sequences of four isolates under the study with 27 other isolatesdownload from GenBank formed two major clusters of MYMIV and MYMV. The present four isolates formed unique cluster with MYMIV group that caused yellow mosaic disease symptoms in blackgram (AF126406), mungbean (AY271893), soybean (DQ389146), and cowpea (DQ389153) in India.

The present results from Pre-CP gene sequence, full length CP gene sequence alignment and phylogenetic analysis of CP gene sequences clearly established that the YMV infecting blackgram in AP is a different variant of MYMIV in coastal Andhra and a same variant in Rayalaseema region.

The full length DNA-A component (2.7kb) of YMV-TPT isolate was amplified with Afl1 and Afl2 primers, cloned, sequenced, assembled and its length was determined as 2746 nt. The complete analysis of DNA-A sequence showed presence 7 ORFs similar to that of DNA-A components of other begomoviruses. The DNA-A encodes AV1 and AV2 on virion sense strands and remaining five genes (AC1, AC2, AC3, AC4, AC5) are encoded on virion complementary strand. The ORFs are similar with respect to size and location to MYMIV isolates except with AV2 and change in translation frames of protein products. An additional ORF 5 was located with unknown function, which is not common in many begomoviruses. Comparison of different ORFs of YMV-TPT isolate with 18 other geminivirus ORFs shows AV2 has >94% DNA homology, AV1 has >96.3%, AC5 & AC3 has >93%, AC2 has >94%, AC1 has >95.5% and AC4 has >95% homology with MYMIV isolates.

The common region (CR) was identified for YMV-TPT isolate by pair wise alignment of the non-coding region between ORF AC1/AV2 in DNA-A. The common region (CR) of DNA-A contained the nonanucleotide sequence (TAATATTAC) that is conserved in the stem loop of all begomoviruses, which has nicking site for the initiation of viral replication. A TATA box (ori region) and several repeated iteron sequence (GGTGT) involved in binding of Rep during viral replication were present in the common region of DNA-A component of YMV-TPT isolate under study. The multiple sequence alignment of CR region of YMV-TPT DNA-A with other isolates shows > 89.7% DNA homology with MYMIV isolates and <70.3% homology with MYMV isolates.

The nucleotide and predicted amino acid sequencing of DNA-A was compared with 22 other isolates downloaded from GenBank. The YMV-TPT isolates showed >95% DNA homology with MYMIV isolates and <81% homology with MYMV, BGYMV, ICMV, ToLCBV, MSV, DoYMV and CLCuRV isolates. Analysis of DNA-A based on amino acid sequence of YMV-TPT isolate with 22 other isolates showed >90% homology with MYMIV isolates and <70% homology with MYMV, BGYMV, ICMV, ToLCBV, MSV, DoYMV and CLCuRV isolates. The phylogenetic tree was constructed using neighbour joining method based on DNA-A sequence of YMV-TPT isolate with 22 other geminivirus sequences downloaded from GenBank database. The analysis of rooted tree for DNA-A of present isolate with 22 other geminivirus sequences showed presence of two clusters, represented by MYMIV and MYMV, The present isolate was part of sub cluster along with MYMIV. The virus was detected up to $10^{-3}$ dilution or 2.32ng/µl DNA concentration by PCR technique using CP gene primers.

The present results from ORFs sequence homology, CR region homology, and complete DNA-A sequence homology at nucleotide and amino acid levels clearly showed that YMV
infecting blackgram in AP is MYMIV. More isolates are to be collected from major growing areas in AP and to be analyzed by sequencing both DNA-A &B components so that existence of new strains / species in YMD of blackgram will be known. Similarly, there is a need to survey for any new biotypes of *B. tabaci* prevalent in AP by molecular and transmission studies.
In the present study twenty six *Trichoderma* isolates comprising seven isolates of *T. harzianum*, eleven isolates of *T. virens*, two isolates of *T. longibrachiatum* and one isolate each of *T. aureoviride, T. citrinoviride, T. piluliferum, T. polysporum, T. pseudokoningii* and *T. reesei* were evaluated for their antagonistic potential against two soil borne plant pathogenic fungi, viz., *Pythium aphanidermatum* and *Fusarium oxysporum f. sp. ciceri*.

Variability existed among the test *Trichoderma* isolates in antagonizing the test pathogen isolates. In case of *Trichoderma - F. o. f. sp. ciceri* interactions, five (19%) interactions resulted in static growth of both the interacting isolates, i.e., neither could overpower the other. Three out of twenty six interactions (12%) resulted in *F. o. f. sp. ciceri* overgrowing on *Trichoderma*. Remaining 69 per cent of *Trichoderma* isolates (18 out of 26 isolates) were found to be antagonistic to *F. o. f. sp. ciceri*. Eighty six per cent of *T. harzianum* isolates (six out of seven isolates) and 73 per cent of *T. virens* isolates (eight out of eleven isolates) were found antagonistic to *F. o. f. sp. ciceri*.

In *Trichoderma – P. aphanidermatum* interactions, four per cent of the *Trichoderma* isolates were overgrown by *P. aphanidermatum* (one out of twenty six), four per cent of the isolates of *Trichoderma* got lysed due to *P. aphanidermatum* (one out of twenty six), in 15% of interactions both *P. aphanidermatum* and *Trichoderma* had static growth (four out of twenty six) and in 76 per cent of interactions (20 out of 26) *Trichoderma* overgrew *P. aphanidermatum* atum. Volatiles of *F. o. f. sp. ciceri* which enhanced the growth of *Trichoderma* isolates Ta, Tc, Th2, Th3, Tpil, Tp01, Tv4 and Tv10 (60.9 to 8.6% increase in growth) Tv2, Tv3, Tv5, Tv8, Tv11 and Tv9 isolates growth was decreased (6.7 to 15.3% inhibition). Among the different species of *Trichoderma, T. virens* was most inhibited (15.3%) by the volatiles of *F. o. f. sp. ciceri*. Thus growth of 31% of *Trichoderma* isolates was encouraged in the presence of *F. o. f. sp. ciceri*, whereas 23% of *Trichoderma* isolates showed decreased growth when paired with *F. o. f. sp. ciceri* up to two days after inoculation. On the other hand, except Th5, all other isolates of *Trichoderma* inhibited growth of *F. o. f. sp. ciceri* in paired plates.

In 36 per cent of *Trichoderma* isolates growth retardation was observed due to the volatiles of *P. aphanidermatum* two days after inoculation and only in 4 per cent of the isolates (only in Tv1) growth promotion was observed. Remaining isolates had no impact. Thus the
present investigation revealed that *Trichoderma* growth was better when paired with *F. o. f. sp. ciceri* (31% of isolates) than when paired with *P. aphanidermatum* (4% of isolates).

Inhibition in the radial growth of *F. o. f. sp. ciceri* due to *Trichoderma* culture filtrates was observed in all the treatments only up to three days. Later on the reduction in *F. o. f. sp. ciceri* growth was nullified in six of the twenty six isolates (23%) whereas in the remaining twenty isolates (76%) reduction in growth was continued. The initial inhibitory effect on *P. aphanidermatum* was nullified upon continued incubation for another day as the growth in culture filtrate amended medium was on a par with check (9.0 cm) except in Th4 (5.6% inhibition) and Tv1 (24.4% inhibition) where inhibition in growth continued.

When different isolates of *Trichoderma* were grown on test pathogenic mycelial growth as sole nutrient source, reduction in growth was observed to the extent of 70 to 98 per cent on *F. o. f. sp. ciceri* and 59 to 82 per cent on *P. aphanidermatum* in comparison to Czepek-Dox broth.

When the fungal mycelium from the interaction zones was observed under microscope, none of the interactions involving *F. o. f. sp. ciceri* or *P. aphanidermatum* and the test *Trichoderma* isolates revealed mycoparasitic signs such as hyphal coiling and formation of appressoria. However, chlamydospore formation and granulation of cytoplasm were found prominent in *Trichoderma–F. o. f. sp. ciceri* interactions. In *Pa-Trichoderma* interactions, lysis of the mycelium, formation of primary septa just beneath the lytic portion, granulation and vacuolation of cytoplasm, bulging and rupture of hyphae were

Soil treated with Th3 (2.5%) and Tv1 (1.0%) recorded significantly lower chickpea wilt incidence, *i.e.*, gave maximum protection to chickpea seedlings with 94 and 98 per cent disease control respectively. Seeds treated with Tv4 and Tv3 (10 and 20% disease incidence respectively) offered maximum protection up to 22 days after sowing with disease control equivalent to 75 and 50 per cent respectively.

None of the *Trichoderma* treatments (soil and seed treatment) were better than seed treatment with metalaxyl in protecting tobacco seedlings from dampingoff.
PLANT PATHOLOGY

Author : RANGASWAMY, E.

Title of the thesis : “STUDIES ON VARIABILITY IN Fusarium udum THE INCITANT OF WILT IN PIGEONPEA”

Major Advisor : Dr. B.PUSHPAVATHI

Degree : M.Sc. (Ag.)

College : COLLEGE OF AGRICULTURE, RAJENDRANAGAR

Accession Number : D 8874

In the present study characterization of the Fusarium udum populations with reference to cultural, morphological, biochemical and amplification pattern of genomic DNA has been taken up to ascertain the pathogenic and genetic variability in Fusarium udum isolates. A total of 26 isolates were collected from major pigeonpea growing areas of Andhra Pradesh and used for further investigation.

The isolates varied significantly for cultural and morphological characters. Among the isolates the size of micro- and macroconidia varied between 7.27×2.88µm (Fu 24) to 13.25×2.68µm (Fu 10) and 23.37×3.17µm (Fu 18) to 40.05×4.71µm (Fu 8) respectively. Chlamydospores were observed in all the isolates and their diameter measured between 9.47µm (Fu 19) to 15.57µm (Fu 1). Colony characters ranged from sparse to dense mycelial growth. According to colony characters they were categorized into four groups viz., white cottony and fluffy growth, white cottony dense growth with smooth margin, white sparse growth in concentric rings and white sparse growth. Considerable variation was also observed in substrate pigmentation for all the isolates on PDA medium. Majorly, the isolates developed different colours viz., yellow, pale yellow, reddish yellow, brownish yellow, pink and light pink. Variation in colony diameter varied from 55.00mm (Fu 22) to 89.33mm (Fu 21). Among the isolates Fu 20 and Fu 22 showed scanty sporulation while abundant sporulation was recorded in isolates Fu 4, Fu 7, Fu 9, Fu 12, Fu 13, Fu 19 and Fu 24.

Based on morphological characters isolates were categorized into five groups and one representative isolate from each group was selected for further investigation. Five isolates were evaluated for pathogenic variability on a set of seven host differentials and three locally growing cultivars. Isolates varied greatly for virulence, disease incidence, disease reaction, latent period and virulence index. As all the five isolates induced symptoms on all the host differentials, they were considered as virulent isolates. However, among the isolates tested based on virulence index, the isolate Fu 15 was found highly virulent and the isolate Fu 24 was weakly virulent.

Among the isolates tested significant variation was found in bio-chemical composition. Total sugars were found to be highest (16.40mg) in isolate Fu 2 and lowest (5.70mg) in isolate Fu 25. Similarly, total protein content of different isolates was ranged between 8.00mg (Fu 5) to 15.40mg (Fu 21). Across the isolates, isolate Fu 8 (5.50mg) showed minimum quantity of total free amino acids, while the maximum quantity of free amino acids was found in Fu 15 (20.16mg).
followed by Fu 7 (20.08mg). All the 26 isolates produced Poly Methyl Galacturonase (PMG) and Poly Methyl Esterase (PME) enzymes and varied significantly in production of these enzymes. PMG activity varied from 25.20 percent (Fu 9) to 64.39 percent (Fu 5) while PME activity varied from 6.40 (Fu 3) to 29.00 (Fu 24) across the isolates.

The effect of different concentrations of culture filtrates was tested against germination, root length and wilting of pigeonpea seedlings and the results showed that germination and root length were reduced and seedling wilt was increased as the concentration of culture filtrates increased.

RAPD analysis of *F. udum* showed polymorphism among the 26 isolates. Data obtained through RAPD studies differentiated the isolates into two major clusters A and B. Co-efficient value of each isolate derived from RAPD study showed that, among the 26 isolates of test pathogen highest similarity coefficient of 0.90 was observed between the isolate Fu 1 and Fu 2; and 0.84 was observed between isolates Fu 6 and Fu 7 and isolates Fu 25 and Fu 26 followed by 0.83 between isolates Fu 16 and Fu 17.
PLANT PATHOLOGY

Author : SOUJANYA LAKSHMI, R.

Title of the thesis : “STUDIES ON BIOLOGICAL CONTROL OF RICE SHEATH BLIGHT CAUSED BY RHIZOCTOIA SOLANI KUHN USING TRICHODERMA SP”

Major Advisor : Dr. P. ANIL KUMAR

Degree : M.Sc. (Ag.)

College : AGRICULTURAL COLLEGE, BAPATLA

Accession Number : D 9029

The present investigation was undertaken to screen five isolate of Trichoderma spp. belonging to three isolates of T. harzianum (Th4, Th7 and Th8), one isolate each of T. virens (Tv11) and T. aureoviride (Ta) against Rhizoctonia solani, the rice sheath blight pathogen and to find feasibility of utilizing the most potential isolate to manage the sheath blight in vivo.

Based on the quantitative and qualitative parameters, the T. harzianum (Th4) with superior radial growth in monoculture and faster occupation of R. solani colony and lysis of R. solani was found better in comparison with other four test isolates and hence choosen for further studies on its antagonistic potential in vitro and in vivo.

Microscopic observations on mycoparasitism of T. harzianum (Th4) on R. solani were observed at the interaction zone using compound and scanning electron microscopes which revealed coiling, parallel growth and appressoria formation by Th4 hyphae around the R. solani hyphae. Penetration of R. solani hyphae by Th4 resulted in the pores on R. solani cell wall (indicating penetration sites), coagulation and lysis of R. solani hyphae.

The production of chitinases, cellulases and proteases by T. harzianum (Th4) was observed when R. solani was used as sole nutrient source. However, 87.5 % reduction in dry wt of Th4 compared to dry wt on Czapek Dox broth suggested that Th4 cannot totally depend on R. solani hyphae for its survival.

A temperature of 30° C and pH 6.0 favoured the Trichoderma, where there was an increase in the antagonistic potential of Th4 and decrease in the radial growth of R. solani. The better growth of R. solani at 20°C indicated the better chances of survival of R. solani at that respective temperature. There was no effect of inhibitory volatiles of T. harzianum (Th4) on the growth of R. solani at all the temperatures and pH levels tested.

Influence on the dry wt of R. solani due to Th4 culture filtrate obtained from three different incubation temperatures was not observed. However, there was reduction in the radial growth of R. solani at maximum concentration (50%) of culture filtrate of T. harzianum (Th4) obtained from three different Ph levels.
Seed treatment or seedling dip with *Th*₄ spore suspension @ 10⁸ spores/ml and 10¹² spores/ml resulted in least lesion area at six days after pathogen inoculation compared to pathogen inoculated check. This indicated that the *Trichoderma* could induce systemic resistance in rice plants.

Hexaconazole (0.2%) spray was found to be effective resulting in least lesion area compared to foliar spray of *Th*₄ spore suspension @ 10⁸ spores/ml and 10¹² spores/ml which were significantly lower than pathogen inoculated check at six days pathogen inoculation.

No drying of inoculated leaf in case of hexaconazole and a two days delay in leaf drying in case of *Trichoderma* treatments compared to pathogen inoculated check revealed that *Trichoderma* could only give an initial protection from rice sheath blight pathogen, *R. solani*. Further, *Trichoderma* was not phytotoxic to rice plants.
Tomato (Lycopersicon esculentum L. Mill.) is an economically important vegetable crop after potato in the world. Chittoor, Adilabad, Kurnool and Ananthapur are the major tomato growing districts in Andhra Pradesh. Out of seventeen districts surveyed, samples collected from fifteen districts positively yielded the Meloidogyne spp. with a high population in loamy soils under irrigated conditions during flowering stage when previous crops were tomato and potato. The density (171.11/250 cc soil) of Meloidogyne spp. was high in Southern zone while it was low (28.08/250 cc soil) in North Telangana zone. The occurrence of Rhizoctonia was high in sandy loam soils, irrigated conditions during flowering stage when previous crop was potato.

The occurrence of Rhizoctonia was also high in Southern zone with 5.19X 10^3 cfu/ g soil. Among the tomato cultivars US 618 was associated with a high density of 149.76/250 cc soil and 136.82/250 cc soil of Meloidogyne spp. and other nematodes respectively while cultivar Sridevi was associated with a low density of Meloidogyne spp. (29.5/250 cc soil) and other nematodes (27.5/250 cc soil).

The cultivar US 618 also recorded a high occurrence of Rhizoctonia with a frequency of 23.0 from soil and root. The root knot nematode population was high (324/250 cc soil, 189/5g root) in sample collected from Choudepalli mandal of Chittoor district, while the Rhizoctonia spp. population was high in Chittoor, Ananthapur and Adilabad districts.

The inoculum level of 2g of fresh mycelium and 2000 J2/kg soil was determined as optimum infection threshold level of Rhizoctonia solani and Meloidogyne incognita respectively.

The interaction studies revealed that the presence of Rhizoctonia solani with Meloidogyne incognita resulted in reduction of shoot length, shoot dry weight and root dry weight by 41.87, 51.58 and 33.08 per cent respectively. Similar reduction was also recorded in root knot index (2.4), number of eggs/root system (9.6), eggs/egg mass (97.60) and nematode population (1601.4/250 cc soil) when fungus was inoculated prior to the nematode. The pre and post emergence rotting and total rotting was increased by 33.46, 43.13 and 76.58 respectively in the treatment where nematode inoculation followed by fungus (N→F). The population of Rhizoctonia solani was also increased (1831 cfu/g) in the treatment (N→F) when compared to
932.6 cfu/g in F alone.

The native isolate *Trichoderma harzianum* was identified as potential antagonist against test fungus *Rhizoctonia solani* with 61.11 per cent reduction. Among the bacterial bio control agents, *Bacillus subtilis* was found to be highly effective in inhibiting the test pathogen by 56.77 per cent inhibition.

Soil solarization resulted in significant reduction of population of *Meloidogyne* spp. (59.56 /250 cc soil) and *Rhizoctonia* spp. (1.66 x 10^3 cfu/g soil) with increased soil temperature by 6⁰C to 8⁰C over ambient temperature. The weed counts were also decreased by 97.96 per cent in solarized plots when compared to in 75.41 unsolarized plots.

Integration of soil solarization, seed treatment with chemicals and *T. harzianum* and *Bacillus subtilis* recorded a maximum per cent reduction of *Meloidogyne* spp. (62.10), *Rhizoctonia* spp. (91.0) and other fungal (60.17) population when compared to inoculated control (742.3/ 250 cc soil, 6.7X10^3 and 77.00X10^3 cfu/g soil) Soil solarization followed by seed treatment with chemicals and *Trichoderma harzianum* and *Bacillus subtilis* also resulted an increase in per cent shoot length (57.13), shoot dry weight (54.27) and root dry weight (43.3) when compared to inoculated control. Similarly, the combination of the treatments also resulted in reduction of root knot index (1.56) when compared to inoculated control (4.67). The per cent pre and post emergence rot was also decreased by 59.0 and 68.32 respectively when compared to inoculated control (26.83 and 22.1 per cent). The fruit yield was increased by 17.96 percent when soil solarization combined with seed treatment of chemicals, *T. harzianum* and *B. subtilis* when compared to inoculated control (22250 kg ha⁻¹). However, among the treatments seed treatment with chemicals was found to be economical as indicated by a high CB ratio of 1:16.30.

Out of thirteen popular cultivars tested against root rot and root knot nematode disease complex, none of the cultivars were found to be resistant against disease complex associated with tomato.
The present investigation was undertaken at the Agricultural College Farm, Bapatla during the two consecutive seasons of rabi 2008-09 (season I) and rabi 2009-2010 (season II). The experiment was laid out in split plot design with nine treatments replicated four times.

The experiment consist of three main plots i.e., water stress levels viz., M₀ (No stress i.e., irrigated at vegetative stage, 20 DAS and at pod filling stage, 55 DAS), M₁ (water stress from vegetative stage i.e., unirrigated) and M₂ (water stress from flowering stage i.e., irrigated only at vegetative stage, 20 DAS) and each main plot consisting of three subplots i.e., foliar sprays at 40 DAS viz., S₀ (No spray), S₁ (Kinetin spray @ 5ppm) and S₂ (Homobrassinolide spray @ 1ppm).

The results indicated that no stress and stress from flowering stage (irrigated plants) were on par with each other, recorded more seedling vigour index (25.9%) over stress from vegetative stage (unirrigated).

Among morphological parameters, plant height, number of productive branches, root length, root volume, root shoot ratio, number and dry weight of nodules were significantly influenced by stress treatments and foliar sprays of kinetin @ 5ppm and homobrassinolide @ 1ppm.

No stress (irrigated at two times) recorded higher values of plant height (39.0%) and number of productive branches per plant (11.2%) over the stress from vegetative stage (unirrigated). No stress with homobrassinolide spray recorded maximum plant height (15.2%) and maximum number of productive branches per plant (7.9%) over the control. Stress from vegetative stage with no spray recorded maximum root length and it was 25.5 per cent more over the control followed by stress from vegetative stage with homobrassinolide spray. Stress from vegetative stage with homobrassinolide spray recorded maximum root volume (19.2%) and root to shoot ratio (13.5%) over the control.

There was an increase in both number and dry weight of nodules in case of homobrassinolide spray; whereas it was only marginal increase of dry weight in case of kinetin spray. However, unstressed plants with homobrassinolide spray recorded maximum number and dry weight of nodules and it was on par with unstressed plants with kinetin spray.
With respect to physiological parameters, plants not subjected to stress recorded an increase in relative growth rate (17.5%), net assimilation rate (39.1%) and leaf moisture retention index (17.2%) over water stress from vegetative stage. No stress with homobrassinolide spray recorded maximum relative growth rate, net assimilation rate and leaf moisture retention index and it was on par with no stress with kinetin spray.

The plants not exposed to water stress accomplished more leaf area (26.1%), leaf area duration (29.6%) and specific leaf area (23.1%) over stress from vegetative stage. The unstressed plants with kinetin spray recorded maximum values of leaf area duration and specific leaf area followed by no stress with homobrassinolide spray indicating reduced leaf enlargement under stress consequently decreased leaf area.

Amongst biochemical parameters, water stress from vegetative stage recorded more proline content (54.0%), more superoxide dismutase activity (98.2%) and catalase activity (43.5%) over no stress and it was further enhanced by the foliar spray of homobrassinolide. Water stress from vegetative stage with homobrassinolide spray recorded increased proline content, superoxide dismutase activity and catalase activity 114.8%, 166.4% and 179.7% respectively, over the control, followed by water stress from vegetative stage with kinetin spray.

No water stress recorded significantly higher SCMR (31.9%) over water stress from vegetative stage and was on par with water stress from flowering stage. No stress with homobrassinolide spray recorded the higher values for SCMR. Stress from vegetative stage recorded significantly higher membrane injury index over no stress. Water stress from vegetative stage with no spray recorded the higher membrane injury index i.e., 29.1% over the control i.e., no stress with no spray.

Stress from vegetative stage recorded significantly higher nitrogen harvest index (30.4%) over no water stress and water stress from flowering stage. Among foliar sprays, no spray resulted higher nitrogen harvest index (27.2%) over homobrassinolide spray @ 1ppm and it was on par with kinetin spray @ 5ppm.

In case of seed yield, no water stress (irrigated at two times) recorded significantly higher seed yield (31.9%) over water stress from vegetative stage (unirrigated). Among foliar sprays, spray with homobrassinolide @ 1ppm resulted higher seed yield (20.9%) over no spray and it was on par with kinetin spray @ 5ppm.

Seed yield has significant positive correlation with primary branches, specific leaf area, relative growth rate, net assimilation rate, SCMR and harvest index and significant negative correlation with membrane injury index.

Hence, it can be concluded that homobrassinolide spray @1ppm would provides better, dry matter partitioning, biochemical regulation and ultimately produce potential seed yield under water stress (drought) conditions in chickpea particularly at coastal regions of Andhra Pradesh.
Groundnut is one of the most important oilseed crops grown in Andhra Pradesh. The crop is affected by a variety of diseases, of which stem rot caused by *Sclerotium rolfsii* is very important and has become one of the major constraints causing damage to the crop. Management of stem rot is difficult because of soil borne nature of the pathogen and its wide host range and the chemical methods are very expensive and will not provide complete protection from the pathogen.

There is worldwide acceptance to the use of ecologically safe, environment friendly methods of protecting crops from the plant pathogens. Using plant produced allelochemicals in agricultural and horticultural practices could minimize synthetic pesticide use, reduce the associated potential for environmental contamination and contribute to a sustainable agricultural system.

*In vitro* studies conducted to reduce the growth of *S. rolfsii* against mustard leaf discs (8 mm size) inoculated with *S. rolfsii* (5 mm size), un-inoculated leaf discs revealed at the end of the experiment *i.e.* at 72 hours, the growth of the pathogen exposed to *S. rolfsii* inoculated leaf discs was reduced by 15.68 per cent over control and in un-inoculated leaf discs it recorded 11.48 per cent over control. Similarly, the *S. rolfsii* exposed to mustard powder 2 mg, 5 mg, 10 mg and 20 mg after 24 hours of exposure to mustard powder, the growth of *S. rolfsii* was completely inhibited in all the concentrations. At the end of the experiment at 96 hours of exposure, mustard powder of 20 mg was found 63.2% inhibitory to the growth of *S. rolfsii*, while 2 mg of mustard powder did not show any effect on *S. rolfsii*, suggesting that the fungus may have the ability to adapt to volatiles at lower concentrations.

The results on the effect of incorporation of *Brassica* sp residues with other treatments on stem and pod rot of groundnut, indicated that the incorporation of mustard plant parts with conventional and non-conventional treatments highly influenced the incidence of stem rot and plant growth. Treatment FYM application @ 6 kg per plot + *in situ* application of *Brassica* residues + rhizobium seed treatment @ 20 g per kg seed (T9) showed highest plant height (25.63, 36.93, 42.50 cm), leaf area (272, 1040, 1348.58 cm²) at 30, 60 and 90 DAS respectively, fresh weight and dry weight (70.91, 26.66 g plant⁻¹) and pod yield (2.16 kg plot⁻¹) at the time of harvest. Soil drenching with propiconazole @ 0.1% + *in situ* application of *Brassica* residues @
4 kg per plot + rhizobium seed treatment @ 20 g per kg seed (62.55%, 67.95%) followed by soil solarization + in situ application of Brassica residues @ 4 kg per plot + rhizobium seed treatment @ 20 g per kg seed (57.10%, 66.70%) resulted in maximum reduction in stem rot and pod rot disease severity per cent over inoculated control respectively. Among all the treatments lowest fungal and bacterial population were recorded in soil drenching with propiconazole @ 0.1% + in situ application of Brassica residues @ 4 kg per plot + rhizobium seed treatment @ 20 g per kg seed (before sowing of groundnut as well as after harvest of groundnut (4.66 x 10⁴, 5.00 x 10⁴; 21.33 x10⁵, 24.00 x 10⁵ cfu g⁻¹ of soil) respectively.

In vitro studies on the effect of dried leaf residues of mustard, cabbage and onion on soil microbial population showed that the population of bacteria was revealed more over the fungi in all the treatments. Minimum microbial population was noticed in the soil exposed to dried mustard leaf volatiles followed by onion and cabbage dried leaf residues.
The field experiment was conducted during late Rabi, 2010-11 at wet land farm, S.V. Agriculture College, Tirupati. Field experiment was laid out in factorial randomized block design, replicated thrice. There are three main treatments i.e. adequately irrigated, imposed mid stress from 30-45 DAS (flowering stage), imposed end stress from 45-60 DAS (pod filling and maturity stage) and seven sub treatments (genotypes).

The results revealed that significant differences between irrigation treatments and genotypes were observed for plant height, leaf area and dry matter production only after imposition of moisture stress at 30 DAS to harvest. The effect of end stress on leaf area and dry matter production and its partitioning was more acute compared to mid stress i.e. imposed stress at flowering. Among the genotypes, WGG-37 and MGG-357 maintained high leaf area and dry matter accumulation under irrigated and moisture stress conditions.

Similar results were also observed with growth and physiological traits viz., leaf area index, crop growth rate, net assimilation rate, leaf area duration, photosynthetic rate, transpiration rate and stomatal conductance. Among the genotypes tested, WGG-37 and MGG-357 recorded superior growth and physiological traits.

Among the drought tolerant traits used to evaluate green gram genotypes, WUE traits specific leaf area(SLA), SPAD chlorophyll meter readings (SCMR) and high temperature tolerance trait i.e. Fv/Fm were significantly reduced under moisture stress conditions compared to irrigated control. However stress at both phenophases showed more or less similar reduction in values of SLA, SCMR, Fv/Fm values. A significant positive correlation between SCMR and WUE and a negative correlation between SCMR and SLA were observed and were already established as good drought tolerant traits. An inverse relation was observed between SLA and seed yield and SCMR and seed yield. Among the two superior genotypes, MGG-357 recorded lowest SLA and high SCMR. Whereas, WGG-37 recorded lowest a SLA with lowest SCMR values.

Yield components viz., number of pods/cluster, number of pods/plant, number of seeds/pod, pod length, pod yield as well as yields were significantly varied between irrigation treatments and genotypes. The effect was more pronounced in end season.
stress. MGG-357 and WGG-37 recorded higher harvest index, yield and its components, whereas the genotype TM 96-2 recorded lowest seed yields both under irrigated and imposed moisture stress conditions.

These results revealed that both MGG-357 and WGG-37 are highly suitable to the southern zone under both irrigated as well as rain fed conditions. However, for drought prone areas MGG-357 is recommended due to its drought tolerance characters. The other genotypes, MGG-348, MGG-360, MGG-347 and LGG-460 recorded moderate growth and yield attributes, whereas TM 96-2 showed poor performance in all respects.
The present investigation was conducted at the Students Farm, College of Agriculture, Rajendranagar, Hyderabad, during kharif 2010-2011. The field trial was conducted following randomized block design with three replications and eight aromatic rice genotypes viz. PUSA-1121, Chittimuthyalu, Godavari Isukalu, RNR-19186, RNR-2378, RNR-2354, RNR-2465 and Sumathi. In this experiment, the morphological traits such as plant height, tillering capacity, number of leaves and root parameters and physiological indices such as LAI, CGR, NAR, RGR, LAD, AGR, LAR, SLW and SLA were evaluated at 15 days interval. Phenological parameters were taken such as days to 50% flowering, days to complete flowering and days to maturity and morphological indices (flag leaf area) were evaluated at flowering stage.

Results of morphological characteristics showed that highest and lowest plant heights were recorded in Chittimuthyalu and RNR 2378, respectively. Maximum number of tillers and number of leaves were recorded by variety RNR 2354. Root parameters like root length, root volume and root weight were highest in the variety RNR 2354 and lowest in Pusa1121. There was significant positive correlation between tiller number and root parameters with grain yield. More number of days to 50% flowering, days to complete flowering and days to maturity were recorded for the variety Sumathi and minimum in Chittimuthyalu. Combined leaf area of first three leaves from the top found significantly different for all aromatic rice cultivars and maximum combined leaf area of first three leaves from the top was found in the variety RNR 2354 and minimum was recorded by the variety Pusa1121.

Results showed that maximum LAI, CGR, NAR, RGR, LAD, LAR and SLW were recorded for the variety RNR 2354. Highest AGR was recorded with variety Chittimuthyalu and lowest was recorded with variety RNR 2354 and RNR 2465. Highest SLA was recorded in RNR 2378 and minimum SLA was recorded in RNR 2354. Yield was significantly and positively correlated with LAI, CGR, NAR, RGR, LAD and SLW. Thus the highest dry matter production was recorded in variety RNR 2354 while minimum dry matter production was recorded for the variety Pusa 1121. Maximum SPAD values were recorded for variety RNR 2354 throughout the crop growth period and minimum was
found for the variety Chittimuthyalu whereas harvest index and nitrogen harvest index were recorded maximum in the variety RNR 2354 and minimum in Pusa 1121. Harvest index, Flag leaf area and SPAD values were positively associated with grain yield in aromatic rice.

Highest grain yield was recorded in variety RNR 2354 and the lowest grain yield was recorded in Pusa 1121. The aromatic rice varieties differed significantly with respect to yield and yield components like number of panicles per meter square, number of spikelets per panicle, 1000 grain weight, filled grain percentage and harvest index which were significantly and positively associated with grain yield.
Two field experiments were conducted under rainfed conditions to study, at Regional Agricultural Research Station, Tirupati in a Randomized Block Design with 15 genotypes during kharif, 2010.

An experiment was taken up on a specially constructed raised platform soil beds (15m x 2m x 1.8 m) to study root mining abilities of groundnut genotypes. Another field experiment was conducted to evaluate 15 groundnut (Spanish bunch) genotypes for morphological, physiological, water use efficiency, thermotolerance characters in different phenophases of crop growth.

The present investigation revealed sufficient genotypic variability among the pre-release and released genotypes for root traits, water use efficiency and thermotolerance. This indicates clearly that these traits can be used to evaluate groundnut (Spanish bunch) genotypes for respective characters. The root mining traits viz., root length, root dry weight, root volume and root-shoot ratio varied significantly among the genotypes. Significant and positive correlations were observed between root length and shoot dry weight and root dry weight with shoot dry weight. Among the genotypes tested, TCGS-1071 and TCGS-1073 recorded higher root mining abilities.

Among the morphological traits studied, TCGS-1070 recorded higher early vigour and early flowering, which are good traits, for drought escapism. However, the genotype did not show yield advantage. Based on the plant height, the pre-release genotypes can be classified into three groups i.e., long statured (TCGS-1075, TCGS-991, TCGS-1043 and TCGS-1073), moderate statured (TCGS-1070 and TCGS-1045) and short statured (TCGS-1014, TCGS-969, TCGS-1076, TCGS-894 and TCGS-1071).

The pre-release genotypes TCGS-991, TCGS-969, TCGS-1043 and TCGS-894 recorded higher photosynthetic rates with low transpiration rates, thereby recording higher total dry matter accumulation and other growth parameters viz., LAI, LAD, NAR and CGR. The study revealed positive correlations among leaf area, leaf dry weight and total plant dry matter. Similarly, LAI recorded positive correlation with CGR.
Among the two surrogate methods used for evaluating WUE of the groundnut genotypes, SLA established negative correlation with pod yield. In contrast, SCMR showed positive correlation with pod yield. However, a negative correlation was observed between SLA and SCMR indicating the importance of unit amount of chlorophyll content per unit leaf area. The genotypes TCGS-991, TCGS-969, TCGS-1043 and TCGS-894 recorded low SLA and high SCMR and thus were found to be of high WUE types. It is imperative to note that above genotypes have also maintained cell membrane integrity and high photosystem II activity when exposed to high temperatures (52°C) and revealed their intrinsic abilities to tolerate high temperatures.

The genotypes varied significantly in yield and yield components. TCGS-991 and TCGS-1043 recorded significantly higher pod yields and shelling percentage with lower Harvest Index. The genotypes TCGS-969 recorded significantly higher pod yield as well as Harvest Index than best checks. Among various drought tolerant traits used, SCMR and photosynthetic rates recorded positive correlation with yield and in contrast SLA showed negative correlation. No other drought tolerant trait showed association with any of the yield components.

In conclusion, TCGS-1071 can be exploited in breeding programmes for high root mining abilities. The cultivars, TCGS-969, TCGS-991, TCGS-1043 and TCGS-894 with high WUE, thermotolerance and moderate root mining abilities can be exploited either as donor source in breeding programmes or may be promoted for multi-location testing under rainfed conditions for making recommendation.
The field study was conducted during kharif, 2010 and was laid out in randomized block design (two factorial) replicated thrice to assess the effect of boron application at time of anthesis (four levels of B control, 0.2 ppm, 0.4 ppm and 0.8 ppm) on performance of seven rice genotypes IET 20979, IET 21007, IET 21106, IET 21114, IET 21519, IET 21540 and Rasi (check).

Among different B levels, 0.4 ppm B treatment gave maximum yield (691 g m$^{-2}$) than control (651 g m$^{-2}$). Among different genotypes, IET 20979 performed better in terms of growth and yield components resulting in significantly higher grain yield (722 g m$^{-2}$) over the check (676 g m$^{-2}$). B nutrient content was also significantly greater in genotype IET 20979 in all plant parts (leaf, stem and grain). The interaction effect between B treatment and genotypes was significant with respect to grain yield and yield components and they were maximum at 0.4 ppm B spray in IET 20979.

Genotypes did not show any significant effect on LAI, SCMR values, leaf weight and culm weight in early stages as treatment was given at flowering stage whereas leaf weight (IET 21519), culm weight (IET 21540) and TDM were significantly increased after B (0.4 ppm) treatment. B significantly influenced reproductive growth in rice genotypes. IET 20979 at 0.4 ppm B spray gave maximum panicle fresh weight and panicle dry weight. IET 21519 genotype possessed highest number of spikelets, number of filled grains (0.4 ppm), high density grain weight and high density grain number (0.8 ppm) B spray. Rasi (check) showed maximum pollen viability and stigma receptivity at 0.4 ppm B spray. B did not vary significantly for panicle number per m$^{-2}$, primary and secondary branches.

This study has revealed that application of boron had resulted increase in grain yield of rice genotypes. IET 20979 and IET 21519 responded more positively to boron application. Increase in grain yield was recorded when B applied at 0.4 ppm as grain and leaf B content showed positive correlation with yield.
PLANT PHYSIOLOGY

Author : UMAMAHESWAR REDDY, K
Title of the thesis : EVALUATION OF RICE (Oryza sativa L.) GENOTYPES FOR TERMINAL HEAT STRESS TOLERANCE
Major Advisor : Dr. A. SIVASANKAR
Degree : M.Sc. (Ag.)
College : COLLEGE OF AGRICULTURE, RAJENDRANAGAR
Accession Number : D 8902

An experiment was carried out at Directorate of Rice Research, Rajendranagar, Hyderabad during kharif, 2010-2011 in Split-Plot design with treatments (Control and high temperature) as main plot treatments and genotypes as sub-plot treatment with 25 rice genotypes. The high temperature treatment was imposed by covering the one set of genotypes with polyethylene sheet to raise the temperature and allowed to grow inside the enclosure from panicle initiation until physiological maturity.

The crop phenology, physiological traits, reproductive characters and yield components were significantly affected by the high temperature stress and such affects varied with rice genotypes. Under high temperature stress conditions crop duration was reduced where such reduction in grain filling was maximum in TRIGUNA, while it was least affected in IET 20944.

Physiological traits viz. water potential; membrane thermostability and chlorophyll content (SPAD chlorophyll meter readings) and chlorophyll fluorescence were significantly affected by high temperature stress over control (normal temperature). Among the genotypes IET 20915, IET 20893 and IET 21513 were found superior in terms of membrane thermostability, further these genotypes also recorded higher values of chlorophyll fluorescence (Fv/Fm ratios) terms of photosystem II efficiency. Genotypes JAYA, IET 20893 and IET 21510 exhibited less reduction in water potential with high temperature stress. The genotypes superior for the membrane thermostability, chlorophyll fluorescence and water potential viz. IET 20907, IET 20915 also exhibited higher photosynthetic rates compared to other genotypes under high temperature stress conditions.

Reproductive traits such as pollen viability, spikelet fertility were significantly affected by high temperature stress conditions over control in all genotypes. Genotypes found superior in term of pollen viability were JAYA, IET 20915 and IET 20926 had higher spikelet fertility under high temperature stress compared to other genotypes.

Yield attributes such as panicle size (primary and secondary branches), dry matter production and harvest index, were significantly reduced under high temperature stress.
Number of spikelets m$^{-2}$, 1000 grain weight and grain yield were significantly reduced in rice genotypes under high temperature stress conditions. Genotypes which are higher values of pollen viability, spikelet fertility and secondary branches in panicles recorded higher grain yield were IET 20926, IET 20893, JAYA, and IET 21510.

Hence, it is concluded that superior performance in terms of higher membrane thermostability, chlorophyll and photosynthetic characters together with higher values of pollen viability lead to higher fertility, and stem reserve mobilization resulted in higher grain yield under high temperature stress conditions which could be taken as traits for thermotolerance in rice. Based on the above traits, rice genotypes viz. JAYA, IET 20926, IET 20893, IET 208907 and IET 20894 were ranked as tolerant to high temperature stress conditions from panicle initiation to physiological maturity while TRIGUNA, IET 20744, IET 20925, IET 20935, IET 20923, and IET 21528 were ranked susceptible.
The present studies were conducted in the Department of Seed Science and Technology and the Department of Entomology, College of Agriculture, Rajendranagar, Hyderabad with the objective to evaluate the relative toxicity of newer insecticides; the residual toxicity of newer insecticides on per cent mortality, adult emergence, oviposition, per cent seed damage, germinability, seed vigour and moisture content upto 40 days and also to study per cent weight loss besides the above parameters for a period of five months under storage.

The mortality response and relative toxicity of selected newer test insecticides viz., spinosad, abamectin, emamectin benzoate, novaluron, lufenuron, neem and the check deltamethrin against the adults of *C. chinensis* was studied. The LC$_{50}$ values based on bioassay studies indicated that among the newer insecticides, abamectin exhibited greater toxicity both at 24 and 48 hours of exposure. The relative toxicity of spinosad, abamectin, emamectin benzoate, novaluron, lufenuron and neem were 0.4694, 2.6116, 0.4317, 0.0179, 0.1325 and 0.0019 at 24 hours and 0.3874, 2.8507, 0.3429, 0.0280, 0.1282 and 0.0028 at 48 hours of exposure compared to check deltamethrin. Thus the insect mortality and toxicity of insecticides increased marginally at 48 hours.

Residual toxicity of newer insecticides on green gram seeds was determined upto 40$^{th}$ day of treatment at various concentrations of insecticides. Per cent mortality and adult emergence of *C. chinensis*, per cent seed germination, seed vigour, per cent moisture content and per cent insect damage was recorded after 40 days. Abamectin showed 100 per cent mortality at 5 DAT, emamectin benzoate at 6 DAT, while spinosad and deltamethrin took more than 7 days, whereas, novaluron, lufenuron and neem recorded relatively low mortality rates. Spinosad, abamectin, emamectin benzoate and deltamethrin recorded lower adult emergence of 16, 17, 32 and 28, respectively, while spinosad treated seeds showed lower moisture content (8.0%), per cent seed damage (0.0%) and oviposition (5.6 eggs) than all other treatments.

In storage abamectin recorded higher germination per cent upto five months followed by emamectin and deltamethrin. Spinosad recorded highest (98%) germination at first month of storage which decreased to 50.33 per cent after fifth month. Vigour index of abamectin was consistently superior to other treatments upto five months Abamectin and deltamethrin showed
low moisture content throughout the storage period. Abamectin, emamectin benzoate and
deltamethrin recorded less oviposition by *C. chinensis* even though spinosad showed very less
oviposition in the beginning. Abamectin had lower adult emergence upto five months, whereas,
spinosad recorded lower emergence at first month and thereby increased adult emergence. Seed
treatments on the per cent weight loss of green gram showed that abamectin (3.73%),
emamectin benzoate (5%) and deltamethrin (4.13%) recorded least loss in seed weight at 5
MAT.

Seed treatment of green gram for residual studies showed the greater effectiveness of
spinosad for shorter periods (40 days) only, while abamectin was effective in relative toxicity,
residual toxicity and storage studies. Thus abamectin recorded the least seed damage of *C.
chinensis* followed by deltamethrin and emamectin benzoate. In spinosad no seed damage was
observed at 1MAT which increased constantly upto 28.66 per cent at 5MAT.
The present investigation was undertaken with an objective to estimate seed nutritional and quality traits and their correlation in normal and quality protein maize (QPM) genotypes. The material for investigation comprised of six quality protein and four normal maize inbred lines and was grown in Randomized Block Design in three replications at College of Agriculture, Rajendranagar during Kharif, 2010. Significant genotypic differences were observed for all the characters studied viz., plant height, days to 50 per cent tasseling and silking, number of rows cob\(^{-1}\), number of seeds row\(^{-1}\) and seed yield.

Study on nutritional traits indicated that protein and oil content were of higher magnitude in case of normal maize genotypes compared to QPM genotypes however the quality of protein was superior in case of QPM. Quality protein maize genotypes exhibited nearly two fold increase in lysine and tryptophan content and in addition to that they had higher starch and fiber content compared to normal maize genotypes. The genotypes like BQPML 5280 and BQPML 5175 of quality protein maize were found to be superior in nutritional parameters estimated for both quality and quantity. In normal maize lines BML 40410 exhibited superior nutritional qualities compared to other genotypes.

The seed quality of maize parental lines was estimated using various physiological quality tests. Initially, QPM genotypes exhibited high seed quality than normal maize. During storage gradual reduction in the nutritional and seed quality parameters was observed. After four months of storage, among the nutritional quality parameters the maximum reduction was observed in starch content and the minimum reduction was observed in fiber content. However, in seedling quality attributes vigour index was found to be highly sensitive to storage and this can be effectively used to rank the seed lots under storage. Quality protein maize lines like BQPML 5280 and BQPML 5199 and normal maize genotypes like BML 7 and BML 40410 registered better nutritional and seed quality parameters.

The correlation studies revealed positive association of seed yield plant\(^{-1}\) and yield components such as cob length, cob girth, number of seed rows cob\(^{-1}\) and number of seeds row\(^{-1}\). Quality protein and normal maize lines exhibited different associations between nutritional and seed quality parameters. In QPM genotypes protein, oil and starch registered positive
correlation with all seed quality parameters where as lysine and tryptophan content recorded negative correlation. However, in case of normal maize protein content exhibited negative correlation with all seed quality parameters while oil and starch content registered positive correlation with all seed quality parameters. Among all the physiological quality tests used for evaluating the seed quality of maize genotypes accelerated aging and vigour index I were found to be positively correlated with field emergence. However, cold test and vigour index II were unable to predict the field emergence in case of quality protein maize genotypes.
Maize grown in more than 166 countries for diverse uses, in different seasons and different agro-ecological conditions. In India, maize is grown in a wide range of climates, extending from extreme semi-arid to sub-humid to temperate conditions. The total cultivated area for maize in India is 8.17 million hectares having production of 19.73 million tonnes with average productivity of 2.41 tonnes ha\(^{-1}\) (2009-10). The maize area under irrigation has increased marginally from \(\sim 11\%\) (1950-51) to only \(\sim 20\%\). Most of the crop area under rainfed condition suffers from abiotic stresses like moisture stress, high and low temperature stress, salinity and nutrient stresses frequently limit growth and productivity of major crop species such as maize. High temperature stress has been the 2\(^{nd}\) major abiotic problem after drought that reduces grain yield by more than 15 per cent. Therefore, to sustain the agricultural production it is necessary to breed varieties which are tolerant to high temperature stress. An efficient technique called Temperature Induction Response (TIR) Technique was developed for identifying high temperature tolerant lines.

By employing TIR protocols have been standardized in maize. Optimum lethal and induction temperatures were assessed for seedling survival and growth during recovery. Using these protocols, 15 maize hybrids were screened for temperature tolerance. The results revealed that 53°C for 3 h where the mortality of seedlings was 80 per cent was considered as optimum lethal temperature and 52°C for 2 h considered as optimum lethal temperature for recovery growth where there was 80% reduction in growth. 35°C – 1h + 40°C – 1h + 45°C – 2h was considered as optimum induction temperature for both seedling survival and growth during recovery as there was maximum recovery after inducing them to lethal temperature. By using these protocols, genotypes like Kaveri50, 30V92 and RHM25 were identified as temperature tolerant and KHM218, GHM145, GK3060, and BIO9637 as temperature susceptible genotypes. The experiment material was further validated by allowing the seedling to grow up to 21 days in plastic containers and their growth was assessed. The supporting data for temperature tolerance was recorded in terms of two parameters namely dry weight and chlorophyll content. Upon perusal of data it has been clear that induction treatments influenced all the growth stages studied. The TIR protocols can be used to screen straight varieties / single cross hybrids that have become popular with seed companies and also farmers.
The varietal characterization and purity assessment are important for maintenance, multiplication, seed certification of cultivars and quality control aspects. Varietal development and its identification is one of the most important aspects to seed industry for seed trade.

The present investigation was undertaken with an objective to characterize 40 varieties of pigeonpea using morphological characters and molecular markers.

A set of 21 qualitative and quantitative morphological traits and 54 SSR markers were used for characterization and diversity analysis of pigeonpea varieties. Out of the 21 characters observed, plant height, days to 50% flowering and maturity, and 100 seed weight were more useful for characterization of the varieties. The genetic diversity analysis involving the variable quantitative traits for the 40 varieties resulted in the grouping of these varieties into seven clusters, thereby confirming their usefulness in discrimination of the pigeonpea varieties.

A total of 54 SSR markers were employed for the present study, of which 22 markers were polymorphic. The polymorphic information content (PIC) for these primers ranged from 0.609 to 0.929.

The cluster analysis based on Jaccard’s similarity coefficient using UPGMA grouped the varieties into seven major clusters. The similarity coefficient among the varieties ranged from 0.20 to 0.82.

The cluster analysis based on morphological and SSR data did not show perfect congruence in clustering patterns. However, a very low correlation existed ($r = 0.0117$) and the SSR markers provided more definitive separation of clusters indicating their better discriminating power than morphological traits.
Grey mold disease of castor caused by Botrytis ricini Godfrey is potentially a very destructive disease, and became a serious problem now-a-days wherever the crop is grown. Study on etiology and symptomatology of the disease, seedborne nature, effect of B. ricini on seed quality parameters, effect of seed health testing methods on the growth of the pathogen, location of B. ricini infection in castor seed, seed to seedling transmission studies, bioassay of fungicides and bioagents was carried out during the present investigation.

The pathogen induced typical grey mold symptoms both under field and artificially inoculated conditions. The characteristic symptoms include grey cob webby wooly growth on flowers and capsules leading to rottenning and softening; hollow mature seed with discoloured seed coat and loss in seed weight; irregular light brown lesions with distinct margins often covered by grayish mouldy growth of the pathogen on the leaves; and hanging down and breaking of tender branches and spikes.

The pathogen was isolated from infected host plant capsules, purified and identified as Botrytis ricini Godfrey based on cultural and morphological characters and the pathogenecity was proved using castor cv. DCS-9.

In moist blotter incubation, 13 fungi viz., Aspergillus flavus, Fusarium verticilloides, Rhizopus spp., Verticillium spp., Alternaria alternata, Aspergillus niger, Phoma spp., Acremonium apii, Trichothecium roseum Cladosporium spp, Curvulario lunata were found associated with seeds of the castor cv. DCS-9. In naturally infected seeds, the incidence of Fusarium semitectum was the highest (37.5 and 35 per cent in unsterilized and surface sterilized seeds respectively). In artificially inoculatd seeds, the incidence of Botrytis ricini was highest (22.5 and 17.5 per cent in unsterilized and sterilized seeds respectively). The association of B. ricini in naturally infected and artificially inoculated (sterilized and unsterilized) seeds was observed, indicating that the pathogen is seedborne in nature. Mean seed quality parameters viz., germination, oil content and seedling vigour index were significantly higher in healthy seeds than B. ricini infected seeds, whereas moisture content was high in B. ricini infected seeds than healthy seeds of castor cv. DCS-9.

Among the five seed health methods tested, maximum growth and sporulation of B.
*B. ricini* was observed on V8 juice agar method followed by castor leaf extract method, whereas, very less growth of *B. ricini* was observed in deep freeze method.

Among the different parts of castor seed *B. ricini* incidence was maximum in caruncle and seed coat in both naturally infected and artificially inoculated seeds. Whereas, *B. ricini* incidence was totally absent in embryo in both naturally infected and artificially inoculated seeds.

Transmission of the fungus from seed to seedling (5 per cent in paper towel method and 2.5 per cent in soil method) was observed in artificially inoculated unsterilized seeds. Maximum seed rotting was observed in paper towel than sand and soil methods. In paper towel seed rotting was maximum (80 per cent) in naturally infected unsterilized seeds and germination percentage was higher (85.0 per cent) in artificially inoculated sterilized seeds. Seedling mortality and seedling infection were very low when compared to seed rotting. In soil seedling infection was very low (2.5 per cent) whereas in sand, seedling infection was totally absent.

Among all the fungicides and biocontrol agents tested against *B. ricini*, carbendazim (0.2%) and *T. viride* (0.4%) were found to be most effective in reducing *B. ricini* incidence whereas hexaconazole and *Bacillus* spp. were found to be least effective in reducing *B. ricini* incidence.

Incidence of *B. ricini* was minimum in seeds treated with carbendazim (0.2%) followed by carbendazim + mancozeb (0.25%) and *T. viride* (0.4%) in blotter method. In paper towel method seeds treated with carbendazim (0.2%) showed maximum germination, shoot, root lengths, shoot, root dry weights and seedling vigour index followed by *T. viride* (0.4%) and carbendazim + mancozeb (0.25%). In sand method, maximum germination, shoot, root lengths, shoot, root dry weights and seedling vigour index was recorded in seeds treated with *T. viride* (0.4%) followed by carbendazim (0.2%).

The disease incidence was found to be lowest when sprayed with carbendazim (0.2%) followed by carbendazim + mancozeb (0.25%) and the reduction in disease over control was maximum with carbendazim (0.2%) followed by carbendazim + mancozeb (0.25%) and *T. harzianum* (0.4%) on the detached racemes of castor cv. DCS-9 under controlled conditions.
Experiments were conducted during 2010-11 in the Department of Entomology and Department of Seed Technology, College of Agriculture, Rajendranagar, Hyderabad. The losses caused by *S. zeamais* in maize seed was assessed based on adult emergence, weight loss (per cent), damaged seeds (per cent), germination and seedling vigour. Relative toxicity of various seed protectants was also studied.

Mean adult emergence ranged from 49.50 to 307.75 over a storage period of six months where high adult emergence was recorded in the sixth month (307.75) and few in the first month (49.50). Weight loss and damaged seed due to *S. zeamais* in maize varied significantly over a period of six months where weight loss ranged from 0.71 to 9.24 per cent while damaged seed ranged from 13.94 to 48.24 per cent. The maize weevil affected germination and vigour index where it was reduced to a maximum of 41.94% and 61.00% respectively.

Studies made on the effect of certain seed protectants against *S. zeamais* revealed that among all the treatments, malathion was found to be superior in causing maximum mortality of adults (91.79%) seven days after treatment. This was followed by abamectin causing mortality of 52.50%. Spinosad has recorded a mortality of 42.14% while deltamethrin recorded 41.79%. Emamectin benzoate was recorded as the least effective with only 28.21% mortality. When adult emergence of *S. zeamais* was observed one month after treatment of maize seeds with seed protectants no adult emergence was observed from any of the treated seeds.

Treatment of seeds with insecticides had no impact either on seed germination, seedling vigour index or moisture content of the seed. Germination in the case of treated seeds ranged from 89 to 93 per cent, highest being recorded in spinosad treated seed (93.00%) followed by deltamethrin (91.00%) while, vigour index ranged from 2162 to 2089, where deltamethrin recorded maximum vigour index of 2162. The seed moisture of treated seeds did not vary significantly over the untreated control, where the seed moisture content ranged from 12.71 to 13.24 per cent during period of storage.

Relative toxicity studies conducted on the insecticides showed that deltamethrin was most toxic to *S. zeamais* with LC$_{50}$ value of 6.85 followed by abamectin (7.26) and malathion (7.30). Emamectin benzoate has 404.60 followed by spinosad with 100.12 as LC$_{50}$ values that were
found less toxic. The order of relative toxicity of the insecticides based on LC$_{50}$ values after 24 hours period of exposure in the descending order was deltamethrin (1.06) > abamectin (1.005) > malathion (1.00) > spinosad (0.07) > emamectin benzoate (0.01). The adult mortality increased marginally at 48 hrs after exposure. Deltamethrin remained as the most toxic insecticide (LC$_{50}$ = 5.35 ppm) even after 48 hours of exposure. The LC$_{50}$ values were 225.75, 55.46, 5.85 and 6.33 ppm for emamectin benzoate, spinosad, abamectin and malathion, respectively where the order of decreasing relative toxicity values was deltamethrin (1.18) > abamectin (1.08) > malathion (1.00) > spinosad (0.11) > emamectin benzoate (0.02).
Irrigation induced problems of water logging and salinity are noticed in many canal commands in India. Pilot studies conducted in some of these command areas demonstrated the potential of subsurface drainage for the control of salinity and water logging, and the improvement of agricultural productivity. Modeling studies provide further insight into salt and water balances during the reclamation process and are useful to make long-term predictions. In this study, DRAINMOD model is evaluated using a 7-year (2002 to 2009) dataset collected from a subsurface drained experimental field (7.5 ha) located geographically at about 15° 28' N latitude and 80° 28' E longitude near Appikatla village in the Krishna Western Delta in Andhra Pradesh, India. The subsurface drainage system consists of two sub-fields with drains installed at two different spacing's of 30 and 60 m. The model was calibrated by using observed data from the pilot area (7.5 ha) considering an equivalent drain spacing of 50 m during the period from 2004 to 2006 and validated using the observed data from 2007 to 2009. The model predicted variables like drain flow, depth to water table, soil salinity and relative yields of paddy crop were in good agreement with observed data as indicated by good statistical model performance measures (Nash-Sutcliffe model efficiency) EF of 0.57, 0.78, 0.72 and 0.30 and Coefficient of correlation(R) of 0.88, 0.97, 0.90 and 1.00 during calibration period and EF of 0.90, 0.69, 0.64 and -0.42 and R of 0.99, 0.88, 1.00 and 0.99 during the validation period. The Root Mean Square Error (RMSE) of 20.7, 13.4, 6.8 and 6.5 and Percent Error (PE) of -4.3, 1.0, 2.01 and 3.7 during calibration period and RMSE of 16.0, 23.2, 10.3 and 40.6 and PE of 15.0, -3.9, 10.22 and 13.9 during the validation period.

The sensitivity value showed that drain flow was highly sensitive to drain depth (0.56) followed by surface storage (0.35), drain spacing (-0.26), drainage co efficient (0.18), distance from surface to impervious layer (-0.15), lateral saturated hydraulic conductivity of layer III (0.15) and K₂ (0.07). There is no effect of initial water depth on drain flow. The model has demonstrated potential to reconstruct the pre-drainage situation at the pilot area. Without drainage system, average (2002- 2009) annual soil salinity increased by 29.5%, crop yield reduced by 6% respectively. As the drain spacing increased from 30 m to 70 m, the average (2002-2009) annual drain flow decreased from 26.54 to 21.13 cm, soil salinity increased from 2488 to 2645ppm and the paddy crop
yield decreased from 95.33 to 93.25% respectively. As the drain depth increased from 0.6 m to 1.4 m, the average (2002-2009) annual drain flow increased from 19.51 to 28.00 cm, soil salinity decreased from 2643 to 2233 ppm and the paddy crop yield increased from 93.25 to 95.33% respectively. The DRAINMOD model showed the potential to simulate the performance of subsurface drainage system at Appikatla.
In the present day context, the human right to water is indispensable for leading a healthy life. Water is a precious natural resource, a basic human need and a prime natural asset. Only 0.016% water is available in lakes and only 0.0001% water is flowing in streams, rivers and drains. With good irrigation structures, proper storage of water in the monsoon and proper irrigation practices, water can be utilized judiciously and efficiently. Particularly in India the water comes as rainfall only during monsoon rains in 3 months of the year. Hence the alternative way is to build big and massive irrigation reservoirs to store the water.

One of the best alternatives found is effective implementation of Lift Irrigation Scheme (LIS) of the natural rivers, drains or streams. The underlying principle is diverting the water to the high elevated topographic lands where irrigation by gravitational contour canals is not possible. This also augments the ground water reservoir. Keeping in view of the importance of lift irrigation schemes and keeping above felt needs of the farmers in to consideration, the present study “Quantity, Quality and Usage Assessment of irrigation water of lift irrigation schemes established on Nallamada Drain in Krishna Western Delta”, has been taken up to study the quality and quantity aspects of the drain water of Nallamada drain to quantify the pumped water and its impact on beneficiary farmers and to study the socio economic aspects of the farmers under lift irrigation scheme on Nallamada drain. Detailed investigations on various aspects of lift irrigation schemes were carried out and the following findings and conclusions were drawn.

It is found that Drain flows from September to December months during 2005-2009 are in the range of 3 - 4.5 TMC. January to April and August months the outflow quantities are in the range of 0.5 to 1.5 TMC. It is estimated that on an average about 43.84 TMC of water flows through the drain annually. The Electrical Conductivity of
drain water up to the end of March, 2009 was less than 1.0 dS/m which indicates that this water is fit for irrigation indicated that the water was fit for irrigation.

Further, the perusal of data shows that pH values of the drain water ranges to be below 8.0 up to December 2008, and between 8.0 - 9.0 during January 2009 - March 2009. SAR values were within the safer limit of less than 10.0 and RSC is found to be less than 2.50 meq/l during September 2008 to March 2009. As Majority of the drain flow is joining the sea, the crop shifts might be recommended for effective leaching and also ground water recharge after thorough analysis of the impact of water table rise, salinity buildup due to capillary rise in the root zone of the crop with a due importance to high productivity and socio economic benefits.

It is found that on average a total quantity of water flow in Nallamada command in a year is 43.84 TMC, in addition to the 6 TMC of water being used by all the Lift Irrigation Schemes above the gauging station for all the crops under Nallamada command in Krishna Western Delta. The quantified 43.84 TMC of drain water is flowing as environmental flows. Under the Nallamada command, it is estimated that the large share of water is utilized for Cotton crop and the less being utilized for bengal gram. The studied Nagulapadu lift irrigation scheme is designed with an irrigation efficiency of 90 per cent.

It is also found that Maize was the most profitable crop as the net returns were observed to be as Rs. 63750 per hectare per year and also the returns on every rupee of expenditure was Rs. 2.90, followed by chilli Rs. 2.30, tobacco Rs.1.30, Cotton Rs. 0.9 and bengal gram Rs. 0.23 for the beneficiary farmers. In case of non - beneficiaries, chilli is the most beneficial crop with a net returns of Rs.138250 per year per hectare and returns on rupee expenditure was Rs. 1.04 and followed by tobacco Rs.0.46, cotton Rs. 0.45, bengal gram Rs. 0.22 and Maize Rs. 0.06 respectively.

During socio - economic survey of beneficiary and non beneficiary farmers in the five randomly selected villages under Nagulapadu lift irrigation scheme, efforts were made to analyze the socio- economic and gender impact of lift irrigation scheme on the lives of deprived farmers. Farmers responded that they are well aware of the assured irrigation helped in increasing the crop yields. There by their income levels increased. Women farmers are of the opinion that their quality of life has been improved after introduction of lift irrigation scheme. They opined that with the increased income levels, they had much better opportunity to provide medical and education facilities for their children. Owing to increased farm income, the beneficiary farmers had better access to the credit facilities from the financial institutions like banks and co-operative societies.
SOIL AND WATER ENGINEERING

Author : RAMANA REDDY, G.V.

Title of the thesis : DESIGN OF SEMI-PERMANENT SPRINKLER IRRIGATION SYSTEM AND ITS PERFORMANCE EVALUATION

Major Advisor : Dr. K. YELLA REDDY

Degree : M. Tech. (Ag. Engg.)

College : COLLEGE OF AGRICULTURAL ENGINEERING, BAPATLA

Accession Number : D 9087

In India, National and State Governments have been spending crores of rupees to promote the concept of Micro-irrigation systems among the farmers and to take up these installations. But the concept of Micro-irrigation especially sprinkler irrigation is not being much popularized due to improper designs by the respective subsidy program implementing agencies, lack of awareness among the farmers about the system operation, maintenance, lack of agronomical support & after sale services to the systems installed by the micro-irrigation companies. Several case studies about the performance of conventional portable sprinkler irrigation systems have revealed that a maximum of 8 to 10% of the supplied units under government subsidy programs are only performing well and the rest are being operated below the satisfactory levels.

At the time of present study, during interaction with the farmers, it was expressed that better performing with less cumbersome and cost effective sprinkler irrigation system is badly needed for them to overcome the present problems of non uniform spray covering less area of wetting etc. It automatically shows that the farmers are fully realized the importance of an efficient semi permanent sprinkler irrigation system in comparison with flood irrigation and conventional sprinkler systems.

Design of semi-permanent sprinkler irrigation system was felt very much essential for the farming community to reduce their overall investment costs towards irrigation in addition to overcome the labor problems for some extent. So far, attempts made for improvement of designs on this research need was very limited. Hence, an attempt was made to bring a reasonably good and cost effective semi-permanent sprinkler irrigation system design in the present study.

The present study mainly focused on the design of semi-permanent sprinkler irrigation system with some improvements over the existing portable and SPSI systems operated by the farmers of Andhra Pradesh. The performance of the designed semi-permanent sprinkler irrigation system was evaluated at field level and the results were compared with the performance of previously existing such systems in addition to several conventional portable sprinkler irrigation systems.
The total system head loss with the telescopic sub main (75mm Ø for 36m, 63mm for 60m and 40 mm Ø for 24m), telescopic laterals (32 mm for 24m and 25 mm Ø for 12 m) and risers of 25mm Ø for 1.5 m long was observed to be 3.99m. where as the telescopic lateral was extended to 48m (32 mm Ø for 24m and 25 mm Ø for 24m, keeping the riser dimensions as same), the total system head loss was found to be 4.97m. The total system head losses in above cases were found to be within the permissible limits of 20% allowable pressure variation within the system from the operating pressure of 25m head.

The performance of sprinkler irrigation system developed at present and the conventional system as control was evaluated based on Christiansen Uniformity coefficients (CUCs) by using Catch Can method. It was observed that the C_u of developed semi-permanent sprinkler irrigation system was 91.1% when system operating pressure was 2.5 kg/cm² with rotating impact sprinklers at a discharge of 0.67 lps.

The total annual cost for both portable SI and SPSI systems were estimated and found that there was a cost reduction of 60.64% in SPSI system (Rs. 7,955.00) over the portable SI system (Rs. 20,213.00). Taking these total annual costs of both the systems into the account and field data collected like crop yield and cost of cultivation from the farmers the benefit cost ratio was calculated. It was observed that the SPSI system designed was more beneficial with B C ratio of 1:1.98 over the portable SI system (B C ratio of 1:1.07). Therefore, the SPSI system designed in the present study was found cost effective over the portable SI system for the farmers.

Regarding the study about the performance comparison of developed system with already available semi-permanent sprinkler irrigation and portable conventional sprinkler irrigation systems which are in practice by the farmers was conducted in Ananthapur, Kadapa and Nalgonda Districts. It was observed that almost all the systems were operating at a low pressure (i.e., pressure ranges from 0.9 to 1.2 kg/cm²), due to which the overlapping of sprinklers and spray pattern was non uniform.

Finally, it can be concluded that the technical feasibility study for successful operation of sprinkler irrigation systems, either portable or semi-permanent/permanent is highly essential before taking up the installation. This research work will certainly be useful as a prerequisite for the implementing agency/organization before deciding the type of sprinkler irrigation system in the farmers’ fields.
Irrigation is a costly and scarce input in agricultural and plays an important role in increasing food production. It is important that the water requirements of crops are known at different management levels within the irrigated area to accomplish effective irrigation management. In order to apply irrigation water efficiently, the water requirement of the crops are to be estimated accurately. Agriculture being the major water consumer in the ambit of multiple uses of water resources, it emphasizes better knowledge on crop water requirement, planning and scheduling of crops with the internationally accepted state of art of predicting models. When supplied unchecked, every consumer, either a farmer or an industrialist or a domestic users, is tempted to use more water, for no extra gain. In most of the irrigation projects, the farmer in the upper reach of the canals over use the irrigation water leaving the tail end farmers starve for water. In the past, due to non availability of sufficient quantities of water in reservoirs canal water was supplied at much lesser rates than normal rate. Inspite of that, the farmer got good yields of previous years this raised question that whether the farmer has been applying more than the required irrigation water or the estimation of crop water requirements was incorrect. Unscientific and injudicious application water in considerable parts of the canals commands in the state of Andhra Pradesh has also resulted in rise of water table and development of salinity. In order to avoid excess irrigation, there is a need to estimate the crop water requirement accurately and compare them with the actual amounts of water applied in the field. Several computer models are now available to estimate the crop water requirements like CROPWAT, CRIWAR etc. Hence a study was conducted on a pilot scale in one of the major distributory viz., Appapuram channel of Kommamur canal of Krishna Western Delta (KWD) system. In the present study, the CROPWAT model was used to estimate crop water requirements of Appapuram channel in Krishna Western Delta.

The methodology consisted of the following main steps; data collection, estimation of water requirements and execution of the linear programming model and evaluation of the modeling results. The first step of this work was the collection of
primary and secondary data about agronomic and economic aspects of agricultural systems of Appapuram channel command area in Krishna Western Delta. The following weather parameters were collected for the period 2000-2010 on a daily basis: air temperature and humidity, wind speed, solar radiation and precipitation. These data were used for the calculation of reference evapotranspiration by using Penman-Monteith equation. Other agronomic parameters acquired during the field visits to the study area included the soil characteristics (texture and depth), the period and length of growing season, water use per crop, water availability on a monthly basis, types of irrigation system and its efficiency, crop productivity under specific input of water, crop coefficient data etc. Data about management and economic aspects were also collected which included total available area, irrigated area, farm size, main cropping pattern in the study area. The second step of this work was dedicated to the estimation of crop water requirements and irrigation requirements for each crop on a weekly/monthly basis. This analysis was done by using CROPWAT and model for the actual cropping pattern in the Appapuram canal command of Krishna Western Delta. Canal operation plan was prepared for average meteorological data for the decade. Canal operation plans were also prepared for good/normal/deficit years. The Linear Programming model proposed in the present study integrates the reservoir level and a field level decision. It considers the soil-moisture status and the reservoir storage as the state variables and the applied irrigation depths as decision variables. The formulation was based on the conceptual model for soil moisture accounting and the reservoir storage continuity relationships.

It was estimated that the gross crop water requirement for Appapuram channel command area to irrigate 8880 ha registered and 4000 ha unregistered ayacut during kharif season and maize 4000 ha during rabi to be 122.82 M. cum. It was estimated the gross crop water requirement for Appapuram channel command area to irrigate 8880 ha registered and 4000 ha unregistered ayacut for paddy during kharif season and maize of 4000 ha during rabi to be 132.7 M. cum in normal/deficit year. The canal operation plan was prepared for estimated gross water requirement for Appapuram channel command area for different scenario. Linear Programming was developed and was effective tool to optimize benefit during deficit years.

Gross Water Requirement (GWR) and Gross Irrigation Requirement (GIR) were effectively calculated using Penman-Monteith method using CROPWAT simulation programme and could be adopted for large scale implementation under large canal network systems. Accuracy of estimation of GWR and GIR at command level greatly depends on the cropping pattern followed and staggering of crops sown in the command area. Estimation of seepage losses in the canal network system greatly influences accuracy of the estimation of GWR/GIR. Gross Water Requirement (GWR) under Appapuram Channel Command was estimated to be ranging from 123 – 133 M.cum. The contribution of effective rainfall towards GWR ranged from 52 - 67 M.Cum indicating the fact that almost 40% - 55% of GWR was met from the effective rainfall itself. The major findings of the present research had clearly demonstrated that the average percentage of excess water released was estimated 32 to 101 % and there was considerable scope to improve the match between irrigation demand and canal supply. To match the irrigation supply vs demand, irrigation water measurements should be made
mandatory at head regulator and at branch canals and distributories. The modernization works of Appapuram Channel should therefore be focused on addressing these issues. Linear Programming model was developed and was effective tool to optimize benefit during deficit years. Sensitivity analysis of the developed LP model was carried out for various water allocations to the command area ranging from 10 to 60 M.Cum. Analysis showed that total cropped area was ranged from 700 ha to 13400 ha with net benefit estimated to range in between Rs. 23 millions to Rs. 1261 millions. Validation of the developed LP model with reference to the ground truth values to be carried out for wider adaptability.

This study was found to be useful for analyzing the performance of the commands in terms of water distribution, water deliveries and crop acreages etc., throughout the year covering Kharif and Rabi seasons.
SOIL AND WATER ENGINEERING

Author : UDAYA BHASKAR, Y.
Title of the thesis : “RESPONSE OF POTATO TO IRRIGATION AND NITROGEN FERTIGATION”
Major Advisor : Dr. V. RAMULU
Degree : M. Tech. (Ag. Engg.)
College : COLLEGE OF AGRICULTURAL ENGINEERING, BAPATLA
Accession Number : D 9086

A field experiment was conducted at Water Technology Centre, College farm, College of Agriculture, Rajendranagar, Hyderabad during Rabi 2010-11 to study the “Response of Potato to Irrigation and Nitrogen Fertigation”. The experiment was laid out in a strip plot design with four main treatments (Irrigation levels) viz., I₁ - Drip irrigation at 1.2 E pan, I₂ - Drip irrigation at 1.0 E pan, I₃ - Drip irrigation at 0.8 E pan and I₄ - surface irrigation at 1.0 IW/CPE and three sub treatments (Nitrogen levels) viz., N₁-150 Kg ha⁻¹, N₂-100 Kg ha⁻¹ and N₃-50 Kg ha⁻¹ and the treatments were replicated thrice. The experimental soil is sandy clay loam with low in available nitrogen, high in available phosphorus and potassium. The fertigation was scheduled once in eight days as per the treatments.

The plant height and LAI were maximum with drip irrigation scheduled at 1.2 E pan at all the four growth stages. Among the fertilizer levels application of N at 150 kg ha⁻¹ recorded maximum plant height and LAI and it was significantly superior over other treatments. The total number of tubers and prime tubers (>60 g) per plant at harvest was significantly affected by fertilizer levels only. Irrigation and N fertilizer levels have no significant effect on the number of non prime tubers per plant (<60 g). The drip irrigation scheduled at 1.2 E pan with application of N at 150 kg ha⁻¹ recorded the highest tuber, haulm and total dry matter production. The least number of tubers and total dry matter production was observed in surface irrigation scheduled at 1.0 IW/CPE with application of N at 50 kg ha⁻¹ while the least haulm dry matter production was recorded with drip irrigation scheduled at 0.8 E pan with application of 50 Kg N ha⁻¹. The highest potato tuber yield (19.01 t ha⁻¹) was recorded in drip irrigation scheduled at 1.2 E pan with application of 150 Kg N ha⁻¹ while the least tuber yield (9.5 t ha⁻¹) was observed with surface irrigation at 1.0 IW/CPE with application of 50 Kg N ha⁻¹. The tuber yield per plant also followed the similar trend.

Nitrogen levels significantly influenced the tuber N and haulm K content. Irrigation levels significantly influenced haulm K content. Both irrigation and nitrogen levels significantly influenced the tuber P and haulm N content while both of them have no influence on haulm P content. Maximum uptake of nutrients (N, P and K) was observed with drip irrigation scheduled at 1.2 E pan and was on par with drip irrigation
scheduled at 1.0 E pan in both haulms and tubers while in case of nitrogen levels, significantly higher uptake was obtained with application of 150 Kg N ha\(^{-1}\). Among the irrigation levels, drip irrigation scheduled at 1.2 E pan recorded higher Nitrogen use efficiency (177.8 Kg tubers Kg N\(^{-1}\)) while drip irrigation scheduled at 1.0 E pan recorded higher water use efficiency (44.15 Kg ha mm\(^{-1}\)). The least NUE and WUE were observed in surface irrigation at 1.0 IW/CPE. Among the nitrogen levels, maximum NUE (220.1 Kg tubers Kg N\(^{-1}\)) was recorded with application of N at 50 Kg ha\(^{-1}\) while the least (101.5 Kg tubers Kg\(^{-1}\)N) was recorded with application of N at 150 Kg ha\(^{-1}\) whereas maximum WUE was recorded with application of N at 150 Kg ha\(^{-1}\) (46.89 Kg ha mm\(^{-1}\)) while the least was recorded with application of N at 50 Kg ha\(^{-1}\) (33.93 Kg ha mm\(^{-1}\)). The protein content of potato tuber was significantly influenced by nitrogen levels only. Drip irrigation scheduled at 1.2 E pan and application of 150 Kg N ha\(^{-1}\) recorded the highest tuber starch content and was found superior to rest of the irrigation and nitrogen levels.

Among drip irrigated treatments maximum net returns (Rs.1,09,416 ha\(^{-1}\)) and BC ratio (2.29) was recorded in drip irrigation scheduled at 1.2 E pan while the least net returns (Rs.57,533 ha\(^{-1}\)) and BC ratio (1.16) were observed with surface irrigation at 1.0 IW/CPE. Application of 150 Kg N ha\(^{-1}\) recorded maximum net returns (Rs.1,03,975 ha\(^{-1}\)) and BC ratio (2.16) among the nitrogen levels.

It can be concluded that for optimum production of potato drip irrigation scheduling at 1.0 E pan with application of N at 150 Kg ha\(^{-1}\) will be the best combination under the present Agro climatic conditions of Andhra Pradesh.
Availability of surface water resources in a river basin is a key and critical parameter in water resources planning and management. Estimation of water resources through conventional methods at spatio-temporal scale is a huge task and hence cannot be repeated and carried out in near real time scale. In view of this, spatial information technologies such as Remote Sensing (RS) and GIS methods have been explored for this purpose and made use for the study of surface water dynamics vis-à-vis rainfall pattern, its distribution and seasonal crop area estimates. The present study has used satellite data from IRS P6 – Resourcesat-1 AWiFS sensor for the years 2004-2011 to study the surface water spread dynamics. Automated water spread extraction algorithm developed by NRSC has been used for the quick processing of satellite data and delineate inter/intra seasonal surface water spread areas for the last 7 years during Kharif and Rabi seasons. The trends in surface water spread area (WSA) variations have been presented at river sub basin level, and also at Godavari basin level and relationships with rainfall pattern, seasonal crop area estimates were also discussed in detail in the study. It was observed that the maximum water spread is 5.09 lakh ha out of Geographical area of 30 Mha of Godavari basin which is 1.69 %; and minimum water spread is 2.45 lakh ha (0.81%) during 2004-05 and 2010-11 respectively. However, the majority of years had water spread area of ~ 4.00 lakh ha and above. It was noted that the 50-70% of surface water spread is contributed from larger water bodies across the sub-basin and rest is from smaller irrigation tanks / rain fed tanks. Hence, the study results can be made use for inputs to the development of indicators for the assessment of agricultural drought which occurs in many parts of the country in India. Satellite derived seasonal crop areas indicate that Kharif crop area grown in Godavari basin is ranging from 127.91 lakh ha (2005-06) to 150.48 lakh ha (2009-10). Rabi crop area grown in Godavari basin is ranging from 48.90 (2004-05) to 69.51 lakh ha (2010-11). It appears that the WSA observed during Sep/Oct will have direct relationship with the Rabi crop area in different study years. The efforts made in this study on surface water spread dynamics are very fruitful and huge database on Godavari basin has been generated in respect of spatio-temporal satellite data water spread. The results are very much relevant for the climate change study groups. Quick image processing techniques that were used for automatic
delineation of water bodies, and the approach can be extended to conduct the similar analysis at national level to study the impact of climate change on the availability of water resources in India.
The present investigation was carried out under field conditions during 2010 in kharif season to study the effects of integrated nutrient management on performance of tomato crop in terms of yield and nutrient uptake. The transformation of applied N and K into various fractions in relation to their availability was studied besides monitoring the changes in soil enzymatic activity. The experiment was conducted in randomized block design with ten treatments replicated thrice. The treatments include, T₁ (Control), T₂ (50% RDNF through inorganic fertilizer + 50% RDNF through vermicompost), T₃ (75% RDNF through inorganic fertilizer + 25% RDNF through vermicompost), T₄ (100% RDNF through vermicompost), T₅ (100% RDNF through inorganic fertilizer), T₆ (50% RDNF through inorganic fertilizer + 50% RDNF through poultry manure), T₇ (75% RDNF through inorganic fertilizer + 25% RDNF through poultry manure), T₈ (100% RDNF through poultry manure), T₉ (50% RDNF through vermicompost + 50% RDNF through poultry manure) and T₁₀ (50% RDNF through inorganic fertilizer + 25% RDNF through vermicompost + 25% RDNF through poultry manure).

The soil under study was slightly alkaline (7.9) in reaction, non saline (0.13 dS m⁻¹) in nature and low in organic carbon (4.6 g kg⁻¹), low in available nitrogen (230.7 kg N ha⁻¹), medium in available phosphorus (25.4 kg P₂O₅ ha⁻¹) and potassium (284.5 kg K₂O ha⁻¹).

The effect of different treatments were evaluated in terms of dry matter production (vegetative, flowering and at harvest) and tomato fruit yield. Plant samples were analyzed for their per cent nutrient composition with respect to N, P and K at vegetative, flowering and at harvest and nutrient uptake was computed. The fresh fruit samples ware analysed for quality viz., ascorbic acid and lycopene contents. Soil nutrient status with regard to available N, P₂O₅ and K₂O were studied at vegetative, flowering and at harvest of tomato crop. The influence of INM was evaluated for soil biological health by assaying soil urease, phosphatase and dehydrogenase activities. The results of the experiment showed that the performance of tomato crop improved significantly with integrated use of vermicompost or poultry manure and nitrogen fertilizers when compared to application of either recommended doses of N as inorganic fertilizer or organic manures alone.
The nutrient uptake, dry matter, fruit and haulm yields of tomato were highest under 25 per cent level of organic manure application in combination with 75 per cent of inorganic fertilizer. Application of organic manures in combination with inorganic fertilizer increased the availability of nutrients to tomato crop at different growth stages. Urease activity was highest under 25 per cent level of organic manure application in combination with 75 per cent of inorganic fertilizer, while the phosphatase and dehydrogenase activities were highest under 100 per cent organic manure applied plots.

Among the different treatment combinations, highest fruit yield (84.97 q ha\(^{-1}\)) was recorded at T\(_3\) (75% RDNF + 25% VC) followed by T\(_7\) (75% RDNF + 25% PM) and T\(_5\) (100% RDNF). However, the values were on par with each other and superior over other treatments. The quality parameters viz., ascorbic acid (30.83 mg 100g\(^{-1}\)) and lycopene content (4.05 mg 100g\(^{-1}\)) were influenced by organic manures. Gross returns were highest under 25 per cent level of organic manure application in combination with 75 per cent of inorganic fertilizer followed by 100 per cent inorganic fertilizer alone. However, net returns and B:C ratio were highest under 100 per cent inorganic fertilizer followed by 25 per cent level of organic manure application in combination with 75 per cent of inorganic fertilizer because of cost prohibitiveness of VC and PM. Based on the results of this study, it can be concluded that the combined use of 75% RDNF + 25% of N through VC or PM is the best for obtaining highest yield apart from maintaining soil biological activity and soil fertility for longer period.
A research problem was undertaken during 2010-11 to study the nutrient status of cotton growing areas of Guntur division in Guntur district of Andhra Pradesh. Representative surface soil samples were collected covering fifteen mandals of Guntur division before sowing of cotton crop. The soil samples were analyzed for their physico-chemical properties. During the square formation and flowering stage, index leaves were collected from the same locations. The leaf samples were analyzed for their nutrient contents as it will give an idea about the plant nutrient status. Finally the cotton kapas yield data was collected from the same locations. The correlation studies were carried out between yield with soil available nutrients and plant nutrient concentrations and also between available soil nutrients with leaf nutrient concentrations.

The soil samples of the cotton growing areas of Guntur division were found to be mildly alkaline and non saline. These soils were low in organic carbon content and soil available nitrogen content but medium to high in available phosphorous content. Most of the soils were rich in available potassium content with exception in sporadic patches. The secondary nutrients were found in sufficient quantity. With regards to the micronutrient contents, the soil samples were sufficient in available manganese and copper but deficient in available iron and zinc content.

The nitrogen concentration in the cotton index leaves were found to be low in both square formation and flowering stage and the concentration also decreases from square formation to flowering stage. During the crop growth period due to heavy rainfall water logging condition prevailed, which may hinders the nitrogen uptake by the plant. The phosphorus and potassium concentration of the leaves were high and their amount decreases from square formation stage to flowering stage. The analyzed leaf samples were rich in calcium content but water logging situation in some areas cause lowering of magnesium concentration in the leaves. All the micronutrients were found in sufficient levels in the index leaf samples irrespective of their availability in soil. This signifies that due to deep rooted nature of cotton crop, it can trap the nutrients from the deeper depths of the soil to meet its nutritional demand.
This year the cotton kapas yield is low (mean 2920 kgha-1) due to abrupt weather condition and severe sucking pest infestation during the crop growth period. The correlation studies revealed that significant positive correlation exist between available potassium and calcium with the yield while magnesium, sulphur and zinc showed significant negative correlation with the yield. In case of leaf nutrient concentration, nitrogen and manganese concentration during flowering stage were having significant positive correlation with the yield but potassium and calcium had significant negative correlation with the yield. The available phosphorous and calcium showed significant positive correlation with the zinc concentration of leaves at square formation stage while available zinc had significant positive correlation with the leaf calcium content. During the square formation stage significant negative correlation existed between organic carbon content of soil and leaf sulphur content. Both available calcium and magnesium showed significant negative correlation with the potassium content of leaves. The available copper had significant negative correlation with leaf copper content at square formation stage but during flowering stage the available copper showed significant positive correlation with the leaf copper content. Significant positive correlations existed between available nitrogen content to the leaf potassium, available potassium, calcium and magnesium with the leaf phosphorous content at flowering stage. The available potassium and magnesium had also significant positive correlation with the iron content of leaves in the flowering stage of crop growth. The available calcium had significant positive correlation with the leaf nitrogen content but it had also significant negative correlation with the magnesium concentration of leaves during flowering stage.

The study indicates that phosphorous application can be skipped for one season without reduction in yield along with split application of nitrogen and potassium to get the sufficiency ranges at square formation and flowering stages which can finally reflect the higher yields.
A field experiment was taken up at Agricultural Research Station farm, Mudhole, Adilabad District during the years 2006-07 and 2007-08 to find out the optimum requirement of nutrients (Mg, Zn and B) for cotton crop as sole and intercropped with soybean. The experimental soil was clay loam (Vertisols), deficient in magnesium (24.17 kg ha\(^{-1}\)), Zinc (0.54 mg kg\(^{-1}\)) and boron (0.39 mg kg\(^{-1}\)) having pH 8.62. The fourteen treatments consisted of Magnesium, Zinc and Boron each three levels and under methods of application; combined soil application of zinc and Boron, combined soil application of Magnesium, Zinc and Boron, combined foliar application of Magnesium, Zinc and Boron, application of FYM and control (only RDF). The trial was laid out in a split plot design with two main treatments i.e., 1. Sole cotton, 2. Cotton intercropped with soybean and fourteen sub treatments replicated thrice. The test crop varieties used were PCH2 Bt for cotton and JS 335 for soybean.

Soil application of 25 kg ZnSO\(_4\) ha\(^{-1}\) along with foliar application of 0.2% ZnSO\(_4\) at 45, 60 and 90 days after sowing significantly increased the cotton stalk yield (3084 kg ha\(^{-1}\)), mean bolls plant\(^{-1}\) (58.75), boll weight (4.71 g), kapas yield (1718 kg ha\(^{-1}\)), lint yield (685 kg ha\(^{-1}\)), cotton seed yield (1033 kg ha\(^{-1}\)), soybean seed yield (732 kg ha\(^{-1}\)) and zinc content (71.84 mg kg\(^{-1}\)) and uptake (170 g ha\(^{-1}\)) by the plant and this treatment is on par with soil application of 50 kg ZnSO\(_4\) ha\(^{-1}\).

Soil application of 5 kg borax ha\(^{-1}\) coupled with foliar application of 0.15 % borax at 60 and 90 DAS significantly increased the cotton stalk yield (3500.28 kg ha\(^{-1}\)), mean bolls plant\(^{-1}\) (56.33), boll weight (5.41g), kapas yield (1974 kg ha\(^{-1}\)), lint yield (742 kg ha\(^{-1}\)), cotton seed yield (1232 kg ha\(^{-1}\)), cotton seed oil yield (244 kg ha\(^{-1}\)), soybean seed yield (841 kg ha\(^{-1}\)), soybean seed oil yield (173 kg ha\(^{-1}\)) and Boron content (57.96 mg kg\(^{-1}\)) and uptake (162.30 g ha\(^{-1}\)) by the plant and this treatment is on par with soil application of 10 kg borax ha\(^{-1}\). Soil application of 10 kg borax ha\(^{-1}\) significantly increased the fibre length over all treatments.

Foliar application of 1.0 % MgSO\(_4\) at 45, 60 and 90 DAS significantly increased the cotton stalk yield (3036.55 kg ha\(^{-1}\)), bolls plant\(^{-1}\) (57.94), boll weight (4.21g), kapas yield (1535.46 kg ha\(^{-1}\)), cotton seed yield (953 kg ha\(^{-1}\)), soybean seed yield (953 kg ha\(^{-1}\)) and magnesium content (0.52 %) and uptake (11.85 kg ha\(^{-1}\)) by the plant and this treatment is on par
with soil application of 25 kg MgSO$_4$ ha$^{-1}$ with three foliar application of 1.0% MgSO$_4$ at 45, 60 and 90 days after sowing.

Combined soil application of 50 kg ZnSO$_4$ + 10 kg borax ha$^{-1}$ significantly increased the boll weight (5.31g), kapas Yield (1881.92 kg ha$^{-1}$), fibre length (32.19 mm) and soybean seed yield (802 kg ha$^{-1}$) over soil application of 50 kg ZnSO$_4$ ha$^{-1}$ alone. Addition of 50 kg MgSO$_4$ ha$^{-1}$ to the above treatment significantly increased the boll weight (5.44 g), kapas yield (1984.42 kg ha$^{-1}$), nutrient content and uptake.

Combined foliar application of 1.0% MgSO$_4$ + 0.2% ZnSO$_4$ + 0.15% borax significantly increased the bolls plant$^{-1}$ (47.93), lint yield (673.64 kg ha$^{-1}$) and fibre length (32.04 mm).

Application of nutrients significantly increased content and uptake of nitrogen and potassium in cotton. Application of magnesium marginally increased phosphorus uptake in cotton. Nitrogen and phosphorus content and uptake in cotton increased with soil application of 25 kg MgSO$_4$ ha$^{-1}$ + foliar application of 1.0% MgSO$_4$ at 45, 60 and 90 days after sowing. Potassium content and uptake in cotton increased by soil application of 5 kg borax ha$^{-1}$ + foliar application of 0.15% borax at 60 and 90 days after sowing.

Application of nutrients did not influence soil pH, EC, available nutrients (N and P) except K. Soil application of 50 kg MgSO$_4$ ha$^{-1}$ registered the highest available K (438 kg ha$^{-1}$) in post-harvest soil.

Intercropping of soybean with cotton did not affect the yield and quality parameters of cotton. On the other hand the system productivity was increased by 41% in cotton + soybean intercropping.
Two hundred representative soil samples (100 – surface and 100 – sub-surface) were collected from twenty four mandals of Nellore and Gudur divisions of Nellore district by following the sampling technique. The soil samples were analysed for various physical, chemical and physico – chemical properties.

The soils were found to be neutral to strongly alkaline (surface - pH 6.47 to 10.27 and sub-surface – pH 6.53 to 12.95) in reaction. The lowest and highest values were observed in A.S.Pet mandal. The ECe of surface and sub-surface varied from 0.12 to 63.80 and 0.17 to 64.50 dSm\(^{-1}\) with a mean value of 3.77 dSm\(^{-1}\) (slightly saline) and 2.91 dSm\(^{-1}\) (slightly saline). The highest value was observed in Muthukuru mandal and lowest in Rapuru mandal.

The soils of the divisions are low in organic carbon, low to high in available nitrogen, medium to high in available phosphorus and high in available potassium. The soils were calcareous in nature, having high calcium carbonate content. The sub – surface soils had higher calcium carbonate content than surface soils with high cation exchange capacity (10.48 to 81.88 cmol (p+) kg\(^{-1}\)). Texturally they are classified under clay, clay loam, sandy clay, sandy clay loam, sandy loam and loam.

Exchangeable calcium and magnesium and available sulphur were found to be above critical limit. Among the DTPA extractable micronutrient cations manganese, copper and iron were found in amounts well above critical limit, whereas the soils were deficit in zinc (69%). The most dominant exchangeable cation was calcium followed by magnesium, sodium and potassium with mean values of 17.19, 13.83, 3.00 and 0.65 cmol (p+) kg\(^{-1}\) respectively. Exchangeable sodium percentage ranged from 0.90 to 56.50 per cent with a mean value of 10.92 per cent. The lowest value was found in Thotapalligudur mandal and highest value was observed in Doravarisatram mandal. Soil pH had a significant and positive correlation with calcium carbonate, exchangeable sodium and had significant negative correlation with available iron. Soil ECe had a significant and positive correlation with exchangeable calcium and ESP.

Thirty two percent of surface samples were found to be neutral in reaction and about 45 per cent of soils comes under mildly alkaline and about 12 per cent of soils were strongly
alkaline in reaction. Out of 100 surface soil samples 81, 7, 4, 1 and 8 per cent of soils were non-saline, slightly saline, moderately saline, strongly saline and very strongly saline respectively.

Among the 100 surface soil samples 12.5 per cent of samples were found to have more than 15 ESP and 29 per cent of samples were observed in between 10 to 15, whereas remaining 58.5 per cent of soil recorded less than 10 ESP. The Management practices required for their reclamation were leaching of soluble salts under saline conditions, application of gypsum and growing dhaincha for the reclamation of sodic soils.
SOIL SCIENCE AND AGRICULTURAL CHEMISRY

Author: KALYANI, K.

Title of the thesis: POTASSIUM STATUS OF CAULIFLOWER (Brassica oleracea var. Botrytis) GROWING SOILS OF RANGAREDDY DISTRICT IN RELATION TO THE SHORT TERM AND LONG TERM AVAILABILITY

Major Advisor: Dr. V. SAILAJA

Degree: M.Sc. (Ag.)

College: COLLEGE OF AGRICULTURE, RAJENDRANAGAR

Accession Number: D 8908

Potassium, an essential plant nutrient with diverse role to play in plant metabolism is required in large amounts by most crops. Although most soils contain large amounts of K, many times the soil fails to supply adequate amounts of the nutrient to meet the normal needs of the plants and responses were observed to its application. Keeping this in view an investigation was carried out to study extensively various aspects of K nutrition of cauliflower. Surface soils in bulk were collected from thirty locations of Rangareddy district and pot culture experiment was carried out. The soils were analysed for their salient characteristics besides conducting incubation studies under laboratory conditions to understand the release pattern of K from soils. Inorganic K fractions were analysed to evaluate the relative efficiency of extractants in determining the available K.

The soils under study are light textured, slightly acidic to slightly alkaline and non saline. The cation exchange capacity of the soils was in the range of 14.39 to 20.02 c mol (P+1) kg⁻¹. The soils were low in organic carbon content ranging from 0.11 to 0.65 per cent, with low to medium available N content of 231.1 to 306.5 kg ha⁻¹, low to medium P2O5 of 10.2 to 48.43 kg ha⁻¹ and medium to high in K2O of 121.5 kg ha⁻¹ to 542.9 kg ha⁻¹.

The level of extraction of K by different extractants followed the order: Boiling HNO3 (1 M) > NaBPh4 (0.2 M) > Citric acid (0.01 M) > NH4OAc (NN) > Oxalic acid (0.01 M) > Acetic acid (0.01 M). Among all the inorganic K-fractions, boiling HNO3 (1 M) extracted higher amounts of K ranged from 654 mg kg⁻¹ to 1794 mg kg⁻¹ with a mean of 1407 mg kg⁻¹.

The contents of K_L (quantity factor) ranged from 0.07 to 1.21 (Mean of 0.382). The AR_K (intensity factor) showed a range of 0.11 to 17.1 (ML⁻¹)¹/² × 10⁻³ with a mean of 3.304 (ML⁻¹)¹/² × 10⁻³. The PBC_K (c mol (P+) kg⁻¹/(ML⁻¹)¹/² × 10⁻³) ranged from 0.025 to 5.727 with a mean value of 0.45.

The release of K was significantly increased from 15 DAI the highest K release was obtained at 60 DAI then it was declined at 90 and 120 DAI.
The mean curd yield was 352.4 g plant$^{-1}$ in the control which showed a significant increase to 454.8 g plant$^{-1}$ with the application of 150 kg K$_2$O ha$^{-1}$. The response to the applied K in terms of curd yield was only 12.2 per cent on Mominpet soil with high native K fertility, where as it was 52.5 per cent with Emamguda soil with low available K. The mean response to the application of K was 25.28 kg cauliflower curd per kg of potassium applied. The mean K uptake was 0.52 g plant$^{-1}$ in the control which significantly increased to 1.01 g plant$^{-1}$ with the application of 150 kg K$_2$O ha$^{-1}$. Application of 150 kg K$_2$O ha$^{-1}$ resulted in 59 per cent increase in the NH$_4$OAc extractable K as against control. Among all the extractants 1N NH$_4$OAc extractable K showed higher positive correlation with curd yield ($r = 0.975^{**}$). It had a significant positive correlation with NaBPh$_4$ (0.2 M) extractable K ($r = 0.926^{**}$). The critical limits of available K for cauliflower growing soils of Rangareddy district were found to be 120.8 and 334.2 ppm respectively for NH$_4$OAc (N N) and NaBPh$_4$ (0.2 M). The critical plant K content of cauliflower was found to be 2.6 per cent.
In the present study twenty representative pedons were selected based on topography from various physiographic units identified in Agri Bio Diversity Park of Acharya N. G. Ranga Agricultural University, Rajendranagar, Hyderabad and on the basis geomorphic units, soils were selected from Upland, Midland and Lowland. All the pedons were studied for their morphological characteristics and horizon wise samples were processed for physical, physico-chemical and chemical characteristics. Based on morphology and analytic data profiles were characterized and classified. The soils were very shallow to deep (5 to 60 cm), dark red to very dark greyish brown (2.5 YR 3/6 – 10YR 3/2), excessively well drained. The results showed that variation in soil properties strongly influenced on land form and topography. The analysis of soils indicated that the upland soils are shallow, midland and lowland soils are medium to deep, but along the slope the depth of soil increased along with other physical properties like clay, water holding capacity, infiltration rate and bulk density. The pH is neutral to moderately alkaline (6.5 to 8.04), low to high in organic carbon (0.18 to 0.96 %), low to medium in CEC (11.5 – 26.5 c mol (p+) kg-1). The base saturation indicated that non-fertile to very fertile and soil texture was sandy loam to sandy clay loam with variation in relation to physiography. The upland soils were exhibiting higher bulk density, particle density and lower water holding capacity, midland and lowland soils were recorded higher infiltration rate and clay percentage. In all soils pH, OC and CEC were consistently increased with depth. The organic carbon content and CEC were higher in lowland soils, which might be due to the clay translocation and organic carbon content accumulation. The soils are low to medium in available N (92.3 to 351.5 kg ha-1), low to medium in available P (6.22 to 28.2 kg ha-1), low to high in available K (93.1 to 293.4 kg ha-1), deficient to sufficient in available S (7.1 to 21.2 mg kg-1). The available micro nutrients are sufficient in all the profiles.

Based on morphological, physical, physio-chemical, chemical and meteorological data, soils were classified according to the revisions of USDA soil taxonomy (2006), that out of 20 profiles ten profiles (P4, 5, 7, 9, 10, 11, 12, 13, 19 and 20) belongs to order of Inceptisols, six profiles belongs to order of Alfisols and other remaining are Entisols. All soils were classified up to the family level. The upland soils classified as coarse loamy, Iso-megathermic, Typic,
Ustorthents (P16, 15 and 18). Further, the profiles P4, 5, 10, 11, 12 and 20 were classified as coarse loamy, Iso-megathermic and Haplustepts and P2 were fine loamy, Iso-mega thermic, Typic Rhodustalfs.

The soils of Agri Bio Diversity Park were classified on the basis of Landscape position that is uplands, midlands and lowlands. Uplands recorded primarily Entisols (P8, 15, 16 and 18) and midland soils with one Inceptisol indicating a transition from Entisols to later Inceptisols. Further Uplands also recorded Inceptisol, where the pedogenic process and the soil development initiated through horizination. The Alfisols were observed in the midlands (P2, 3, and 6) and lowlands (P1, 11 and 17), illustrating the development of a matured profiles, with a good depth in all horizons with sequence. The study evidently indicate that the topographically and relief plays an important role in soil development.

The detailed soil survey was conducted in Agro Bio Diversity Park. Topographical map by using instrument total station was developed with scale 1:2500. Further, on the basis of the topographical and planimetric data, two sites were identified for the construction of check dams with an ultimate objective of conservation and management at 0.5 contour interval was prepared.

The soil resource inventory for identifying the soil related constraints has been prepared based on field survey and laboratory investigation. Further the major constraints like erosion, runoff and drainage resulting in soil material loss must be controlled with a combination of various practices in a system approach especially with trees, crops and an abiotic component may be integrated for the restoration and conservation of soil and land resources including native flora and fauna insitu. Hence appropriate soil and water conservation practices needed to be undertaken simultaneously to conserve and preserve the native flora and fauna which are found in Agro Bio Diversity Park of Acharya N.G. Ranga Agricultural University, Hyderabad. It is concluded that characterization and classification of Agri Bio Diversity Park soils basic information at initial stage is useful to overcome the soil management constraints for further development and maintenance of park in better way.
SOIL SCIENCE AND AGRICULTURAL CHEMISTRY

Author : RAMA LAKSHMI, CH.S.

Title of the thesis : VERMICOMPOSTING FOR EFFECTIVE WASTE MANAGEMENT AND ITS EVALUATION UNDER INM IN RICE-PULSE CROPPING SYSTEM

Major Advisor : Dr. P. CHANDRASEKHAR RAO

Degree : Ph. D.

College : COLLEGE OF AGRICULTURE, RAJENDRANAGAR

Accession Number : D 9098

The present investigation was carried out at Regional Agricultural Research Station, Anakapalle during 2009 and 2010, to study the nature and properties of humic substances and to monitor the changes in nutrient status and enzyme activities during composting and vermicomposting of different organic residues i.e sugarcane trash, weeds, vegetable market waste and paddy straw. After preparation of different composts, field experiments were conducted in rice-pulse cropping system for evaluation of different vermicomposts. The results revealed that the duration of vermicomposting varied from 55 to 60 days for various organic residues under study, while it took almost 110 days for composting. Total organic carbon and C/N ratio decreased with the passage of time during vermicomposting and composting in all the organic residues, however the percent decrease was more in vermicomposting than composting in a particular period of time. Total nitrogen content of different vermicomposts and composts increased during composting process, however more increase was observed in vermicomposting than composting. In both the composts, highest and lowest total nitrogen was recorded in vegetable market waste and paddy straw, respectively. In both the composts paddy straw recorded the highest C/N ratio while vegetable market waste exhibited lowest C/N ratio. At the end of vermicomposting i.e at 60 days the C/N ratio was reduced to 21.60, 12.70, 11.34 and 21.57 in cane trash, weeds, vegetable market waste and paddy straw, respectively. Whereas in composting the C/N ratio at maturity (110 days) was 24.71, 13.76, 12.73 and 24.89 in cane trash, weeds, vegetable market waste and paddy straw, respectively. The humic and fulvic production increased with incubation in both the composting methods and in all the treatments. At the end of vermicomposting significant increase in humic acid content (10.85 %) was recorded in vegetable market waste than cane trash and paddy straw vermicompost. A well known index for humification is the HA/FA ratio, in both the composts paddy straw compost recorded minimum ratio and maximum ratio was recorded in vegetable market waste compost. In both the composting methods the total nitrogen content of humic acid was found to increase with the progress of the composting, while reverse trend was noticed with C/N ratio. Comparatively the total nitrogen content of humic acid was more in vermicomposts than composts. Functional group analysis in different vermicomposts showed that, as incubation proceeded there was an increase in contents of total acidity, carboxyl groups and phenolic OH groups. At the end of composting higher total acidity and carboxylic groups of humic acid was recorded in vegetable market waste, while phenolic groups were higher in composts and vermicomposts obtained from
paddy straw. In both the composting methods the enzyme activity (urease, phosphatase, dehydrogenase and cellulase) decreased with increasing the composting period in all the organic residues. However highest urease, phosphatase and dehydrogenase activity was recorded in vegetable market waste compost, while lowest in paddy straw compost. Whereas cellulase activity was high in paddy straw and low in vegetable market waste and weed composts. Almost 50 to 55 % increase in dehydrogenase activity in vermicomposting than composting and 48 and 26 % increase of acid and alkaline phosphatase activity in vermicomposting than composting. It was observed that total NPK and micronutrient content in both the composts were significantly higher in vegetable market waste compost with narrow C/N ratio and the reverse trend was followed in cane trash and paddy straw. Reduction in pH was observed in all matured composts compared to their initial values.

Evaluation of different vermicomposts under rice-pulse cropping system revealed that the organic carbon content, macro and micronutrient status was increased with the incorporation of different vermicomposts than 100 % chemical fertilizer treatment, however all the treatments were significantly superior over control. Among different treatments 75 % RDFN+ vegetable market waste compost @ 2.5 t ha⁻¹ performed better in all aspects and it was on par with 75 % RDFN + weed vermicompost @ 2.5 t ha⁻¹ and 50 % RDFN+ vegetable market waste compost @ 2.5 t ha⁻¹. Among different treatments, humic substances were significantly higher in T₇ (75 % RDFN + vegetable market waste @ 2.5tha⁻¹). The humic acid and fulvic acid obtained from the selected treatment (T₇) showed that the potentiometric titration curves were sigmoidal in nature suggesting weak acidic character of these fractions. The conductometric titration curves of humic fractions indicated that they behave as weak acids which can be due to slow increase in conductance with the addition of NaOH to neutralize its acidity. Urease, phosphatase, dehydrogenase and cellulase activities at different growth stages of the crops gradually increased over the age of the crop and attained higher activity at flowering and gradually decreased at harvest. Significantly higher nutrient uptake was recorded in all the INM treatment than 100 % chemical fertilizer treatment, however it was superior than absolute control. At flowering and at harvest higher nitrogen uptake was recorded in the treatment which received 75 % RDFN+VMWVC @ 2.5 tha⁻¹ to kharif rice over 100 % recommended dose of chemical fertilizer. Among different INM treatments, 75 % RDFN in combination with different vermicomposts (T₅ to T₈) recorded significantly high grain and straw yields compared to 50 % RDFN in combination with different vermicomposts i.e T₁ to T₄. However, higher grain yield (5.85 t ha⁻¹) was recorded in 75 % RDFN+ VMW VC @ 2.5 t ha⁻¹ and it was on par with 50 % Prathista organic manures + 50 % chemical fertilizers (5.80 t ha⁻¹), 75 % RDFN+ WVC @ 2.5 tha⁻¹ (5.60 t ha⁻¹) and 100 % Prathista organic manures (5.60 t ha⁻¹).

Cumulative and residual effects of Integrated Nutrient Management practices of kharif rice on rabi greengram revealed that, all the cumulative treatments showed higher values of soil nutrient status, humic and fulvic acid content, enzyme activities and nutrient uptake by green gram than their corresponding residual treatments in both the years. Further it was also observed that in both cumulative and residual effects the treatment which received 75 % RDFN + VMW VC @ 2.5 tha⁻¹ during preceding rice crop performed better in all aspects. All the cumulative effects recorded higher seed yields than their respective treatments for residual effects. The over all effect of chemical fertilizers were found to be lower than integrated use of different vermicomposts with respect to soil nutrient status, enzyme activity, humic substances, growth and yield of both rice and greengram during both the years.
The treatment with 100% Prathista Organic manures (T_{11}) is highest profitable among all the treatments (BCR = 2.92) and it was closely followed by T_{7}; 75% RDFN + VMWVC @ 2.5 t ha^{-1} (BCR = 2.81) and least profitable is absolute control i.e T_{10} (BCR=1.65). In *rabi* greengram, both cumulative and residual treatments are profitable. Highest profitable treatment in both cumulative and residual effects was T_{7} (3.85 and 3.76) followed by T_{12} (3.76 and 3.65), T_{6} (3.73 and 3.64) and least profitable is absolute control i.e T_{10} (2.08 and 1.64).
A crop nutrient survey was conducted in Karimnagar, Nizamabad and Warangal districts of Andhra Pradesh covering 30 mandals and 150 maize fields for developing the DRIS foliar diagnostic norms for N, P, K and Zn and to identify the yield limiting nutrients in maize. The population was divided into low (122 observations) and high yielding groups (28 observations) based on the third quartile method for developing the DRIS foliar diagnostic norms. A wide variation in soils and management practices were noticed in selected maize fields under study. Index leaf samples were collected from all the selected fields at tasseling/silking stage and analyzed for N, P, K, Zn, Cu, Fe and Mn contents. A wide range of variation in chemical composition in index leaves was observed irrespective of yield level. Based on the Critical Nutrient Concentration (CNC), N, P, Zn and Cu contents in index leaf samples of Maize under study were deficient to an extent of 73, 12, 17 and 1 per cents respectively, and no deficiencies were observed with respect to K, Fe and Mn. The extent of nutrient deficiencies diagnosed by CNC method were changed depending up on the critical level adopted. Negative or low correlation coefficients were found between grain yield and nutrient concentration of Fe and Mn. However, grain yields were often correlated with N, P, K, Zn and Cu content in corn leaves. Based on the highest variance ratio between low and high yielding populations, forms of expression for different nutrients and their norms were selected. DRIS norms were established for various nutrient ratios obtained from high yielding population of maize crop and were further utilised to compute the DRIS indices, which assessed the yield limiting nutrients and their requirement in order of priority. The DRIS derived sufficiency ranges for N, P, K and Zn from nutrient survey of corn crop in three districts were 2.27 to 2.72, 0.23 to 0.39, 2.43 to 2.87 per cent and 26.6 to 66.2 mg kg\(^{-1}\), respectively. The number of nutrients diagnosed as yield limiting by DRIS is more than those identified by the CNC method. The extent of deficiencies observed by DRIS indices was also more when compared to that of the conventional Critical Nutrient Concentration (CNC) method in case of P, K and Zn but it was vice versa in case of N. The majority of the nutrients identified as deficient by CNC method also find place among the nutrients diagnosed as limiting by DRIS method indicating the adequacy of any nutrient is to be judged better in terms of its level in relation to the other nutrients, which is the basic philosophy of the DRIS method. The DRIS indices computed for the corn crop, identified not only the yield limiting nutrients, but also prioritized the deficiencies, which varied from field to field. Nutrient diagnosis with DRIS indices was found to be more appropriate in identifying the yield limiting nutrients than the conventional critical nutrient concentration (CNC) method for getting the high yields of maize.
Two experiments one with factorial nutrient combinations of N, P, K and Zn and another response study was conducted during Kharif 2010 to assess the effectiveness and validity of developed DRIS norms. The good yield response and shifting of priority of yield limiting nutrients were observed with the application of first two limiting nutrients in priority. Similarly, in factorial experiment, few selected treatmental combinations were studied to know the progressive diagnosis of nutrients which clearly indicated the effectiveness and validity of derived DRIS norms and indices in this study. Thus, DRIS indices were found to be more appropriate and effective than conventional Critical Nutrient Concentration (CNC) in identifying the yield limiting nutrients in maize and thereby getting increased yields with their rectification.
A field experiment was conducted on a sandy clay loam soil (Typic Haplustalfs) during rabi, 2009-10 at wet land farm, S.V. Agricultural college (ANGARU), Tirupati. The experiment was laid out in a Randomized block design with factorial concept. The treatments comprised of 3 levels of pressmud cake (0, 5 and 10 t ha$^{-1}$) and 4 levels of gypsum (0 kg ha$^{-1}$, 500 kg ha$^{-1}$ at basal, 500 kg ha$^{-1}$ at flowering and 500 kg ha$^{-1}$ each at basal and flowering) with 12 treatment combinations and replicated thrice. The groundnut variety Narayani was selected as a test crop.

Application of pressmud cake significantly decreased the pH of the soil from 0 to 10 t ha$^{-1}$ whereas application of gypsum significantly increased the pH of the soil. Further, application of different levels of gypsum significantly increased the E.C of the soil.

Application of pressmud cake significantly increased the available N, P, K, Ca, Mg, S, Fe, Zn, Mn and Cu of the soil from 0 to 10 t ha$^{-1}$ and application of pressmud cake @ 10 t ha$^{-1}$ recorded the maximum available N, P, K, Ca, Mg, S, Fe, Zn, Mn and Cu in soil. Application of gypsum also significantly increased the available N, P, K, Ca, Mg and S in soil and the maximum available N, P and K were recorded due to application of gypsum @ 500 kg ha$^{-1}$ each at basal and flowering. The interaction effect between gypsum levels and pressmud cake levels on available N, P, K, Mg and S was found to be non-significant. Furthermore, application of pressmud cake @ 10 t ha$^{-1}$ along with application of gypsum @ 500 kg ha$^{-1}$ each at basal and flowering recorded the highest available ‘Ca’.

Application of 10 t ha$^{-1}$ of pressmud cake significantly increased the uptake of N, P, K, Ca, Mg, S, Fe, Zn, Mn and Cu by plants at flowering and haulms and seed at harvest. Application of gypsum @ 500 kg ha$^{-1}$ each at basal and flowering significantly increased the uptake of N, P, K, Ca and S by plants at flowering and in haulms and seeds at harvest. However, application of pressmud cake @ 5 t ha$^{-1}$ along with application of gypsum @ 500 kg ha$^{-1}$ each at basal and flowering recorded the highest uptake of N, P, K, Ca and S by plants at flowering and in haulms and seeds at harvest.

Application of 10 t ha$^{-1}$ pressmud cake significantly increased the yield attributes (No. of pods per plant, 100 pods weight, 100 kernel weight and shelling percentage) of groundnut.
Application of gypsum @ 500 kg ha$^{-1}$ each at basal and flowering recorded the maximum number of pods per plant, 100 pod weight, 100 kernel weight and shelling percentage. However, the application of pressmud cake @ 5 t ha$^{-1}$ along with gypsum @ 500 kg ha$^{-1}$ each at basal and flowering recorded the maximum yield attributes (except shelling percentage).

Application of pressmud cake @ 5 t ha$^{-1}$ recorded the maximum pod and haulm yield. Application of gypsum @ 500 kg ha$^{-1}$ each at basal and flowering recorded the maximum haulm and pod yield. Further, application of pressmud cake @ 5 t ha$^{-1}$ along with application of gypsum @ 500 kg ha$^{-1}$ each at basal and flowering recorded the maximum pod and haulm yield in groundnut.

Application of pressmud cake @ 10 t ha$^{-1}$ recorded the highest protein and oil content of groundnut. Application of gypsum @ 500 kg ha$^{-1}$ each at basal and flowering recorded the highest protein and oil content of groundnut.
A study has been conducted to assess the natural resources of Marpaka watershed. The study area, Marpaka watershed is located in Nidamanur and Kanagal mandals of Nalgonda district of Andhra Pradesh. The Marpaka watershed is located between 16° 54’ 30” to 16° 56’ 45” N latitude and 79° 19’ 20” to 79° 21’ 15” E longitude with an average elevation of 185 m from the mean sea level (MSL) with total geographical area of 868.61 ha. The mean annual rainfall is 681 mm. Nine soil profiles were excavated in different physiographic units based on the satellite image and topomap information. Also 150 samples were collected from different units of soil and land variations in Marpaka watershed. Analytical data and GPS points were utilized in characterization and classification of soils as well as in preparation of various maps on 1:10000 scale under GIS environment. For preparation of soil, land use / land cover and groundwater potential maps satellite digital data from LISS IV sensor on board of IRS P6 satellite was used. The soils of Marpaka watershed were slightly acidic to moderately alkaline in soil reaction and all soils had low level of salinity and posed no problem in selection of crops. More than 90 percent of soils were loamy sand and sandy loam in texture. The bulk density of the soils of Marpaka watershed varied from 1.25 to 1.92 with overall mean value of 1.50, low to high in organic carbon and calcareous. The cation exchange capacity of the soils in Marpaka watershed ranged from 12.08 to 18.84 percent with overall mean value of 15.60 percent. The soils were low to medium in N content, low to medium in P and medium to high in K content. The surface samples were extrapolated using the Krigging module available in the ARCGIS software. The soil maps for distribution of NPK and S were generated.

The soil map was generated by the interpretation of image characteristics, topomap, and slope information. The watershed was divided into valley, pediplain shallow, pediplain moderate, pediment and linear ridges and dolerite dykes. The soil of valleys represents very deep soils and belongs to Typic Haplusterts and Vertic Haplusterts taxonomic units. pediplain shallow was having deep soils and mostly belongs to Typic Haplusterts and Typic Haplustalfs. The middle pediplain contains deeper soils and belongs to Typic Haplustalfs and Typic Ustorthents taxonomic units. The pediment was shallow soils and containing Lithic Ustorthents, Typic Ustorthents and Lithic Haplusterts. Linear ridges and dolerite dykes were shallow soils belongs to Typic Ustorthents. Agricultural land use / land cover map was prepared, based on the texture and ground truth observations; the study area was divided into nine units under land use.
Majorly the study area consists of single cropped area followed by marginal lands under cultivation. Based on the Lithology, slope and drainage, the study area was classified as pediplain moderately weathered suitable for large diameter dug wells yielding 50-60 m$^3$ day$^{-1}$. Shallow weathered pediplain over granite gneiss suitable for deep bore wells yielding 25-50 liters m$^{-3}$. Pediment over granite gneiss, acts as run-off zone not suitable for ground water movement. Linear ridges and dolerite dykes, acts as barrier for ground water movement. Based on the sediment yield index, gully plugs and check dams are suggested. Gully plugs are suggested in the 1$^{st}$ order stream to reduce the head ward erosion of the soil. Check dams are suggested in the 2$^{nd}$ order stream to reduce soil erosion and to improve the ground water recharge. Based on the land capability classification, Physiography and soil suitability of the study area instead of existing crop like Cotton; Tomato and Chilli crops are proposed. Also soil conservation practices like agro forestry, horti pasture and silvi pasture are suggested.
The present investigation was carried out to study the Delineation of nutrient status of Bt cotton grown soils under predominant soil orders of different villages in various mandals in Kurnool district of Andhra Pradesh. For this purpose, ninety holdings with standing Bt cotton crop at flowering stage (60 DAS) were selected and the soil samples were collected from 0 - 30 cm depth. The plant samples were also collected from the plants in the fields from which soil samples were drawn. The soil samples were analyzed for their physical and physico-chemical characteristics viz., soil texture, bulk density, pH, EC, OC, free calcium carbonate; and chemical characteristics viz., available N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn and B. Similarly plant samples were analysed for nutrient concentration (N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn and B) in index tissues and also nutrient uptake in whole plant at 60 DAS (flowering stage) of Bt cotton crop. Ultimately yield was recorded at harvest.

Based on the status report of Scarce Rainfall Zone, 2001, the soils were identified into three predominant orders viz; Alfisols, Inceptisols and Vertisols. From each of the three orders, 30 holdings were selected. The soils were slightly acidic to moderately alkaline in reaction, non saline and medium to high in organic carbon. All the surface soils are non calcareous in nature.

Regarding the available nutrients status, the Bt cotton grown soils were medium in available nitrogen, high in available phosphorus and potassium. All the Bt cotton grown soils were sufficient in Ca, Mg and S.

Available Fe, Mn, Zn, and Cu were above their respective critical limits while boron deficiency was registered in Alfisols and Inceptisols were 53.33 and 20.00 per cent of samples, respectively.

In Alfisols, available N was positively and significantly correlated with silt content. In Inceptisols, available K was negatively and significantly correlated with sand content; whereas, in Vertisols, available N was positively and significantly correlated with bulk density. In Alfisols, available Mg was negatively and significantly correlated with bulk density and EC and available Ca was positively and significantly correlated with CaCO3. In Inceptisols, available Ca was positively and significantly correlated with clay content and in Vertisols, available Ca was
positively and significantly correlated with clay content and pH and negatively and significantly correlated with sand content.

In Alfisols, available B was positively and significantly correlated with clay and bulk density and negatively and significantly correlated with sand content. In Inceptisols, available B was negatively and significantly correlated with EC and CaCO3 and available copper was positively and significantly correlated with pH. Vertisols did not show any correlation between micronutrients and physical and physico-chemical properties.

The index leaf nitrogen phosphorus and potassium were in the optimum range. The leaf N, P and K were significantly and positively correlated with their respective soil nutrients. The leaf Ca, Mg and S contents were found to be sufficient to high and showed positive significant correlation with their respective soil nutrients.

All the leaf micronutrients (Fe, Mn, Zn, Cu and B) were found to be sufficient and showed positively and significantly correlated with their respective soil nutrients.

Among the nutrient uptake of major nutrients in Bt cotton, Vertisols registered the maximum uptake of P and K. Incase of secondary nutrients, Vertisols contained the maximum uptake of Ca and Mg compared to Inceptisols and Alfisols. Incase of micronutrients, highest uptake of Fe, Zn, and B were registered in Vertisols. With regard to dry matter, not much variation among the three soil orders was recorded. The highest seed cotton yield (25.56 q ha-1) was recorded in Vertisols.
SOIL SCIENCE AND AGRICULTURAL CHEMISTRY

Author: SESHAGIRI, G.

Title of the thesis: INTEGRATED NUTRIENT MANAGEMENT IN SWEET SORGHUM (Sorghum bicolor (L.) Moench) IN SANDY LOAM SOILS (ALFISOLS)

Major Advisor: C. MASTHAN REDDY

Degree: M Sc. (Ag.).

College: S.V. AGRICULTURAL COLLEGE, TIRUPATI

Accession Number: D 9002

A field experiment was conducted at S.V. Agricultural College Farm, Tirupati campus of Acharya N.G. Ranga Agricultural University of Andhra Pradesh, during kharif, 2010, to identify the suitable integrated nutrient management practices for sweet sorghum in sandy loam soils.

The present investigation was laid out in a randomized block design with three replications. There were nine treatments viz., 100% RDF (80:40:40 N: P2O5:K2O kg ha⁻¹) (T1), 75% RDF + FYM @ 5 t ha⁻¹ (T2), 75% RDF + FYM@ 5 t ha⁻¹ + Azospirillum @ 5 kg ha⁻¹ + Phosphorus solubilising bacteria @ 5 kg ha⁻¹ (T3), 50% RDF + FYM @ 5 t ha⁻¹ (T4), 50% RDF + FYM @ 5 t ha⁻¹ + Azospirillum @ 5 kg ha⁻¹ + Phosphorus solubilising bacteria @ 5 kg ha⁻¹ (T5), 75% RDF + Vermicompost @ 2.5 t ha⁻¹ (T6), 75% RDF + Vermicompost @ 2.5 t ha⁻¹ + Azospirillum @ 5 kg ha⁻¹ + Phosphorus solubilising bacteria @ 5 kg ha⁻¹ (T7), 50% RDF + Vermicompost @ 2.5 t ha⁻¹ (T8), 50% RDF + Vermicompost @ 2.5 t ha⁻¹ + Azospirillum @ 5 kg ha⁻¹ (T9). Among the integrated nutrient management practices studied, the highest available N and K content in the soil as well as in the index leaves was recorded with 100% RDF (T1) at flowering stage of sweet sorghum. Application of 75% RDF + Vermicompost + Azospirillum + Phosphorus solubilising bacteria (T7) was the next best treatment in recording available N and K content in the soil as well as in the index leaves.

The highest concentration of Fe, Mn, Zn and Cu in the soil as well as in the index leaves at flowering stage was recorded with 50% RDF + FYM (T4). Application of 50% RDF + Vermicompost (T8) was the next best treatment. The lowest available Fe, Mn, Zn and Cu were recorded with 100% RDF (T1) in the soil as well as in the index leaves.

The highest available major & micronutrients in the soil and as well as in the index leaves at harvest were recorded with 50% RDF + FYM (T4) in sweet sorghum. The next best treatment was the application of 50% RDF + Vermicompost (T8). While the application of 100% RDF (T1) recorded the lowest available major & micronutrients in the soil as well as in the index leaves at harvest of the crop.

The highest stature of growth components like plant height, cane diameter, total fresh biomass, yield and economic returns were recorded with 100% RDF (T1) followed by 75% RDF
Vermicompost + *Azospirillum* + Phosphorus solubilising bacteria (T7). The lowest plant height, cane diameter, total fresh biomass, yield and economic returns were recorded with 50% RDF + FYM (T4).

The highest total sugar index and commercial cane sugar yield was recorded with 100% RDF (T1) than rest of the INM treatments tried. The next best treatment was the application of 75% RDF + Vermicompost + *Azospirillum* + Phosphorus solubilising bacteria (T7). The lowest total sugar index and commercial cane sugar yield was recorded with 50% RDF + FYM (T4).
The present investigation was carried out to study the nutrients status of rice grown soils and index leaf of rice crop grown in different villages of various mandals in Nellore district, Andhra Pradesh. For this purpose, 60 fields were selected after the harvest of the rice crop and the soil samples were collected from 0-30 cm depth. Index leaf samples were also collected from the plants in the fields from where the soil samples were drawn. The soil samples were analysed for their physical and physico-chemical characteristics viz., soil texture, pH, EC, organic carbon, CEC and free calcium carbonate and chemical characteristics viz., available N, P, K, Ca, Mg, S, Fe, Mn, Zn, and Cu. Similarly, index leaf samples were also analysed for their N, P, K, Ca, Mg, S, Fe, Mn, Zn and Cu.

The texture of the rice grown soils varied from sandy clay loam to clay. The soils were neutral to strongly alkaline in reaction, non-saline and low to medium in organic carbon. The CEC values in rice grown soils were low to medium. All the soils were non-calcareous in nature.

Regarding the nutrients status, the rice grown soils were low to medium in available nitrogen and medium to high in available phosphorus and potassium. All the rice grown soils were sufficient in available Ca, Mg and S. Available Fe, Mn, Zn and Cu in rice grown soils were above their respective critical limits while 1.66 per cent of the soils were deficient in available Zn.

The index leaf nitrogen, phosphorus and potassium contents were above their respective critical limits. The leaf N, P and K were positively and significantly correlated with their respective soil nutrients. The index leaf Ca, Mg and S contents were found to be sufficient in all samples. The leaf Ca, Mg and S contents were positively and significantly correlated with their respective soil nutrients. The leaf Fe, Mn and Cu contents were found to be above their respective critical limits. However, 13.33 per cent samples were deficient in leaf Zn. The leaf Fe, Mn, Zn and Cu contents were positively and significantly correlated with their respective soil nutrients. The grain yield of rice crop under the investigation ranged from 1900 to 2500 kg acre⁻¹ with a mean value of 2269 kg acre⁻¹. The trend of variations with respect to the rice yield among the different management practices and within the same management practice was more or less negligible. However, the grain yield of rice crop under study was considerably to be high in the farmer’s field who applied farmyard manure along with inorganic fertilizers as compared to inorganic fertilizers alone.
Simple correlation studies revealed that N, P, K, Ca and S were positively and significantly correlated with organic carbon. Available K and Cu were positively and significantly correlated with soil pH while available P and Ca were negatively and significantly correlated with soil pH. Available N, K and S were positively and significantly correlated with CaCO$_3$. However, available P was negatively and significantly correlated with clay content.
SOIL SCIENCE AND AGRICULTURAL CHEMISTRY

Author: THANDAVA KRISHNA, J.
Title of the thesis: LONG TERM EFFECT OF CULTIVATION AND MANAGEMENT PRACTICES ON HUMIC FRACTIONS, SOIL PROPERTIES, YIELD AND NUTRIENT UPTAKE BY ONION IN MAIZE-ONION CROPPING SYSTEM

Major Advisor: Dr. P. CHANDRASEKHAR RAO

Degree: M Sc. (Ag.).

College: COLLEGE OF AGRICULTURE, RAJENDRANAGAR

Accession Number: D 8911

The present investigation was carried out during the *rabi* season of 2008. The project was initiated during *kharif* 2003. The initial soil sample before the start of experiment i.e., during 2003 was collected and analyzed for physico-chemical and chemical properties. The physicochemical analysis revealed that the soil pH and EC were 7.6 and 0.55 dSm\(^{-1}\). Soil organic carbon content was 3.6 g kg\(^{-1}\). The available phosphorus and potassium content were 24.0 kg ha\(^{-1}\) and 293.0 kg ha\(^{-1}\).

There were no significant change in soil bulk density, pH and EC. The soil bulk density varied from 1.37 Mg m\(^{-3}\) (T\(_6\)) to 1.47 Mg m\(^{-3}\) (T\(_7\)) both at zero days and harvest. The bulk density was higher in inorganic fertilizer applied treatments and lower in purely organic manures applied treatments. After six years of the experiment the pH was slightly increased in all the treatments expect treatment receiving both organic and inorganic sources to supplement equally that recommended dose of nitrogen and EC (0.26 dSm\(^{-1}\) to 0.32 dSm\(^{-1}\)) was slightly decreased in all the treatments. There was build up in the organic carbon content status of the soil due to application of the both organics and inorganics continuously for six years from 3.6 g kg\(^{-1}\) to 7.5 g kg\(^{-1}\).

There was build up in the available P and K status of the soil due to the application of organics and inorganics continuously for six years from 24.0 kg ha\(^{-1}\) and 293.0 kg ha\(^{-1}\) to 44.4 kg ha\(^{-1}\) and 372.1 kg ha\(^{-1}\) in the treatment receiving both organic and inorganics sources supplement equally that recommended dose of N at zero DAT. The available N, P and K were increased up to 60DAT and the decreasing trend was observed later stages of the crop growth up to harvest. Similar results were also find in inorganic nitrogen Fractions i.e., ammoniacal and nitrate nitrogen and potassium fractions i.e., water soluble and exchangeable potassium.

The enzyme activity (dehydrogenase, acid and alkaline phosphates and urease) was increased up to 60 DAT and decreasing trend was observed later stages of crop growth upto harvest. The increased activity of enzymes at 60 DAT could be attributed to increased root rhizosphere, increased microbial growth and thus contributing to increased activity. The enzyme activity decreased at harvest and was close to initial values. These could be due to reduction in extracellular enzymes and cell debris.
The higher content of humic acid was recorded as compared to fulvic acid. The content of humic acid and fulvic acid in the soil increased with increasing levels of organic manures. The organic manures during decomposition first produce lower weight of fulvic acids and these fulvic acid fractions polymerized and form higher weight of humic acids these resulting higher amount of humic acids. Total acidity and carboxyl groups and phenolic – OH groups were more in fulvic acids as compared with humic acids. These were non – significant. The non – significant variation in the properties of humic substances indicated that these properties are inherent and are not influenced by management practices. However there could be decrease in the content of humic substances as a whole.

The bulb and stover yields of onion varied from 71.14 q ha\(^{-1}\) to 96.76 q ha\(^{-1}\) and 13.31 q ha\(^{-1}\) to 24.26 q ha\(^{-1}\). The N, P and K uptake by onion was varied from 10.1 kg ha\(^{-1}\) to 17.5 kg ha\(^{-1}\), 1.92 kg ha\(^{-1}\) to 4.02 kg ha\(^{-1}\) and 29.5 kg ha\(^{-1}\) to 39.5 kg ha\(^{-1}\). Fifty percent recommended dose of N P K plus 50 percent N as FYM treatment recorded highest yield and organic manure applied treatment recorded higher yield than only inorganic sources recommended fertilizers applied treatments.
The field experiment was conducted at Water Technology Centre, College farm, College of Agriculture, Rajendranagar, Hyderabad during Rabi 2010-11. The experiment was laid out in a Randomized Block Design, consists of 10 treatments viz., Soil application of recommended dose of N,P,K (T₁), 125% RDF N & K through fertigation at daily interval (T₂), at 3 days interval (T₃), at weekly interval (T₄), 100% RDF N & K through fertigation at daily interval (T₅), at 3 days interval (T₆), at weekly interval (T₇), 75% RDF N & K through fertigation at daily interval (T₈), at 3 days interval (T₉), at weekly interval(T₁₀) and replicated thrice. Recommended dose of phosphorus was applied as basal for all the treatments. The experimental soil is sandy clay loam, low in available nitrogen, medium in available phosphorus and potassium.

Maximum dry matter production of 4793 kg ha⁻¹ was recorded in cabbage with application of 125% RDF N & K through fertigation at daily interval which was statistically on par with 100% RDF N & K through fertigation at daily interval (4553 kg ha⁻¹). The cabbage yield was observed to be higher under daily fertigation of N and K with 100% and 125% recommended dose with 16.92 and 15.53 t ha⁻¹ respectively. Total nutrient uptake was highest (146.65 kg ha⁻¹ N and 189.41 kg ha⁻¹ K) with the application of 125% RDF of N and K through fertigation at daily interval. Fertigation has no significant effect on total phosphorus and sulphur uptake. The highest (100.50 kg kg⁻¹) N and K (131.37 kg kg⁻¹) fertilizer use efficiency was recorded with daily fertigation of 75% recommended dose of N and K and the highest water productivity (7.92 kg m⁻³) was recorded in daily fertigation with 100% RDF.

Application of 125% recommended dose of N and K through fertigation at daily interval resulted in the highest head diameter (14.40 cm). The highest head weight (923 g) was resulted from application of 100% RDF through fertigation at daily interval. Significantly higher Total Soluble Salts content (4.66%) and ascorbic acid content (118.37 mg 100 g⁻¹) was registered under daily fertigation of 125% RDF N & K. Daily fertigation with 100% N and K resulted in the highest gross return (Rs.84,635 ha⁻¹) and net return (Rs.62,692 ha⁻¹) and benefit cost ratio of 2.85. Hence it can be concluded that for achieving maximum yield and net profits, the cabbage crop can be given fertigation at daily interval with 100 per cent of recommended dose of fertilizers.
A long term field experiment was started at the Regional Agricultural Research Station, Tirupati of Acharya N.G. Ranga Agricultural University during kharif, 1981. The present study was undertaken during kharif 2010 with a prime objective of monitoring the changes in soil physical and chemical properties over a period of time. The soil of the experimental field was red sandy loam (Haplustalf). The experiment has eleven treatments each replicated four times in a randomized block design. The treatments include T1: Control (no manure or fertilizers), T2: Farm yard manure @ 5 t ha⁻¹ (once in 3 years), T3: 20 kg Nitrogen (N) ha⁻¹, T4: 10 kg Phosphorus (P) ha⁻¹, T5: 25 kg Potassium (K) ha⁻¹, T6: 250 kg gypsum ha⁻¹, T7: 20 kg N + 10 kg P ha⁻¹, T8: 20 kg N + 10 kg P + 25 kg K ha⁻¹, T9: 20 kg N + 10 kg P + 25 kg K + 250 kg gypsum ha⁻¹ at flowering stage, T10: 20 kg N + 10 kg P + 25 kg K + 100 kg lime ha⁻¹ at flowering stage, T11: 20 kg N + 10 kg P + 25 kg K + 250 kg gypsum ha⁻¹ + 25 kg zinculphate ha⁻¹ (as basal, once in 3 years).

Pod yield and yield attributing factors were studied along with available soil nutrients and soil physical changes during kharif 2010. Soil samples were collected from each plot at surface (0-15 cm) and subsurface (15-30 cm) before sowing of crop. Soils were analysed for different parameters.

The physical properties were improved in the plots which received FYM (or) gypsum (or) lime (or) combination of nutrients along with gypsum (or) lime. Among the treatments NPK + Gypsum + ZnSO₄ treated showed higher hydraulic conductivity, infiltration rate, maximum water holding capacity and pore space with less bulk density.

Application of FYM and inorganic fertilizers with different combinations to groundnut over a period of 30 years did not change soil Ph and EC significantly but markedly changed the organic carbon and available nutrient contents of the soil. The available phosphorus and available potassium were gradually depleted in all the treatments but the magnitude of depletion was less in the treatments which received P and K respectively. The build-up of exchangeable calcium and magnesium content of the soil over a period of thirty years was observed. Application of gypsum or lime increased the sulphur content of the soil over a period of thirty years to rainfed groundnut. With respect to the micronutrients Zn was significantly higher in
NPK+gypsum+ZnSO4 treatment whereas the iron was highest in +P+K treatment as compared to others.

Pod and haulm yields were significantly influenced by the treatments. The higher pod and haulm yields were observed in the treatment NPK+gypsum+ZnSO4 treatment which received all major nutrients alongwith secondary and micronutrient. The plots which received single nutrients i.e., N or P or K alone and FYM alone are inferior as compared to the combined application of nutrients. This shows the requirement of all the nutrients for better crop growth and yields.
A field experiment was conducted at Water Technology Centre, College Farm, College of Agriculture, Rajendranagar, Hyderabad during rabi, 2010-11. The treatments consisted of seven surface drip irrigation treatments with irrigation schedule based on pan evaporation replenishment factors of 0.4, 0.6 and 0.8, either kept constant throughout the crop life or combinations of these were taken at vegetative, flowering and pod development stages, in addition to furrow irrigation at IW/CPE ratio of 0.8 with an irrigation water depth of 50 mm. The experiment was laid out in a randomized block design with three replications.

Higher pigeon pea yields were registered when irrigation was scheduled by drip at 0.8 Epan throughout crop life (I₃) which was on par with 0.6 Epan throughout crop life (I₂) and 0.6 Epan up to flowering and 0.8 Epan later on (I₆) and were significantly superior over other drip irrigation treatments and furrow irrigation. Similar trends were observed in growth and yield attributing characters. Furrow irrigation at 0.8 IW/CPE ratio with an IW of 50 mm throughout the crop life was statistically inferior in comparison to drip irrigation treatments except 0.4 Epan throughout the crop life (I₁) which recorded lower yield. Drip irrigation treatments recorded higher water productivity ranging from 2.05 to 2.63 kg m⁻³ in comparison to furrow irrigated crop (1.48 kg m⁻³). Maintaining higher moisture regimes in drip irrigated treatments resulted in higher protein content and protein yield over other treatments. Lowest protein content and protein yield were registered in furrow irrigated treatment (I₈).

The seasonal ETᵣc requirement of pigeon pea varied from 203.8 mm to 407.5 mm among different drip irrigation treatments. It was highest in 0.8 Epan throughout the crop life (I₃) followed by 0.6 Epan up to flowering and 0.8 Epan later on (I₆) as compared to other irrigation treatments. The seasonal ETᵣc under furrow irrigated crop was the highest and amounted to 413.9 mm. The average daily ETᵣc rate varied from 1.23 mm to 2.58 mm under different treatments.

The quadratic water production function indicated that the predicted maximum yield (Yₗₘₐₓ) of 842.2 kg ha⁻¹ was obtained at 372.3 mm of seasonal water requirement. The water production function did not emerge through the origin and the value of
regression constant (a) was negative, indicating that some minimum amount of irrigation water i.e., crop ET was required to be expended to realize the economic yield in pigeon pea crop.

It can be concluded that pigeon pea can be grown as *rabi* crop under Rajendranagar conditions irrigated with drip system at 0.8 Epan throughout the crop life with an optimal seasonal water requirement of 372.3 mm. This gave a maximum yield of 842.2 kg ha\(^{-1}\) and was found remunerative under the prevailing prices of output and input. Further, it was observed that this practice of growing of *rabi* pigeon pea under drip irrigation is economically viable. Under limited water supply situations, scheduling irrigations at 0.6 Epan throughout the crop life (I\(_2\)) or 0.6 Epan up to flowering and 0.8 Epan later on (I\(_6\)) with an optimal seasonal water requirement of 363.1 mm was found to be most productive and remunerative.
The study is confined to the three districts of Telangana, viz., Karimnagar, Nalgonda and Warangal. The crops in these districts are mainly dependent on rainfall. Hence information about estimates of rainfall and frequency of droughts would be useful for strategic crop planning. Estimation of rainfall is generally carried out corresponding to a single period independently without considering the inter-dependence of the rainfall received in the different periods of season. In this context the multivariate approach based on cluster analysis has been advocated to study the pattern of rainfall in the different periods of the season. Application of this approach to rainfall data provides different clusters. The cluster averages of these clusters represent the different rainfall patterns. The study was based on the 56 years of monthly rainfall data covering 1952-53 to 2007-08 for certain districts of Telangana region, Andhra Pradesh State viz., Karimnagar, Nalgonda and Warangal. It was observed that the multivariate approach has efficiently identified the “representative” rainfall pattern in these districts. The rainfall patterns identified through the multivariate approach in the three districts of Telangana viz., Karimnagar, Nalgonda and Warangal revealed that rainfall in South-West monsoon was inadequate for the kharif crops; similarly, the rainfall patterns of North-East monsoon and Hot-Weather period were found to be not sufficient for the rabi crops and preparatory cultivation for kharif crop respectively. An attempt was also made to study the frequency of drought in these districts. It was observed that all the three districts had frequently experienced Drought (D) conditions as well as Excess (E) rainfall condition; however, frequency of droughts was relatively more dominant. The rainfall in other categories, viz., Below Normal (BN), Near Normal (NN) and Above Normal (AN), was relatively less frequent.
An attempt was made to study the spatial and temporal variations in area, production and productivity of cotton in the major cotton growing districts of Andhra Pradesh i.e., Guntur, Prakasam and Adilabad. The study was based on 42 years of cotton data from 1967-2008.

The approach based on graphical analysis was applied to study the variations in area, production and productivity of cotton. An attempt was also made to measure the growth in the area, production and productivity of cotton with due consideration of discontinuity in the data.

The graphical analysis indicated that the time series data on area, production and productivity of cotton exhibited a discontinuous trend in all the three major cotton growing districts of Andhra Pradesh.

In Guntur district, the shifts in area and production were considerable as compared to those of productivity, whereas the shifts in productivity were considerable when compared to those of area and production in Prakasam and Adilabad districts.

In Guntur and Prakasam districts, the area and productivity were relatively more consistent (with less c.v) than the production; whereas in Adilabad district, the area was relatively more stable than the production and productivity.

In Guntur and Prakasam districts, the rate of growth in area, production and productivity was of relatively high order in the first sub-period over the other sub-periods; whereas the rate of growth in production and productivity was of relatively high order in the second sub-period over the other sub-periods in case of Adilabad district. Productivity played significant role in influencing the crop production (over the area) in Guntur and Prakasam districts; whereas area under the crop and crop productivity were dominant factors in influencing the cotton production of Adilabad district.
Spline model was relatively efficient than the conventional model for forecasting the cotton productions in Guntur and Adilabad districts; whereas in Prakasam district, the conventional model was found to be relatively better due to the illusionary variations in the production data.
Present study has been undertaken to estimate the growth rates of the selected important horticultural crops viz: Bhendi, Brinjal (vegetable crops) Mango, Guava (Fruit crops) Coconut, Cashew nut (Plantation crops) and to fit the adequate trend equation for the future projections by 2013 AD.

The reference period of study was from 1995 to 2009 and the study was carried for Andhra Pradesh state as a whole.

Attempts have been made to examine the trends in area, production and productivity of selected horticultural crops. Linear and compound growth rates were calculated for this purpose. Ten growth models were fitted to the area, production and productivity of selected crops and the best-fitted model for future projection was chosen based upon least Residual Mean Square (RMS) and significant AdjR². Besides, the important assumption of randomness of residuals was tested using one sample run test.

The study revealed that the area, production and productivity of bhendi marked a significantly increasing trend during the study period. Brinjal also showed significant increasing trend in area and production but there was a stagnant systematic trend in case of area. In case of mango, there was a substantial increase in area compared to production which was in decreasing trend and productivity which has negative non significant growth rates with decreasing trend. Guava exhibited a stagnant significant trend in area, production and productivity and the same was observed in future projections by 2013 AD. It was revealed from increasing production of coconut, the productivity has attributed increasing trend but there was a decreasing trend in area. In case of Cashew nut, a significant upward trend in area and production with non significant positive trend in productivity was observed.
Present study entitled “Study of Fertilizer Consumption Pattern in Prakasam and Nellore Districts of Andhra Pradesh” had been attempted to identify the trends with shifts in fertilizer consumptions, to identify the determinants of fertilizer consumption and developing forecasting model for fertilizer consumptions. The reference period of study was from 1977-78 to 2008-09 and the study was carried out for the Prakasam and Nellore Districts of Andhra Pradesh.

Trends in Fertilizer consumption, Total cropped area, Gross irrigated area, Rainfed area were identified by computing compound growth rates. However, the time series data on these dependent variables exhibited a discontinuity over the study period. Hence, the growth in fertilizer consumption was measured after identifying the period of discontinuity which leads to formation of sub periods in the data. These years of discontinuity or shifts were identified by the graphical approach (control charts).

The determinants of fertilizer consumption were identified by multiple linear regression using non-price factors like Total cropped area, Rainfed area, Gross irrigated area.

The conventional trend models were fitted to the season wise fertilizer consumption and the best fitted models for forecasting the fertilizer demand were identified based on significant Adj $R^2$ and least Residual Mean Square (RMS).

The study revealed that the N, P, K and NPK total fertilizer consumption marked a significant increasing trend for the Prakasam and Nellore Districts of Andhra Pradesh. In both districts phosphate showed high compound growth rate compared to remaining three i.e., N, K, NPK total. Phosphate consumption recorded highest compound growth rates i.e., 8.32, 6.94 in Prakasam and Nellore districts respectively. The total NPK fertilizer recorded highest consumption in Nellore district with a mean consumption of 66435 tonnes.
In Prakasam district total cropped area, gross irrigated area and rainfed area recorded negative growth rate but in Nellore district total cropped area and rainfed area recorded negative growth rate and gross irrigated area showed positive growth rate.

Out of the three independent variables viz., total cropped area, gross irrigated area and rainfed area that were included in the regression model, in maximum cases gross irrigated area significantly affected the fertilizer consumption except in Nellore district where total rainfed area had significantly affected the Phosphate fertilizer consumption.
Cotton is known to be sprayed with heavy doses of pesticide during its cultivation. These residues pollute all the units of ecosystem posing a threat to human as well as other organisms. Pesticides are known to leave a residue in the soil as well as the substrate on which they are sprayed. To eliminate the affects of pesticide through clothing the concept of organic cotton was evolved. Therefore, the study was directed to discern the effect of pesticide residue on properties of cotton.

Organic and non organic cotton of same variety, DHB-915, cultivated under same climatic conditions was procured from the experimental plots of organic farming unit. These fibres were processed into yarn and later woven into fabric under similar conditions. Fibre, yarn and fabric of both types were subjected to laboratory tests to assess the physical and chemical properties The standard BIS procedures were followed to assess the physical properties of fibre, yarn and fabric. The pesticide sprayed on the crop, lambda cyahalothrin, was analysed for residue at each stage through Gas chromatography.

The residue analysis revealed that only non organic cotton fibre contained the residue of lambda cyahalothrin residue of 0.05 ppm. Organic cotton samples i.e fibre, yarn and fabric and non organic cotton yarn and fabric showed residues below detectable levels.

Organic cotton fibres were found to be short length fibres with span length lower than the non organic cotton fibre. Non organic cotton fibre had more yellowness with dark reflectance while organic cotton had more whiteness. According to the USDA colour grade for cotton, both types of cotton were categorized as light spotted.

Uniformity ratio and elongation were similar in organic as well non organic cotton. Both the fibres were fine and had average maturity. The strength of the organic cotton was lower than that of non organic cotton. The traces of the residue present did not affect the non organic cotton properties significantly.
Yarn count of organic cotton was finer than the non organic cotton. Also, it was more hairy with less nep. The spinning ability of non organic cotton was good with high strength. The residues were below detectable level in both organic and non organic cotton yarn.

The geometric properties of non organic cotton fabric were better than the organic cotton fabric. Though organic cotton had greater number of picks per inch, cover factor and fabric weight were slightly high in non organic cotton fibre. The aesthetic properties of both organic and non organic cotton were similar. Both types of fabrics became hairy and pill slightly. Pesticide residues were below detectable levels and did not affect the fabric properties in any manner. The handle properties of organic cotton were good over non organic cotton. The non organic cotton had greater thickness. No residual role was observed to alter the handle properties. Both the fabrics were equally permeable to air and had similar water repellancy. Organic cotton had good thermal conductivity than the non organic cotton fabric. Non organic cotton fabric had higher tear strength and tensile strength with low extension over the organic cotton fabric. Greater tear strength was found in non organic cotton in warp direction.

Hence, it can be concluded that the pesticide residue was not carried over to yarn stage and later to fabric stage. Also, the residue present did not have any significant effect on the fibre, yarn and fabric properties.
Exposure to ultraviolet radiation is a risk factor in population spending in outdoor activities. Long-term exposure to UV light can result in tanning, ageing of skin, photodermatosis, skin reddening, and sunburn, increased risk of skin cancer, eye damage and DNA damage. To combat the problems encountered with the increased UV radiation, scientists have been searching for different ways. In textiles UV protective finish is a latest technological advancement. Inorganic UV blockers like ZnO, TiO₂, SiO₂ are more stable & preferred to the organic UV blockers as they are non-toxic & chemically stable under high temperature through nano coating of the fabrics with UV blocking agents.

Generally curtains are provided with lining material to protect from sunlight and it requires a lining fabric which also adds weight and cost of the drapery. Non-wovens are light in weight and provide better drape when used as linings to curtains besides being cost effective compared to woven fabrics. Among many fibres used for making non-wovens, polyester in original or recycled form produces good strength and required drape.

Needle punching technology was selected for fabricating the non-woven fabrics. Finishing was carried out by pad-dry-cure technique. Accordingly sixteen non-woven fabrics consisting of formulated control and finished non-woven fabrics were subjected to laboratory testing and subjective evaluation.

Among all the treated unexposed and exposed fabrics C₁ had high fabric weight and A₃ had low fabric weight. This could be attributed due to the finishing solution and padding. The thickness of the unfinished fabrics was higher than finished fabrics. There was no change found in thickness between the unexposed and exposed samples which may flatten the fibres due to finishing. Unfinished fabrics had low drape, compare to finished fabrics. High drapability was observed in A₃ and B₃ finished fabrics before and after exposing to sunlight. Increase in air permeability of the fabrics was observed in all finished fabrics compare to unfinished and among all finished fabrics A₃ had high air permeability and C₁ had low air permeability even after exposure to sunlight.

Thermal conductivity of the treated unexposed and exposed fabrics was improved after treatment. The higher CLO the lesser is the conductivity of the material. The CLO
values of the treated decreased, which indicates that the thermal conductivity was increased. The exposed samples had higher thermal conductivity than the unexposed samples. It was observed that the tenacity of all treated fabrics decreased. Maximum loss of strength was observed in 1 percent concentration of unexposed finishing samples. Same trend was observed even in exposed samples.

The increase in tear strength was progressive with the increase in concentration of the finish. It was interesting to note that all finished exposed samples increased in tear strength when compared to unexposed samples. By taking the results in to consideration the increase in tear strength in all treated samples might be attributed to criss cross layering of fibre arrays during the formation of web of non-wovens, the padding and UV finish. Maximum weight loss was observed in more cotton content fabric attained highest weight loss compared to other fabrics. The weight loss was decreased from control to finish and finished to exposed fabrics indicating improved in abrasion. In abrasion resistance recycled polyester fabrics fared better than virgin polyester and cotton.

Subjective evaluation reveled that finished fabrics were more suitable for drapery lining as compared to unfinished. Most of the respondents reported that A1, A2, and A3 fabrics are not suitable for drapery linings which was composed of 50% cotton and 50% virgin polyester. The appearance of these finished fabrics was poor and stiffness was limpy. As this study reveled that the 50% virgin polyester and 50% cotton combination lower in strength compared to cotton and recycled polyester. The UPF rating was improved for all the finished fabrics with maximum UPF ratings. Among the Boncentration of nano particles one percent expression showed highest UPF Value. It also indicated that finished samples of 30% cotton+70% virgin polyester (B), 50% cotton+50%recycled polyester (C) and 30% cotton+70% recycled polyester (D) fabrics provided high resistance for UV radiation and therefore employed for the end use.
Increasing global competition in textiles has created many challenges for textile researchers. Novel finishes of high added value for apparel fabrics are also greatly appreciated by the most demanding consumer market. Antimicrobial textiles with improved functionality find a variety of applications such as health and hygiene products, specially the garments worn close to the skin and in the area of medical applications.

Textile materials are good carriers of various types of microorganisms and can cause health related problems to the wearer. In order to protect from the wearer from such infection the textile fabrics can be finished with antimicrobial agents. There are several studies in literature in which natural materials have been used to give antimicrobial finishing to the textile materials. One of the major limitations in the natural materials based antimicrobial finishing is the non durability of the finish since they cannot form any bond with the textile materials. Microencapsulation of natural materials is one of the methods used to increase the durability of the antimicrobial finishing on the textile materials.

Thus, in the present study an attempt was made to finish cotton textiles with microcapsules from plant sources with combination of gum sources to impart the antimicrobial finish. Microcapsules were prepared with plant sources as a core material and gum sources as wall material at two different concentrations. Scanning Electron Microscope (SEM) at 1600 to 8500 magnification revealed that the microcapsules were between 1.24μm to 2.29 μm. Increase in gum percent resulted in increase in size of microcapsule.

Finish was applied to woven and knitted textiles using pad-dry-cure method with curing at 35° to 40°C. The antibacterial activity was evaluated by a modified qualitative test method AATCC-147, 2004 for the growth inhibition and AATCC-30, 2004, for anti fungal activity against both *Staphylococcus aureus* and *Escherichia coli*.

Antibacterial bacterial activity was found to be zero in both untreated woven and knitted fabrics. Among the treated fabrics, periwinkle with all gum sources showed higher Zoï against E.coli over S. aureus in both woven and knitted fabrics. Fabrics finished with microcapsules with 5 per cent gum as wall material had high Zoï than their
counter parts. Treated knitted samples performed better than woven samples for all sources.

Microcapsules made from sources CS and PG with bagawathi gum at 10 per cent concentrations showed least Zoi on both the fabric types.

There was a slight decrease in antibacterial activity of all sources and concentrations after the first wash. Improved antibacterial activity was found in woven and knitted samples after third wash at 5 per cent concentration with PW+GA and PW+BG, and decrease in combination of CS+GG. A decreased antibacterial activity was observed in both woven and knitted samples against both organisms after fifth wash compared to first and third wash. All plant sources with 5 per cent GA were found to possess good Zoi among all treatments in woven samples against both organisms even after ten washes. The results of antifungal activity indicated that there was minimal fungal growth for few sources while samples washed for five and ten cycles did not support any fungal growth. Analysis of geometric parameters of fabrics showed a slight increase in yarn count, fabric count, fabric weight in few samples and decrease of thickness in majority of samples. These findings indicated that periwinkle in both concentration with all three wall materials exhibited better antibacterial activity among all.
There is growing interest in the use of natural fibres as reinforcing components for both thermoplastic and thermo set matrices, because of the ideal benefits offered by natural fibres such as convenient renewability, biodegradability and environmentally friendliness. Natural fibre reinforce composites is an emerging area in polymer science. Among natural fibres Jute, sisal, mesta banana, coir, sunhemp and palymara are abundantly available in India have a potential as reinforcers in composites.

In India sisal is not cultivated and the sector is unorganized. Sisal is currently found on embankments, bunds and road sides, serving the purpose of soil conservation and protection as hedge plantation. Presently sisal fibres are collected and utilized for conventional purposes like ropes, anchor, cordages and handicrafts. They are not optimally utilized and commercially exploited with respect to their superior characteristics/quality and wide applicability. Andhra Pradesh is the home of mesta and it has maximum area under sabdariffa in the country. Cannabinus is called mesta while sabdariffa is roselle, which is coarser than jute, yet it is a substitute of jute contributing seven percent by mesta and five percent by roselle to jute production. With the above concept, this study was undertaken with the major objective of fabricating non-conventional fibre composites for agricultural use.

Market survey was carried out in the surroundings of Hyderabad on availability of composite materials for agricultural use. Mulching mat, shade net, mass stick, greenhouse, poly house, pot and nursery tray were the products available in most of the shops and the cost differs according to the product. The material used for making these products was high density polyethylene.

The natural fibers used in this study are mesta and sisal. The matrix bases used for making composites are CSNL and polyester resin. Mesta single ply yarn was made into woven fabric where as sisal paper board and non-woven were developed by delignification of the fibre. The process in methodology for the extraction of fibre, fabrication and composite preparation are discussed in detail. Two concentrations of resin were selected and standardization was done by adding turpentine and acetone in CSNL resin. The resin mixed with acetone was selected, because of its liquidity and fast
drying ability. The standardization of polyester resin was done based on the minimum and maximum levels recommended by resin manufacturing company ABR Organics. Based on this, concentration levels were selected and optimized.

Mesta fabric and sisal non-woven were utilized for fabricating mulching material and sapling bag with CSNL resin by hand lay-up method. The other components fabricated with polyester resin were flower pot, hand winnower, tub, bowl, fruit and vegetable collection tray and nursery tray by resin transfer moulding technique. The performance characteristics of composites were assessed by field testing and subjective evaluation. The test composites were subjected to various laboratory tests to evaluate the physical, performance and mechanical properties of the composites following the standard procedures laid down by ASTM. The data obtained was compiled, tabulated and statistically analyzed. Statistical tool such as Two sample T test with unequal variances was selected for comparison of two fibres, where as correlation was used for quantifying the dependency of various characteristics on one another and percentages were calculated for the subjective evaluation.

Tensile strength of the composites was observed to be decreased in sisal when compared with mesta. As far as impact strength and compressive strength go which is directly related to over all toughness, sisal had very high impact strength and compressive strength. Regarding water absorption test conducted among the two selected fibers, sisal had more water absorption than mesta. Flexural strength is a property which denotes the bending strength was high in mesta which gave an additional fiber property to be spun. The increase in flexural strength in mesta is due to the interface adhesion between the fibre and matrix. The density of mesta and sisal was not very high which gave the property of non-conventional fiber composites.

Fabricated mulching material showed cent percent weed control, wet ability, high yield in tomato orchid. In nursery tray tomato and brinjal seeds showed cent percent germination with healthy growth and better water retention which was acceptable. Developed sapling bag and flower pot showed that plant growth was better with high water retention, temperature control in soil and acceptable due to bio degradability. The rural women could perform the winnowing process on par with the ordinary winnower. The developed product seemed to be strong, light weight; termite proof with more durability. The handling of fertilizer in the tub was serving the purpose with more comfort than the normal tubs due to compact shape and durability. The vegetable collection tray was useful without distorting the shape and also maintains the spoilage of fruits and vegetables. They felt the use of the non-conventional fibre tray was more durable than the commercially available trays. The use of the above mentioned fabricated devices by the selected farmers was satisfactory with the cost and utilization of available resources.

By considering the data from objective and subjective evaluation, the study indicated that mesta and sisal fibre were suitable for developing composite devices for different agricultural operations. According to the preferences of the respondents, both the fibre products were considered as most suitable and the cost of production was
economically viable for adoption at the commercial level. Hence the results of the study can be adopted by the farmers to produce better yield of crop and also generates sustainable rural self employment.
Pregnancy is an important stage for every woman bringing joy in the family but on the other hand, pregnancy involves many changes in women’s body and lifestyle. It requires lot of attention. Clothes which help the mother-to-be feel well dressed are a great satisfaction to her and encourage her to continue many of her regular activities. Fashion designers and manufacturers are now providing attractive garments for the maternity wardrobe. One may also choose from a large variety of fabrics and designs within a wide price range.

By considering the mobile and comfort features, a study was carried on designing smart and comfortable dresses for pregnant women in order to enhance their work performance during pregnancy. Pregnancy is typically broken into three periods, or trimesters, about three months each. While there are no hard and fast rules, these distinctions are useful in describing the changes that take place over time. Physical changes an expectant mother will undergo include: gain in weight, larger abdomen, enlarged breasts and swollen ankles and fingers. During pregnancy, the magnitude and distribution of loads acting on the spine change dramatically and the spine undergoes adjustments in its form to accommodate these changes. The clothing needs to be designed to support the abdomen of pregnant women. Many pregnant women made alterations to their dresses and used during pregnancy which they felt were not comfortable. The availability of pregnant wear in the market is also very limited. Therefore, the present study was taken up with this objective “To design comfortable dresses for pregnant women”.

A questionnaire was developed to know the preferences of colour, design, type of dress material, type of garment, information about the biosensor, use of smart maternity dress from the respondents. The respondents had preferred cotton fabrics because of the comfort property and colors as per the season. The preferences with regard to design included different patterns, enrichments, types of dresses, accessories and fabric attributes.

Accordingly ten designs for pregnant wear were developed and subjected to assessment by a panel of judges. Four designs were selected based on the preferences given by the respondent and providing comfort. A Doppler was commercially purchased.
and modified to suit to the designed dresses by making the device smaller. Nine fabrics consisted of four plain and five printed fabrics were selected and assessed for geometrical, handle and comfort properties following the standard procedure laid down by BIS. The data obtained in the study was compiled, tabulated and statistically analyzed using frequency and percentage for subjective evaluation and two sample t- test for objective evaluation.

The results indicated that the yarn count of warp in all fabrics was higher than the weft, indicating that warps are finer. All fabrics were found to be balanced as the ratio between the warp and weft thread count was within admissible range and all fabrics could be classified under the category of light weight fabrics only. The fabrics were considered as flexible and contribute to the comfort of the pregnant wear. The drape of the fabric influences the drape of the garment, the designed garments had perfect drape which avoided clinging of the garment to the distorted figure during pregnancy.

The subjective evaluation of the designed dresses assessed the performance such as suitability, comfortability, acceptability of the designs after wearing by 30 respondents. They assessed the fitment of the biosensor to the dress and comfort ability of biosensor and giving information about foetal heart rate. These were some parameters which were evaluated by the pregnant women. The result of evaluation shows that dress1 was more comfortable, higher acceptable for design and good quality of fabric, highly suitable for fitment of the biosensor to the dress than other dresses.

The costs of dresses were economically viable for adoption at the commercial level. Dress 1, dress 2, dress 3 were low priced when compare to market rates.
Sugarcane juice was subjected to heat and chemical treatments. Pasteurization temperature and chemical concentrations were optimized. Following treatments were given to juice viz. untreated; pasteurization at 80°C for 10 min + chemical treatments (KMS @ 150ppm and citric acid @ 0.05%); pasteurization at 80°C for 10 min + chemical treatments (KMS @ 150ppm and citric acid @ 0.05%) + sterilization at 80°C for 20 min. All the samples were packed in glass bottles, polyethylene Tetraphthalate (PET) bottles and low density polyethylene pouches (LDPE). After packaging all the samples were subjected to irradiation at 0.25kGy, 0.5kGy and 1.0kGy. Non-irradiated samples were taken as control. The storage studies were carried out upto 90 days at room and refrigerated temperature.

Jaggery was packed in LDPE pouches and paper bags and then subjected to irradiation at 3 kGy, 5kGy and 7kGy. Irradiated and non irradiated samples were stored at room temperature upto 90 days.

On treatment moisture content, ascorbic acid, viable bacterial count and viable yeast and mold count were decreased significantly (P>0.05) where as no significant effect was observed on reducing and total sugars in cane juice. Irradiation also showed a similar effect except of total sugars which decreased on irradiation. Because of good barrier properties to oxygen and water vapor glass and PET bottles were found to be at par in increasing the shelf life of sugarcane juice in comparison to LDPE pouches. Irradiation and packaging material statistically showed no significant differences on organoleptic properties of juice.

On storage, ascorbic acid and total sugars were decreased significantly (P>0.05). Moisture content, viable bacterial count and viable yeast mold count were increased on storage at 5% significant level. The increase was more at room temperature than at low temperature. Scores for colour, taste, flavor, texture and overall acceptability were decreased with increase in storage period.

Among all the treatments pasteurization at 80°C for 10 min + chemical treatments (KMS @ 150ppm and citric acid @ 0.05%) + sterilization at 80°C for 20 min was found to be best in maintain the shelf life of juice with 1.0kGy irradiation doses. Among glass
bottles, PET bottles and LDPE pouches, glass and PET were found to be best in maintaining the quality of juice.

Effect of irradiation and packaging was found to be statistically non significant (P>0.05) on reducing sugars, sucrose, viable bacterial count and viable yeast and mold count of jaggery except that of moisture content which showed an significant increase (P>0.05) on irradiation in jaggery. Irradiation at 7.0kGy dose was found to be best in maintaining the keeping quality of jaggery. Irradiation and packaging material showed no significant changes on organoleptic properties.

On storage moisture content, reducing sugars, viable bacterial count and yeast and mold count increased significantly (P>0.05) in jaggery. Decrease in sucrose content was observed during storage. No significant changes (P>0.05) were noticed in scores for colour, taste, flavor, texture and overall acceptability during storage period. Jaggery irradiated at 7.0kGy stored in LDPE pouches was found to be best till the end of the storage period.

Therefore it has been concluded that pasteurization at 80°C for 10 min with preservatives (KMS @ 150ppm and citric acid @ 0.05%) and sterilization at 80°C for 20 min along with irradiation dose 1.0kGy was found to be best combination in increasing the shelf life of cane juice.

For Jaggery irradiation dose at 7.0kGy was found to be best in increasing the shelf life upto 90 days without having much affect on its physico-chemical, nutrional and organoleptic properties.

Hence the present study conducted is a preliminary step for preservation of sugarcane juice and jaggery. Consumers have become more conscious about food safety therefore hurdle technology has arisen in response to number of developments and therefore provides a framework for combining a number of milder preservation techniques to achieve an enhanced level of product safety and stability.
The use of pesticides has become inevitable in agriculture due to diverse reasons. Farmers are compelled to administer pesticides owing to the affluence of pests, eventually affecting the yield and quality of crops grown. This certainly affects the economy of farmers and the nation as a whole. Consequently, there is excessive use of pesticides to combat the issues. Pesticide usage is age old and over the decades, there have been various alterations in the pattern of usage owing to surged awareness.

Therefore, the current investigation was undertaken to estimate pesticide residues in selected food grains grown in the Central Telangana Zone (Warangal, Medak and Khammam) of Andhra Pradesh. The crops selected for the study were jowar, maize, blackgram and bengalgram. The recommended package of practices of pesticide usage by the farmers was studied using structured questionnaire specifically developed for the study.

The selected food samples were analyzed for nutritional quality (standard procedure given by AOAC) and pesticide residue content in two forms i.e. whole and processed forms. The nutritional parameters analyzed were moisture, protein, fat, ash, fibre and carbohydrate. The pesticide residues analyzed were monocrotophos, acephate, chloropyrifos, quinalphos, carbofuran and endosulfan (Sharma 2007).

The results revealed most of the farmers (40.0%) were illiterates, followed by 28% studied up to 1st to 5th class, 20.0% studied up to 6th and 10th class, 9.0% studied up to intermediate and only 3.3% were with degree qualification. Besides agriculture farmers were exploring ancillary occupation such as horticulture (10.0%), poultry (14.0%) and dairy (69.0%).

Major crops grown by the farmers in the area during kharif season were maize (60%), jowar (32.0%), blackgram (16.0%) and bengalgram (10.0%). The major crops grown during rabi season were maize (34.0%), jowar (36.0%), blackgram (29.0%) and bengalgram (10.0%). Fifty to seventy percent of the farmers were getting the yield per acre as
recommended by Central Telangana Zone, Warangal. Maximum percent of the farmers (50 - 60 %) were applying the pesticides more than the recommended level for various crops.

Pre processing techniques adopted by the farmers were dehulling for blackgram, bengalgram and jowar, popping for maize, germination technique for jowar and bengalgram and flour making process for all the four samples. The post processing techniques adopted by the farmers were washing and soaking for blackgram, bengalgram and jowar, roasting for maize and bengalgram and boiling for maize and bengalgram.

The moisture content of whole and processed jowar was 10.21% and 10.60% respectively. It was 10.34g % and 10. 80 g% for whole and processed maize respectively. The whole and processed blackgram contained 9.65 g% and 10.60 g % moisture respectively. The moisture content was 7.65 g% and 8.50 g% in whole and processed bengalgram.

The protein content was 8.88 g%, 7.77 g%, 21.82 g% and 21.48 g% in whole jowar, maize, blackgram and bengalgram respectively. The same was 8.95 g%, 8.17 g%, 23.88 g% and 23.41 g% in processed jowar, maize, blackgram and bengalgram.

The fat content was 1.70 g% and 1.87 g% in whole and processed jowar. The whole and processed maize contained 1.25 g% and 1.51 g% of fat respectively. The fat content was 0.98 g% and 1.64 g% in whole and processed blackgram. It was 3.97 g% and 4.30 g% for whole and processed bengalgram respectively.

The ash content of whole and processed jowar was 1.50 mg% and 1.65 mg% respectively. It was 1.30 mg% and 1.64 mg% for whole and processed maize respectively. The whole and processed blackgram contained 3.69 mg% and 4.30 mg% ash respectively. The ash content was 3.09 mg% and 3.78 mg% in whole and processed bengalgram.

The fibre content was 1.30 g%, 2.68 g%, 2.81g% and 2.68 g% in whole jowar, maize, blackgram and bengalgram respectively. The same was 0.95 g%, 1.97 g%, 0.78 g% and 1.85 g% in processed jowar, maize, blackgram and bengalgram respectively.

The carbohydrate content was 76.66 g%, 76.63 g%, 57.86 g% and 61.13 g% in whole jowar, maize, blackgram and bengalgram respectively. The same was 75.96 g%, 75.89 g%, 56.78 g% and 58.14 g% in processed jowar, maize, blackgram and bengalgram respectively.

Statistically significant difference at 5% level was observed with regard to all the nutrients analysed between the whole and the processed samples, except protein in jowar and maize, fat and ash in jowar and carbohydrate in jowar, maize and blackgram.

The pesticide residues analyzed in selected whole and processed food grains were below the detection limits (BDL). Residues of pesticides are relatively less likely to persist in cereals and pulses than in vegetables or fruits. The amounts of residues thus, detected are low to negligible. This perhaps was due to the fact that cereals and pulses contained low moisture content, thus not enabling pesticide residues to persist.

Farmers in the zone experienced many health implications as a consequence of unsafe handling and application of pesticides, due to lack of knowledge .There is a need to educate
the farmers about ill health effects of not taking proper precautions during the application of pesticides and to avoid the minor and major health ailments.

Most of the pre and post processing techniques adopted by the farmers such as drying, dehulling, decortication and milling etc., may result in ultimately below detectable levels of pesticide residues in whole and processed food grains indicating the safety of use of food grains produced by the farmers by applying monocrotophos, endosulfan, acephate, quinalphos, chloripyriphos and acephate pesticides at the point of study.
The Krishna zone of Andhra Pradesh was selected to carry out the study is endowed with a rich variety of soils and it occupies an important place in agriculture, which is the most important occupation of the people. This zone covers Krishna, Prakasam and Guntur districts. Paddy is the major food crop cultivated in Krishna zone. Other grain crops like maize, black gram, green gram etc are also cultivated to a large extent.

Thirty farmers were selected from Krishna zone and interviewed with the help of the questionnaire and rice, maize, black gram and green gram samples were collected from ten farmers each for analysis. Samples thus procured were analyzed for proximate and pesticides at Quality Control Lab, Rajendranagar, Hyderabad. The questionnaire covered information on package of practices in relation to pesticide usage, crop yield, storage practices, processing and consumption patterns of the selected grains.

From the compiled data it was evident that majority of the farmers were either small or marginal farmers of 30 to 70 years age, with educational qualification as illiterates, below 10th class and intermediate. The source for the procurement of seeds was from government agencies and private shops whereas for pesticides it was mainly from private shops. Majority of the farmers used more than the recommended dosage of pesticides. The yields of the crops were observed to be on par with the expected yield. Majority stopped application of pesticides 1 month before harvesting. Mode of application of pesticides was spraying and broad casting by all the farmers and the no precautions were taken by majority of the farmers.

The source of knowledge for application of pesticides was mainly from pesticide shopkeeper, head of the family and neighbour farmers.

The source of irrigation was mainly rain fed along with well, river water and bore. The source of procurement of seeds was either government agencies or private shops whereas for pesticides it was mainly from private shops. Farmers used higher doses of pesticides compared to the recommended levels. The yield of the crops was observed to be
on par with the expected yield which reflected the efforts of the farmers in the care of the crop. Majority of the farmer stopped application of pesticides before one month of harvesting. Mode of application of pesticides was spraying and broad casting by all the farmers and only few have used masks and gloves. The source of knowledge for application of pesticides was mainly from pesticide shopkeeper, head of the family and neighbour farmers. The expenditure on pesticides was mostly about Rs3,000/- to Rs4,000/- per annum.

The duration of storage for the selected crops before sale was one month 6 months and before consumption. The type of storage structures used was gunny bags, bins and tins. The primary processing techniques adopted was milling and flouring for cereals and dehulling for pulses. The cooking techniques adopted for cereals were washing, boiling and soaking for rice, whereas for pulses it was washing, soaking, germination and boiling for green gram.

The nutrient composition for i.e., moisture, protein, fat, fibre, ash and carbohydrates was analyzed using standard procedures. Significant difference was observed between whole and processed food grains with respect to all the 6 nutrients of the four selected crops except for moisture in maize, protein in green gram, fat in rice and black gram. The proximate nutrients thus analyzed showed slight difference when compared with the book values of Nutritive Values of Indian Foods owing to the varietal and cultivation differences.

The pesticide residual content of the whole and processed rice, maize, black gram and green gram for the pesticides monochrotophos, quinalphos, endosulfan, chlorpyrifos, acephate and carbofuran was below the detectable level (BDL) indicating that stoppage of pesticidal sprays 1 month before harvesting, the lag period between production and consumption being more than 6 months contributed for the decline in pesticide residues. This is an encouraging factor for the safety of consumption of the grains with sufficient storage period and suitable processing.
The current investigation was undertaken to estimate pesticide residues in selected cereals and pulses grown in the Godavari zone (East and West Godavari districts) of Andhra Pradesh. The crops collected for study was rice, maize, black gram and Green gram. The recommended package of practices and the farmers’ pattern of pesticide usage were studied using a structured questionnaire. Information was obtained on the pesticides used in the zone, the dosage applied, yield of crops, the persons and sources who advised them on pesticide usage, the storage structures, the pre and post processing practices, implications of pesticides on health of farmers and the annual expenditure on pesticides. Thirty farmers were selected randomly for the study.

Besides, the study included the estimation of proximate composition of the selected food grains from the zone. The proximate analyzed were moisture, protein, fat, ash, fibre and carbohydrate. The samples were analyzed in whole and processed forms. A multi residue determination procedure was used to analyze pesticides by the gas chromatogram. The experimental aspect of the study was undertaken at the Quality Control laboratory, A.N.G.R.A.U. The pesticides analyzed in rice, maize, black gram and green gram were monocrotophos, acephate, chloropyrifos, quinalphos, carbofuran and endosulfan. Endosulfan is the exceptional pesticide that belongs to the organochlorine group of pesticides with the rest belonging to organophosphate group.

The values of the proximates i.e., moisture, protein, fat, fibre, ash and carbohydrates were tabulated in the results and discussion. The nutritional quality of the selected food grains were nearly equal to the proximate content reported by Gopalan et al. (2004).

Statistically significant difference at 5% level was observed with regard to the nutrients moisture, fibre, fat (except for maize), protein (except for maize and green gram) and carbohydrate. And statistically significant difference at 5% level was not observed in ash.
The pesticide residues analyzed in selected whole and processed food grains were below the detection limits (BDL). Residues of pesticides are relatively less likely to persist in cereals and pulses than in vegetables or fruits. The amounts of residues thus, detected are low to negligible. This perhaps was due to the fact that cereals and pulses contained low moisture content, thus not enabling pesticide residues to persist.

Farmers in the zone experienced many health implications as a consequence of unsafe handling and application of pesticides, due to lack of knowledge. There is a need to educate the farmers about ill health effects of not taking proper precautions during the application of pesticides and to avoid the minor and major health ailments to the farmers.
The subject of extrusion cooking is a major importance in food and feed processing. Currently limited extruded snacks with added roots and tubers are available. Hence an attempt was made to formulate extruded snacks in combination with corn grits, black gram dhal, roots and tubers like potato (Solanum tuberosum), yam (Dioscoreaspp.), sweet potato (Ipomoea batatas L.), Colocasia (Esculenta) and beet root (Beta vulgaris) to increase their utility. Corn, black gram dhal and roots and tubers were added in the 60:20:20 ratios respectively and subjected to extrusion cooking to produce puffed snacks. Process variables (barrel temperature, screw speed, feed rate) of a single screw extruder were kept constant (120 ± 5°C, 200 ± 10 and 25 ± 5 kg/hr).

The physico-chemical characteristics of the extrudates were studied and compared. Extrudates with beet root incorporation had the least expansion ratio of 3.4 and highest bulk density 0.15 g/cm³. The internal structure of the control sample is more porous, but the size of the pores is small, while in potato the pores are big in size and less in number when observed under Scanning Electron Microscope (SEM).

The initial moisture content of the extrudates ranged from 2.1 to 3.3 % g. Protein content was maximum (11.9) in product made from corn, black gram dhal and beetroot and minimum (10.4) in sweet potato incorporated extruded snacks. The ash content ranged from 0.5 to 3.3 g. Fat content of the developed extrudates ranged from 5.09 to 12.8 g.

Among different formulations the most accepted products were extrudates made by incorporating corn and black gram dhal alone and corn, black gram dhal and potato. During storage period of 2 months deterioration in texture and mouth feel was observed in extrudates made with beet root and sweet potato.

The extruded snacks were stored in Metalized Polyethylene Terephthalate (MPET) for a period of 2 months and the moisture content after storage period was observed to be increased in control and potato snacks.
Hence the result of study revealed that most acceptable root and tuber based extruded snacks can be prepared. The product can be explored for commercialization as an innovative snack food using roots and tubers thus increasing its utility.
Increased realization in the recent years regarding the presence of harmful pesticide residues in the food consumed had a negative impact on an individual’s health. Food safety is an area which has concern on the account of food on human health. Therefore, the present study was undertaken to assess the pesticide residue of the selected whole and processed food grains grown in Southern zone of Andhrapraadeh. The selected samples rice, redgram, blackgram and bengalgram were collected randomly from the farmers of 3 districts (Chittoor, Nellore and Kadapa) and homogenised.

The study had two aspects as field work and lab analysis. Field work included the procurement of samples from the farmers and to know the awareness of the farmers regarding the pesticide package of practices. The lab work included the analysis of nutritional quality and pesticide residue content.

The values of the proximates i.e., moisture, protein, fat, fibre, ash and carbohydrates were tabulated and the results obtained showed that there exists significant difference between whole and processed food grains with respect to all the 6 parameters of the four selected crops except for protein of blackgram, fibre and fat of rice, ash and carbohydrate of redgram and bengalgram.

The pesticide residual content of the selected whole and processed grains showed that average percent recoveries at the spiking levels were not detected (BDL) for any of the pesticides in all the samples. As the samples selected had enough safety limiting period the pesticide metabolites were degraded. Prolonged storage and exposure to pre-processing techniques also contributed for the declinement of pesticide residues. So, the pesticide residues of samples were declined. Therefore, cereals and pulses are safe for consumption.
Tomatoes are one of the most widely used and versatile vegetable crops. They are consumed fresh and are also used to manufacture a wide range of processed products.

Tomatoes and tomato products are rich in health-related food components, as they are good sources of carotenoids in particular lycopene, ascorbic acid (vitamin C), vitamin E, potassium, folate and flavonoids.

Gaur gum is a white to creamy coloured free flowing powder and free from extraneous matter. Its ability to suspend solids, to bind water by hydrogen binding and form strong tough films accounts for its rapid growth. It is used as thickener, stabilizer, and emulsifier in various industries. Keeping in view the utilization of guar gum, nutrition and health benefits of tomatoes, the present work has been carried out to develop guar gum based tomato ketchup powder.

Ketchup is the most important product of tomato and is consumed extensively. Tomato ketchup was prepared according to the standard recipe given by Srivastava (1994) and then the hydrocolloid guar gum was added in different concentrations i.e.0.5%, 1.0% and 1.5%. As the ketchup above 0.5% concentration attained thick consistency, the concentration of guar gum was reduced and the concentration of 0.2% and 0.5% was incorporated which resulted in a very good consistency of ketchup.

Tomato ketchup powder was prepared and standardized by mixing tomato powder with different spice powders along with sugar, salt and chilli powder. Then the hydrocolloid guar gum was added in different proportions i.e.0.5%, 1.0%, and 1.5%.

Various Physico-chemical and nutritional properties like colour, viscosity, moisture, protein, fat, carbohydrate, fiber, ash, acidity, TSS were analysed for tomato pulp, tomato ketchup and tomato ketchup powder.

The sensory evaluation of tomato ketchup and tomato ketchup powder was carried out by using nine-point hedonic scale before and after the storage period. The shelf life
studies were conducted one month for tomato ketchup and two months for tomato ketchup powder.

The lightness, hue and brightness value of tomato pulp were 20.87, 22.21 and 14.17 respectively. In tomato ketchup the lightness value for control and experimental samples i.e. G1 and G2 was 22.07, 23.51 and 25.58 respectively. The hue value for control and experimental samples i.e. G1 and G2 sample were 20.75, 20.60 and 18.25 respectively and the brightness value of control and experimental samples i.e. G1 and G2 was 13.22, 13.17 and 11.10 respectively.

The lightness value of tomato ketchup powder in the control and experimental samples i.e. KPG1, KPG2 and KPG3 were 59.95, 60.21, 60.31 and 60.40 respectively. The Hue value was 20.67, 20.58, 20.15 and 19.76 for control, KPG1, KPG2 and KPG3 respectively. The Brightness values were 32.35 (control), 32.23 (KPG1), 32.20 (KPG2) and 31.96 (KPG3) for control and the experimental samples.

The viscosity function data of tomato ketchup and reconstituted tomato ketchup powder revealed that viscosity decreased with increased shear rate. Among the tomato ketchup samples control had highest viscosity (7.87 pa.s) at the shear rate of 4.68 S$^{-1}$ and lowest viscosity (1.44 pa.s) at the shear rate of 34.38 S$^{-1}$. The highest viscosity for G1 sample (14.59 pa.s) was found at the shear rate of 4.68 S$^{-1}$ and lowest viscosity (3.28 pa.s) at the shear rate of 34.79 S$^{-1}$. The highest viscosity for G2 sample (20.51 pa.s) was found at the shear rate of 4.69 S$^{-1}$ and lowest viscosity (4.01 pa.s) at the shear rate of 34.59 S$^{-1}$.

Among the tomato ketchup powder samples control had highest viscosity (7.87 pa.s) at the shear rate of 4.68 S$^{-1}$ and lowest viscosity (1.44 pa.s) at the shear rate of 34.38 S$^{-1}$. The highest viscosity for KPG1 sample (10.32 pa.s) was found at the shear rate of 4.74 S$^{-1}$ and lowest viscosity (2.86 pa.s) at the shear rate of 34.87 S$^{-1}$. The highest viscosity for KPG2 sample (12.76 pa.s) was found at the shear rate of 4.65 S$^{-1}$ and lowest viscosity (2.27 pa.s) at the shear rate of 34.75 S$^{-1}$. The highest viscosity for KPG3 sample (16.65 pa.s) was found at the shear rate of 4.70 S$^{-1}$ and lowest viscosity (3.57 pa.s) at the shear rate of 34.90 S$^{-1}$.

The moisture, protein, fat, carbohydrate and fiber content in tomato pulp were 94.70g %, 1.00g %, 0.10g %, 3.50g % and 0.90g % respectively. The ash, sodium, carotenoids, titrable acidity and TSS of tomato pulp was 0.60mg%, 6.80mg %, 351μg, 1.59 % and 4.20 0°Brix respectively.

Among the tomato ketchup samples the moisture content in control and experimental samples i.e. G1 and G2 were 84.01g %, 80.05g % and 78.96g % respectively. The protein content of control sample was 1.36g% and 1.37g% in G1 and 1.38g % in G2 samples. The fat content was 0.25g % in control sample and it was 0.25g% and 0.24g % in G1 and G2 samples respectively. The carbohydrate content in control and experimental samples i.e. G1 and G2 was 10.01g %, 13.34g % and 14.80g% respectively. The fiber content in control sample was 0.97g % and in experimental samples i.e. G1 and G2 it was 1.10g % and 1.18g % respectively. The ash content was found to be 3.40mg% for control sample and it was 3.44mg % and 3.44mg % for the experimental samples i.e. G1 and G2 samples. The sodium content was 7.64mg % in control sample and 7.66mg % in the experimental samples i.e.G1 and G2 respectively. The carotenoid content for control sample was 252μg % and for the
Experimental samples i.e. G1 and G2 it was found to be 252.16µg % and 252.12µg %. The titrable acidity was 2.93mg% for both the control and G1, 2.94mg% was in G2 sample. The TSS was 25.34 °Brix, 26.16°Brix and 26.33° Brix respectively in control, G1 and G2 samples respectively.

Among the tomato ketchup powder samples the moisture content was 4.47g % in control sample and in the experimental samples i.e. KPG1, KPG2 and KPG3 it was 4.07g %, 4.03g % and 3.53g % respectively. The protein content in control sample was 11.30g % and it was 11.33g %, 11.33g % and 11.36g% in KPG1, KPG2 and KPG3 samples. The fat content was 2.24g % in control and KPG1 and it was 2.25g% in KPG2 and KPG3 samples. The carbohydrate content in control and the experimental samples i.e. KPG1, KPG2 and KPG3 was 70.22 g %, 70.17g %, 71.17g % and 70.22g % respectively. The fiber content in control sample was 3.07g % and in the experimental samples i.e. KPG1, KPG2, KPG3 it was 3.19g %, 3.22g % and 3.27g % respectively. The ash content was 8.90mg %, 9.00mg %, 9.00mg % and 9.33mg % respectively in control and the experimental samples i.e. KPG1, KPG2 and KPG3. The sodium content was 8.60mg% in control, 8.59mg% in KPG1 and 8.60mg% in KPG2 and KPG3 samples. The carotenoid content in control and experimental samples i.e. KPG1, KPG2 and KPG3 was 432μg %, 431.60μg %, 431.60μg %, and 431.30μg % respectively. The titrable acidity in control sample was 3.91% and 3.93% in KPG1 and KPG2 samples and it was 3.94 % in KPG3 respectively. The TSS content was 25.33 °Brix, in control sample and in the guar gum incorporated samples i.e. KPG1, KPG2 and KPG3 it was 26.0°Brix, 26.33°Brix and 26.67°Brix respectively.

The sensory evaluation of tomato ketchup and tomato ketchup powder showed that different levels of guar gum incorporated in tomato ketchup and tomato ketchup powder had significant effect on consistency. The optimum consistency for tomato ketchup was obtained at 0.2 % and for tomato ketchup powder it was 1 % concentration.

The tomato ketchup was stored at room temperature for 1 month and tomato ketchup powder for 2 months in polypropylene packing material and evaluated by the same group of sensory panelists at the end of storage period. Statistically significant difference was not observed in sensory parameters like colour, flavor, taste, aroma consistency and overall acceptability in both the products i.e. Tomato ketchup and Tomato ketchup powder after storage.

This study indicated that guar gum which acts as a thickener can be used in the preparation of instant tomato ketchup powder mix and tomato ketchup which can be industrially exploited and can thereby be available at lower cost and with good nutritional value.

Preparing ketchup and storing it for the longer time may cause bacterial growth and lead to spoilage. Ready to use ketchup powder mix can be prepared which can be stored for a longer period without microbial contamination and easily transported to long distance with less storage space and less cost of transport. Such instant mixes can fetch high market demand as this will reduce the cost and provide acceptable quality ketchup with good nutrition to the consumer.
Pasta is a highly acceptable food worldwide and is generally produced from wheat semolina. The commercially produced pasta is rich in starches and protein. The addition of millet flours to the pasta will improve the dietary fiber content addition of Flax seed provides Omega-3 fatty acid. In the present study, wheat and wheat+millet pasta were formulated at 5, 10 and 15% incorporated levels of whole flaxseed flour.

Among the tested formulations, wheat and sorghum pastas at 5% incorporation of flaxseed flour were rated high sensorially. The overall acceptability, color, texture, flavor were rated high for the 5% flaxseed flour incorporated pasta compared to the control. The firmness increased and the stickiness decreased due the incorporation of flaxseed flour into pasta. Bulkiness increased due to the increased fiber content in wheat pasta but decreased in wheat+sorghum pasta. There was a proportionate decrease in acceptability with the increase in percentage of flaxseed flour due to the change in color of the pasta.

Cooking quality tests on pasta showed higher water absorption as the incorporation level increased. Swelling indices were observed to be higher in sorghum pasta compared to wheat and increased proportionally as the flaxseed flour percent increased. Cooking losses were observed to be higher in pasta with higher levels of flaxseed flour due to weak starch protein matrices. Other cooking qualities like dry matter and cooking time also showed marked difference from the control samples but no significant difference was observed in the acceptability and overall quality of the pasta.

Proximate analysis of the formulated pasta products showed an increase in protein, fat and dietary fiber content as the incorporation levels of FF increased. It was revealed that flaxseed incorporated pasta was better in terms of nutritional profile when compared to the control pasta. Protein levels increased by 30% at the highest level of flaxseed flour (15%) and dietary fiber increased by almost 4 times in the pasta from 2.4 in control to 8.7 in 5% flax incorporated sorghum pasta.
The Omega 3 (ALA) content increased progressively with the increase in flaxseed flour levels. The values were 112-114mg/g pasta for 5% flaxseed flour, 200-228mg/pasta for 10% and 340-343mg/g for 15% flaxseed flour. Requirements of adults are met by 30 g of uncooked pasta containing 5% flaxseed flour. Omega-3 and Omega-6 fatty acids were found to be 50% and 15% respectively in the ground flaxseed flour and did not differ after processing.

The storage studies indicated that there was no deterioration in the wheat pasta up to 15% incorporation of flaxseed flour until 3 months. In case of sorghum pasta shelf life studies indicated that it was stable only at 5% level. The overall acceptability was the same for 5% FF wheat and sorghum pasta before and after 3 months storage.

Therefore, the present study on the development and evaluation of millet and wheat based pasta incorporating flaxseed flour establishes that there is a possibility of incorporation of whole flaxseed flour into cereal products like pasta. The improved nutritional profile of the formulated pasta shows that new products can be formulated by incorporating flaxseed flour. Due to these factors the formulated pasta can be promoted as a health food in general and as a functional food which has protective effects against cardio vascular diseases.
Use of fertilizers and pesticides increased with Green revolution. Since then there has been a steady increase in their use for different crops. It has been established that indiscriminate and improper use of pesticides is hazardous for human and animal health. Pesticide residue has also become an important parameter of quality assessment of food crops for both domestic and export market. With this background it was felt necessary to study the pesticide levels for major crops grown in different regions of the state, which will help in monitoring the quality of the crops being produced. Therefore, this project was taken up in the Southern Telangana Zone of Andhra Pradesh.

The package of practices with respect to usage of pesticides, most commonly used primary processing techniques of Jowar, Maize, Red gram and Black gram in the Southern Telangana Zone was collected from pre-tested personal interview schedule.

The results of the study showed that majority of the farmers preferred to cultivate drought tolerance crops like Jowar and Maize in both Kharif and Rabi seasons. Less percentage of farmers cultivated Red gram followed by black gram. Most of the farmers (70.0%) were marginal farmers (1-5 acres) while few farmers (16.6%) had 5-10 acres and only 10.0% of them had 10-15 acres and only 3.3% had above 15 acres of land for cultivation. The yields of the crops from all respondents were as per the standard recommendations in Vyavasaya Panchangam.

Carbofuran (+66.6%), Monocrotophos (+56.2%) and Quinalphos (+25.0%) were used over and above the recommended. Majority of the farmers (40.0%) used the seed from the previous crop or procured from private shops, while from government Cooperative society (10.0%) and Regional Agricultural Research Station (10.0%). Pesticides were procured from private shops (96.6%) by farmers while few farmers (3.3%) followed their own formulations. All the farmers followed the recommended post harvest interval period of pesticide
application for all selected crops. All the crops studied were subjected to primary processing like milling (Jowar and Maize), dehulling (Red gram and Black gram) before consumption. Most of the farmers stored Jowar and Maize for home consumption whereas pulses were for sale. 90.0% of farmers stored food grains in jute bags followed by tins (6.6%) and bins (3.3%). Even though over the years the number of the pesticides used has increased (76.6%), the frequency of application has decreased (66.6%). However, even with decrease in the quantity of the pesticide used (70.0%), the health associated problems have increased (56.6%). The choice of pesticide by farmers is being influenced by the shop keeper’s advice (46.6%) followed by that of AEO/AO (20.0%), neighbours (13.3%), head of the family (10.0%) and pesticide labels (6.6%). Majority of farmers (60.0%) do not take any precautions while preparing and applying the pesticide mix. Only 13.3% of them used only mask, 10.0% used only gloves and 16.6% people used both. The health associated problems experienced after application of pesticides by farmers included headache (83.3%), skin rashes (23.3%), vomiting (20.0%), diarrhoea (13.3%) and blurred vision with burning eyes (3.3%).

Maize, Jowar, Redgram and Blackgram samples were procured from farmers of various villages of Mahaboobnagar, Nalgonda and Ranga Reddy Districts and Regional Agricultural Station (RARS), Palem, Southern Telangana Zone of Andhra Pradesh. The samples were primarily processed into dehulled and milled products at College of Home Science, Saifabad, Hyderabad.

Pesticide residues were estimated in whole and processed food grains using Gas chromatography with ECD/ NPD. Analytical results showed that pesticide residues in whole and processed forms of Jowar, Maize, Red gram and Black gram were Below Detectable Limits (BDL).

Residues of pesticides in food are reduced in time, handling and processing that occur between harvesting of raw agricultural commodities and consumption of prepared foodstuffs. Residues of post harvest insecticide treatment on stored staples such as cereal and pulse grains generally decline slowly.

Moisture, Protein, Fat, Ash and Crude fiber was estimated by standard methods (AOAC, 2005) in selected whole and processed grains. Moisture, Fat and Protein values of whole and processed food grains were significantly different. Results showed that ash content in Red gram; Crude fiber and Carbohydrate in Red gram and Black gram were significantly different with processed grains showing higher percentage of nutrient content.
FOODS & NUTRITION

Author: RAMCHANDANI, N.M.

Title of the thesis: PESTICIDE RESIDUE CONTENT AND NUTRITIONAL QUALITY OF SELECTED WHOLE AND PROCESSED FOOD GRAINS GROWN NORTH COASTAL ZONE OF ANDHRA PRADESH

Major Advisor: Dr. K. UMA DEVI

Degree: M.Sc.

College: POST GRADUATE RESEARCH CENTRE, RAJENDRANAGAR

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Pesticides have become an integral part of crop cultivation practices. This may be attributed to rapidly increasing population which has posed a stress on the food production industry. Despite resulting in bountiful production, pesticides also pose a serious threat to mankind. Cereals and pulses form a major part of an average Indian diet and are thus usually consumed in reasonably larger quantities. Therefore, it becomes essential to analyze their pesticide residue content if any, so as to identify whether they may be safely consumed in such proportions.

The present study was designed to compare the proximate nutrient content and the pesticide residue levels of the selected crops before and after processing. The intention was also to determine whether the pesticide residue levels, if present, of whole and processed crops were within the Maximum Residue Levels (MRLs). The information on the package of practices adopted by the farmers and their comparison with the recommendations has been studied.

The farmers were selected using random sampling technique. Eighteen rice farmers and ten each of ragi, maize, black gram and green gram were selected and interviewed using the structured questionnaire. The questionnaire enumerated the cultivation practices deployed, with special reference to pesticide application. The pesticide dosages applied were compared against the recommendations specified by the Regional Agricultural Research Station, Anakapalle, in order to check whether the interviewed farmers adhered to the recommendations or any deviations existed. Samples of each of the selected crops were collected from the interviewed farmers and homogenized. Standard sampling techniques were used at each level of sample selection until the required quantity of sample feasible for chemical analysis was obtained.

The primary processing techniques adopted for the selected grains were also known through the structured questionnaire, with an aim to apply similar processes in laboratory settings and thereafter subject. Processing done for rice was boiling. Black gram and green
gram were cleaned and dehulled. Ragi and maize were milled to flour. Milled rice, whole
ragi, maize, black gram and green gram were taken as raw samples.

Proximate nutrient compositions of the selected whole and processed crops were
analyzed. The results thus obtained were statistically analyzed and interpreted using 2-way
factorial ANOVA and it was found that the nutrient composition of raw grains were
significantly different from the processed ones. Fiber, as obvious was high in raw grains
compared to the processed ones due to the presence of husk in the former. The protein and
fiber content of maize and ragi did not change significantly after processing. The fat content
of ragi and black gram did not change significantly after processing. There was no significant
difference between the carbohydrate content of raw and processed ragi. Green gram moisture
content also did not change significantly after processing.

The proximate nutrients thus analyzed were checked against the values specified by
the National Institute of Nutrition and slight deviations were observed.

During the pesticide residue analysis, it was found that pesticide residue levels in all
the selected crops were below detectable limits (BDL), therefore no statistical analysis or test
could be applied to them. This could be attributed to the fact that the pesticides were applied
below the levels recommended by the Regional Agricultural Research Station, Anakapalle.
Also the post-harvest time reported was too long which could have led to the loss of the
pesticide into the environment. It may be noted that the selected crops were cereals and
pulses that come under the category of non-perishables and do not require any pesticide
application in the post-harvest period; this could have also contributed to the lower pesticide
residue levels.

Therefore, it may be derived from the findings of this study that the crops specifically
studied under it viz., rice, ragi, maize, black gram, green gram cultivated in the North Coastal
Zone of Andhra Pradesh may be safely consumed without the risk of high pesticide residue
content.
The prevalence of overweight and obesity appear to be increasing at an alarming rate. Pressures from the “obesogenic” environment are driving up obesity rates and it is observed that a large number of obese children maintain their obesity into adulthood when the risk of obesity-associated morbidity is much higher. Therefore an attempt was made to assess the nutritional status of obese preschool children and identify the associated factors of obesity among these preschoolers. The objective of the study was to assess the nutritional status of obese preschool children by anthropometric assessment and dietary assessment and identify the causative factors for childhood obesity and study the knowledge, attitude of mothers related to childhood obesity and find out the dietary practice followed by the mothers in regard to their children.

From the selected five private schools boys and girls of preschool age, 3-5 years were screened for BMI and 30 children with BMI >95th percentile were selected as obese children and 30 children with BMI between 25th - 50th percentile were selected as non-obese controls.

Nutritional status of preschool children was assessed by taking their height, weight, mid upper arm circumference and triceps skin fold measurements. Parent’s BMI was assessed from their height and weight measurements. A three day- 24 hour diet recall survey on obese and non obese preschool children and their parents provided average food intake of each individual, from which proximate nutrients and energy intake was calculated. Mothers of non-obese and obese children were assessed for their knowledge, attitude and practices related to obesity in children using the questionnaire developed as part of the research work.

The demographic and socio-economic and cultural factors associated with obesity indicated that more number of girls compared to boys and more number of 4-5 year old children compared to 3-4 year preschool children were found to be obese. The incidence of obesity among preschool children was high whose mothers had graduate level of education and were homemakers and fathers who had PG/professional level of education. All the obese preschool children belonged to nuclear family with a family size of < 4 members and medium size 5-6 members.
Mothers of obese children in general entered pregnancy with a greater body weight compared to non-obese group mothers. The incidence of obesity among preschoolers born under cesarean delivery was 1.7 times more than children born under normal delivery. Sixty three percent of obese children were born under cesarean delivery. In any birth order girls were found to be more obese than boys and more of first born children were obese compared to second and third born children. Seventy percent of the obese children had a birth weight of 3.0- 4.0 kg. Early introduction of supplementary foods among obese children has been observed. The higher percentage of commercial food supplements fed to the obese children laid foundation for obesity at infancy, which must have continued to preschool age. Majority of obese children were reared by the mothers unlike some non obese, who were taken care either by grandmothers or care takers.

Both boys and girls of obese category were taller (>50th percentile) indicating the lack of association between stunting and obesity among preschoolers. There was a significant difference between the weights and BMI of non-obese and obese children, but triceps skin fold measurements of the preschool children showed similar trends in percentile distribution. The MUAC of obese boys and girls matched with 75th, 90th and 95th percentiles of NHANES I. Irrespective of wide variation in body weight and BMI of both the groups the individual Mid upper arm circumference was found to be a determinant of BMI of obese children (p<0.05) after applying linear regressions equations.

The average height of parents of both the groups showed no significant difference. The weight was significantly high among mothers (p<0.05) and fathers (p< 0.01) of obese children compared to the mothers and fathers of non obese children. The BMI of mothers of non-obese was low (p<0.05) compared to mothers of obese preschool children. Fathers of obese children also had high BMI (p<0.01). Mothers (90%) and fathers (70%) of obese children were obese or overweight. BMI of mothers of non-obese children influenced their children’s BMI (p<0.05) and the height of fathers of non-obese children influenced their children heights (p<0.01).

Obese children relatively had a very high intake of carbohydrate (251 ± 87 gm), protein (46 ± 11.8gm), fat (71.4 ± 18 gm) and a total energy intake (1857 ± 525 kcals) which were significantly high compared to non obese children. The percent calories consumed from carbohydrates, protein and fat showed no significant difference between the groups. Obese children of 3-4 years consumed on an average 184% more fat, 187% more protein, 96% more energy while, non obese also consumed 84% more fat,122% more protein, 10% more energy compared to recommended dietary allowances. The obese children of 4-5 years showed a high fat intake of 177% Vs 7% in non-obese, protein of 199% Vs 93% non-obese and 37% energy compared to age specific requirements. The carbohydrate intake of 3 -4 yr children strongly influenced their energy intake (p<0.01), whereas, carbohydrate and fat intake among the 4-5 year old obese children and only fat intake in non-obese children showed a strong influence on their energy intake (p<0.01). Results also indicated that anthropometric measurements of non-obese and obese children did not determine their energy intake. Though majority of fathers and mothers were found to be obese, their dietary intake, especially energy and protein were found to be around 30- 34% less than the recommended dietary allowances.
Response to knowledge and attitude tests showed that mothers of obese children had better knowledge and attitude compared to mothers of non-obese children. The practice of consuming snacks several times a day, binging snacks while watching television, between meals and all the day was observed to be relatively high in obese children. Obese children spent longer hours sitting and watching television and more mothers of obese children didn’t allow them to play outdoors. A marked difference was found in the readiness of non-obese children for physical activity compared to the obese children.

Attitudes and practices outweigh the role of parental knowledge in maintaining normal nutritional status of preschool children. Children of obese or over weight parents, the first born children, commercial supplements fed at infancy, ignoring binge habits in children, allowing passive TV watching, not allowing any outdoor physical play, feeding high calorie nutrients in quantities of two to three times more than requirements for their age were found to be the crucial factors in causing obesity among preschool children. Motivation and training of parents for acquiring skills of correct feeding and engaging the preschoolers in more physical play might be the solution.
The current investigation was undertaken to estimate pesticide residues in selected cereals and pulses grown in the Northern Telangana zone of Andhra Pradesh. The major districts were Karimnagar, Nizamabad and Adilabad. The crops collected for study were jowar, maize and soyabean. The recommended package of practices and the farmers’ pattern of pesticide usage were studied using a structured questionnaire. Information was obtained on the pesticides used in the zone, the dosage they applied, yield of crops, the source of procurement of pesticides, the persons and sources who advised them on pesticide usage, the storage structures, the processing and cooking practices, implications on health of farmers and the annual expenditure on pesticides. Thirty farmers were selected randomly for the study. Besides, the study included the estimation of proximate composition of the selected food grains from the zone. The proximate analyzed were moisture, protein, fat, ash, fiber and carbohydrate. The food samples were analyzed in two parts, whole and processed. The methods followed were that of Association of Official Analytical Chemists (AOAC). A multiresidue determination procedure was used to analyze pesticides by the gas chromatogram. The experimental aspect of the study was undertaken at the Quality Control laboratory, A.N.G.R.A.U. The pesticides analyzed in jowar, maize and soyabean were monocrotophos, acephate, chloropyrifos, quinalphos, carbofuran and endosulfan. Endosulfan is the exceptional pesticide that belongs to the organochlorine group of pesticides with the rest belonging to organophosphate group.

The pesticide residues analyzed in jowar, maize and soyabean were below the detection limits (BDL). Residues of pesticides are relatively less likely to persist in cereals and pulses than in vegetables or fruits. The amounts of residues thus detected are low to negligible. This perhaps is due to the fact that cereals and pulses contain lower moisture, thus not enabling pesticide residues to persist post harvest.

Farmers in the zone experienced many health implications as a consequence of unsafe handling and application of pesticides. There is an immense lack of awareness among farmers in the zone with regard to the safe practice in administering pesticides. Most of the
farmers, being small, did not have the affordability to administer the recommended dosage of pesticides, eventually; the yield among them was lower than that expected.
FOODS & NUTRITION

Author: SHARAT, ENUCONDA.

Title of the thesis: UTILIZATION OF GUAR GUM IN THE PREPARATION OF TOMATO SAUCE POWDER

Major Advisor: Dr. K. UMA MAHESWARI

Degree: M.Sc.

College: POST GRADUATE RESEARCH CENTRE, RAJENDRANAGAR

Accession Number: D 8927

Product diversification is the need of the hour due to rapid changes in socio-economic living patterns in the cities. Further more, with the increase in life expectancy as well as standard of living, people now, not only require convenience but also anticipate health benefits from the foods.

Plant gums and mucilages possibly belong to a functional group. Plant gums are mostly exudates which may be produced at the site of injury to the plant, while mucilages are found in different parts of the plant particularly in seeds and bark. Guar gum is a white to creamy coloured free flowing powder and free from extraneous matter. Its ability to suspend solids, to bind water by hydrogen binding and form strong tough films accounts for its rapid growth and uses in various industries. Keeping in view the utilization of guar gum, nutrition and health benefits of tomatoes, the present work has been carried out to develop guar gum based tomato sauce powder.

The optimum cooking time of tomatoes was standardized as 3 min as it had maximum pulp recovery and solid recovery at this period.

Tomato sauce was prepared according to the standard recipe and then the hydrocolloid guar gum was added in different concentrations i.e.0.5%, 1.0% and 1.5%. As the sauce above 0.5% concentration has attained thick consistency, the concentration of guar gum was reduced and the concentration of 0.2% and 0.5% was done which resulted in a very good consistency of sauce.

Tomato sauce powder was prepared and standardized by mixing tomato powder with different spice powders along with sugar, salt and chilli powder. Then the hydrocolloid guar gum was added in different proportions i.e.0.5%, 1%, and 1.5% etc.

Various physico-chemical and nutritional properties like colour, viscosity, moisture, protein, fat, carbohydrate, fiber, ash, sodium, carotenoids, titrable acidity and TSS were analyzed for tomato pulp, tomato sauce and tomato sauce powder using standard methods of AOAC.
The sensory evaluation of tomato sauce and tomato sauce powder was carried out by using nine-point hedonic scale before and after the storage period. The shelf life studies were conducted for one month for tomato sauce and for two months for tomato sauce powder and again the sensory evaluation was carried out for both the tomato sauce and tomato sauce powder.

The lightness, hue and brightness values of tomato pulp were 20.87, 22.21 and 14.17 respectively. In tomato sauce the lightness values of control and experimental samples i.e. G1 and G2 are 22.07, 23.51 and 25.58. The hue value of control and experimental samples i.e. G1 and G2 are 20.75, 20.60 and 18.25 and the brightness values of control and experimental samples i.e. G1 and G2 are 13.22, 13.17 and 11.10 respectively.

The ‘L’ values of tomato sauce powder in the control and experimental samples i.e. SPG1, SPG2 and SPG3 were 59.95, 60.21, 60.31 and 60.40 respectively. The Hue values were 20.67, 20.58, 20.15 and 19.76 for control, SPG1, SPG2 and SPG3 respectively. The Brightness values were 32.35 (control), 32.23 (SPG1), 32.20 (SPG2) and 31.96 (SPG3) for control and the experimental samples.

The viscosity function data of tomato sauce and reconstituted tomato sauce revealed that viscosity decreased with increased shear rate. Among the tomato sauce samples i.e control, G1 and G2 the viscosity was found to be highest for all the samples at lowest shear rates i.e. 7.8726 N, 9.3394 N and 14.591 N and lowest at maximum shear rates that is 1.447 N, 2.059 N and 3.289 N.

For the tomato sauce powder samples i.e. SCP, SPG1, SPG2 and SPG3, the viscosity was found to be 7.8726 N, 8.7135 N, 9.6944 N and 10.321 N at lowest shear rates and at the maximum shear rate it was found to be 1.447 N, 1.4826 N, 1.9863 N and 2.8625 N for SCP, SPG1, SPG2, SPG3 samples respectively.

The moisture, protein, fat, carbohydrate and fiber content in tomato pulp were 94.70g%, 1.00g%, 0.10g%, 3.50g% and 0.90g% respectively. The ash, sodium, carotenoids, titrable acidity and TSS content of tomato pulp were 0.60 mg%, 6.80 mg%, 351μg, 1.59% and 4.20 °Brix respectively.

Among the tomato sauce samples the moisture content in control and experimental samples i.e. G1 and G2 were 84.10g%, 80.90g% and 78.96g% respectively. The protein content of control sample was 1.27g% and 1.30g% in G1 and 1.32g% in G2 samples. The fat content was 0.25g% in control sample and it was 0.25g% and 0.24g% in G1 and G2 samples respectively. The carbohydrate content in control and experimental samples i.e. G1 and G2 was 10.52g %, 14.17g% and 16.25g% respectively. The fiber content in control sample was 0.97g% and in experimental samples i.e. G1 and G2 it was 1.10g% and 1.18g% respectively. The ash content was found to be 2.11mg/100g for control sample and it was 2.14mg/100g and 2.17mg/100g for the experimental samples i.e. G1 and G2 samples. The Sodium content was 7.66mg/100g in both the control and the experimental samples i.e. G1 and G2 respectively. The carotenoid content for control sample was 254.20 μg/100g and for the experimental samples i.e. G1 and G2 it was found to be 254.10 μg/100g and 254.00 μg/100g.
The titrable acidity was found to be similar for both the control and the experimental samples i.e. for G1 and G2 (2.93mg/100g).

The TSS content was 26.33\(^{0}\) Brix, 27.33\(^{0}\) Brix and 27.50\(^{0}\) Brix respectively in control and G1 and G2 samples.

Among the tomato sauce powder samples the moisture content was 4.46g% in control sample and in the experimental samples i.e. SPG1, SPG2 and SPG3 it was 4.06g%, 4.03g% and 3.53g% respectively. Protein content in control sample was 10.30g% and it was 10.33g%, 10.34g% and 10.36g% in SPG1, SPG2 and SPG3 samples. The fat content was 2.43g% in control, SPG1 and SPG2 samples and it was 2.44g% in SPG3 sample. The carbohydrate content in control and the experimental samples i.e. SPG1, SPG2 and SPG3 was 68.69g%, 70.48g%, 71.12g% and 71.42g% respectively. The fiber content in control sample was 3.06g% and in the experimental samples i.e. SPG1, SPG2, SPG3 it was 3.23g%, 3.26g% and 3.36g% respectively. The ash content was 9.12mg/100g, 9.19mg/100g, 9.24mg/100g and 9.31mg/100g respectively in control and the experimental samples i.e. SPG1, SPG2 and SPG3. The sodium content was 8.60mg/100g in control, SPG1 and SPG3 samples and 8.59mg/100g in SPG2 sample. The carotenoids content in control and experimental samples i.e. SPG1, SPG2 and SPG3 was 432μg/100g, 431.60μg/100g, 431.60μg/100g, and 431.30μg/100g respectively. The titrable acidity of control and SPG1 samples was 3.91% and in SPG2 and SPG3 it was 3.92% respectively. The TSS content was 25.66\(^{0}\) Brix, in control sample and in the guar gum incorporated samples i.e. SPG1, SPG2 and SPG3 it was 26.00\(^{0}\) Brix, 27.33\(^{0}\) Brix and 27.66\(^{0}\) Brix respectively.

Statistically significant differences at a P<0.05 were observed in moisture, carbohydrate and fiber contents when control sample was compared to that of experimental samples in both tomato sauce and powder. It was mainly due to the addition of guar gum which increased the carbohydrate and fiber content and decreased the moisture content.

The sensory evaluation of tomato sauce and tomato sauce powder showed that different levels of guar gum incorporated in tomato sauce and tomato sauce powder had significant effect on consistency. The optimum consistency for tomato sauce powder was obtained at 1.5 percent and for tomato sauce it was 0.5 percent concentration.

The tomato sauce was stored at room temperature for one month and tomato sauce powder for two months in polypropylene packing material and evaluated by the same group of sensory panelists at the end of storage period. Statistically significant difference was not observed in sensory parameters like colour, flavor, taste, aroma consistency and overall acceptability in both the products i.e. tomato sauce and tomato sauce powder after storage.

This study indicated that guar gum which acts as a thickener can be used in the preparation of instant tomato sauce powder mix and tomato sauce which can be industrially exploited and can there by be available at lower cost and with good nutritional value.
Keeping in mind the need for developing value added, ready to eat snack bars using different functional foods for combating or preventing malnutrition in different segments of population, this project was planned to develop amaranth based nutritious snack bars.

Apart from grain amaranth and Jaggery (basic recipe), experimental bar contained ingredients like pumpkinseeds, sesame seeds, tofu, groundnuts, gum acacia and Jaggery. The bars, both basic and experimental were prepared and analysed for moisture, energy, protein, fat and crude fibre using standard analytical methods. The bars were packed in HDPE and LDPE covers and assessed for shelf life, change in acceptability and microbiological quality before and after storage of one month at room temperature.

The experimental sample was found to have better acceptability for fresh and stored products. Experimental product showed better texture than the basic product.

The moisture content of basic bar was found to be 3.8 g% whereas it was 4.1 g% for the experimental bar. The protein content was found to be 9.70 g% in basic bar and 10.3 g% in experimental bars. Fat content of basic bar was 2.62 g% experimental bar it was 2.84 g%. Ash content of the basic bar was found to be 2.2 g% whereas the ash content of experimental bar was 2.28 g%. Calcium content of the both the bars was determined and the calcium content in basic bar was 472.2 mg% whereas for experimental bar it was 473.09 mg%. Iron content of basic bar was found to be 11.5 mg% and for experimental bar it was 16.35 mg%.

The sensory parameters evaluated were colour and appearance, texture, taste, flavour and overall acceptability for both basic and experimental bars. The scores for colour of the bars ranged from 3.5 to 4.5 and texture 3.2 to 4.2 on hedonic scales of 5 point. The scores for flavour, taste, and overall acceptability ranged from 2.4 to 4.3, 2.7 to 4.5 and 3.9 to 4.9. All the parameters were highly rated by all the panellists for experimental bars than basic bars. There was no significant change in taste, texture, colour, flavour and overall acceptability of both the basic and experimental bars during the entire storage period. The interaction between treatments and packaging material was found to be non-significant (p>0.05) during storage period on overall acceptability of grain bars. Microbial analysis...
indicated that TBC and TMC count in the fresh bars was 10cfu / g for the basic product where as the experimental bars had these counts below detectable levels (BDL).

The cost per kg of basic bar was calculated to be Rs/- 8.00 per 100g and for experimental bar it was calculated to be Rs/-12.00 per 100 g of the product. The calculated price was comparable to the bars available in market.

From the present study, it can be concluded that the value added amaranth based nutritious bar would be very useful in supplementing some of the nutrients for the school age and adolescent group. In this connection, grain bars have an advantage over other food items used for supplementation, in that, a bar can come in handy when there is no time to sit down and eat a food item as in case of school children, college going adolescents, working men or women or in case of sport persons. Hence, the product nutritious bar can be explored, for commercialization as a step in this direction will go along away in improving in utilization of the amaranth grain.
WITHANIA somnifera (WS) possess therapeutic value against a large number of ailments such as mental diseases, asthma, inflammation, arthritis, rheumatism, tuberculosis, infections, fever and a variety of other diseases including cancer. WS root powder was incorporated into biscuit that are prepared from sorghum and wheat alone and sorghum (70%) and wheat (30%) blend. WS was added to the biscuit formulations at 1.5, 2.0 and 2.5% and tested for sensory quality and consumer acceptability. The sensory evaluation by the trained panel revealed that the mean score for various sensory parameters for control sorghum biscuits ranged from 3.7 – 4.3 where as for WS fortified biscuits ranged from 2.9 to 4.0. Significant (at 5% level) difference was observed in the textural quality between control and WS fortified sorghum biscuits.

Similar trend was observed in the biscuits made from sorghum + wheat blend where in the biscuits without WS had scores of overall acceptability ranging from 3.3 to 4.3 and those with WS from 2.5 to 4.0. There was significant difference between control and WS fortified wheat biscuits. However in case of the wheat biscuits this was quite different and showing higher mean scores (2.9 - 4.2) with addition of WS than that of without WS (3.7 to 4.1). Significant difference was observed between control and WS fortified wheat biscuits (P< 0.05).

The mean score of sorghum sweet biscuits ranged from 3.7 - 4.1 and those in WS incorporated sorghum sweet biscuits from 2.4- 4.2. The high range in WS fortified biscuits indicates that there is wide variation in the scores and can be attributed to the two extremes in the acceptance level of the panel with regard to the taste and flavor of the biscuits. This shows that the inclusion of WS in sorghum biscuits might have contributed to the sensory acceptability in some sensory attributes.

Similar trend has been observed in case of sorghum + wheat sweet biscuits, where in the scores for biscuits without WS ranged from 3.7-4.0 and those in with WS from 2.4-4.2. There was significant difference at P<0.05 between control and WS fortified biscuits.

In case of biscuits made from wheat the sensory scores ranged from 3.9-4.3 and those in WS fortified biscuits from 2.7-4.2. Significant difference was observed between the
samples. These studies indicate the inclusion of WS in biscuits influenced the sensory scores differently in different food models. The lower score in the WS fortified biscuits can be attributed to the native bitterness of the WS powder and this was less pronounced in sweet biscuits made out of sorghum than in other biscuits. The acceptability was decreasing with the increasing concentration of the WS.

Withaferine A content was found to be 0.215g/kg and 0.0023g/kg in root powder and 2.5% WS incorporated biscuits respectively. Malonyldialdehyde (MDA) which is an indicator of lipid peroxidation and as a measure of antioxidant capacity was found to be 284.5, 450.1, 377.9, 420.5 and 351.7 n mole/100g of WS powder, SW-SWT0, SW-SWT3, SA-SWT0 and SA-SWT3 respectively.

Sensory analysis of the biscuits made with and without WS incorporation revealed that the acceptability of these biscuits were almost equal at 1.5% inclusions in salt and sweet biscuits. However with increased level of inclusion there was a decreasing trend in the overall acceptability. The study found the optimum level of WS inclusion in biscuits model as 1.5% and beyond that sensory quality is affected. The studies on consumer evaluation confirmed that biscuits with 1.5 and 2.5% WS inclusion are almost equally accepted may be due to their perception levels. The study further indicated that among the three types of flour used for the biscuit preparation the sorghum and wheat flour blend found to be better accepted (6.7-6.9) for inclusion of WS compared to other type’s flours (6.3-6.6).

Nutrient analysis of selected biscuit formulations revealed that the percentage fat, protein and moisture content are decreasing as the percentage of WS is increased. The protein and fat content of biscuits ranged from 5-9.41% and 18.08-26.76% respectively. The mineral content was found to be 18.47-76.33mg/100g, 0.49-8.64mg/100g and 0.45-1.15mg/100g of calcium, iron and zinc respectively.

Shelf life studies revealed that free fatty acid content of fresh and stored biscuits (2 months) ranged from 0.21-0.49% and 0.22-0.53% respectively and these values are in the admissible levels.

The studies on the WS fortification of biscuits demonstrated that WS which is widely accepted as a therapeutic herb for many aliments can be utilized in food fortification such as biscuits. Further studies on the retention of other bioactive compounds and the clinical studies on the supplementation effect of these biscuits would be helpful in promoting these biscuits as a functional food.
In the present study residue levels of certain chlorines hydrocarbons, organophosphates (OP) and carbamates were determined. The nutritional quality of whole and processed, in four grains i.e. maize, bengalgram, groundnut and jowar and the effect of processing of grain on the residue levels was determined. Samples were procured from scarce rainfall zone of Andhra Pradesh, RARS Nandyal. By using a structured questionnaire, information was collected from 30 farmers of Anantapur and Kurnool districts on package of practices in relation to pesticide usage, storage, processing and consumption of grains. Residues were estimated by using multi residue analytical technique employing gas chromatograph (GC), with electron capture detector (ECD) equipped with capillary columns. In all the four grains, residue content was Below Detectable Level (BDL), the residues of grains are influenced by the storage, handling and processing that occurs between harvesting of raw agricultural commodities and consumption of prepared foodstuffs.

The proximates moisture, ash, protein, fat, fibre and carbohydrates were estimated. The moisture content of maize, bengalgram, groundnut and jowar were 7.05 g/100g, 4.95 g/100g, 3.65 g/100g and 7.35 g/100 g w.w. After processing, moisture content of maize reached to 7.95 g/100g. Bengalgram decreased to 4.55 g/100g, groundnut decreased to 2.4 g/100g and jowar increased to 7.4 g/100g. It is noticed that there is significant difference between the moisture content of selected whole and processed food grains.

The ash content of maize, bengalgram, groundnut and jowar were 1.35 g/100g, 3.15 g/100g, 2.6 g/100g and 1.6 g/100g w.w. After processing, ash content of maize increased to 1.5 g/100g, Bengalgram increased to 3.28 g/100g, groundnut increased to 2.7 g/100g and jowar decreased to 1.4 g/100g. It is noticed that there is no significant difference between the ash content of whole and processed food grains.

The protein content of maize, bengalgram, groundnut and jowar were 7.4 g/100g, 17.74 g/100g, 29.31 g/100g and 9.32 g/100g w.w. After processing, the protein content of selected grains was increased. The protein content of maize increased to 7.99 g/100g, bengalgram increased to 19.67 g/100g, groundnut increased to 29.83 g/100g and jowar
increased to 9.48 g/100g. It is noticed that there is significant difference between the protein content of whole and processed food grains. The fat content of maize, Bengalgram, groundnut and jowar were 3.5 g/100g, 4.07 g/100g, 38.73 g/100g and 2.7 g/100g w.w. After processing, fat content of maize increased to 3.52 g/100g, Bengalgram increased to 4.87 g/100g, groundnut increased to 39.68 g/100g and jowar decreased to 2.29 g/100g. It is noticed that there is no significant difference between the fat content of selected whole and processed food grains.

The fibre content of maize, Bengalgram, groundnut and jowar were 2.14 g/100g, 7.36 g/100g, 3.17 g/100g and 1.79 g/100g w.w. After processing, fibre content of maize decreased to 2.03 g/100g, Bengalgram decreased to 1.26 g/100g, groundnut decreased to 2.86 g/100g and jowar decreased to 1.39 g/100g. It is noticed that there is significant difference between the fibre content of selected whole and processed food grains.

The carbohydrate content of maize, Bengalgram, groundnut and jowar were 78.56 g/100g, 62.73 g/100g, 22.54 g/100g and 77.24 g/100g w.w. After processing, carbohydrate content of maize decreased to 77.01 g/100g, Bengalgram increased to 66.37 g/100g, groundnut decreased to 22.53 g/100g and jowar increased to 78.04 g/100g. It is noticed that there is significant difference between the carbohydrate content of selected whole and processed food grains.

Thus it is concluded that residues of none of pesticides were detected and the proximate content of food grains increased or, in some cases decreased after processing. The present study showed that storage, handling and processing that occurs between harvesting of raw agricultural commodities and consumption of prepared food stuffs were found more effective in reduction of pesticide residues. Therefore the grains grown in scarce rainfall zone of Andhra Pradesh are safe to consume, they may not pose any hazards to human health.
HOME SCIENCE EXTENSION

Author: RUBEENA, Md.

Title of the thesis: DESIGNING TRANSFER OF TECHNOLOGY (TOT) CALENDAR FOR WOMEN CLIENTELE OF K.V.K.S USING INFORMATION NEED ANALYSIS (INA) TOOLS- A STUDY IN CENTRAL TELANGANA ZONE, A.P.

Major Advisor: Dr. A. MARY SWARNA LATHA

Degree: M.Sc.

College: POST GRADUATE RESEARCH CENTRE, RAJENDRANAGAR

Accession Number: D 8915

With the fast development of new agricultural technologies, it is increasingly felt that the technical knowledge of the farm women acquired over the generations is not being updated. The vital aspect of transfer of improved farm related technologies to the rural women has largely been neglected. Training of farmers/farm women and inservice extension functionaries is a critical input for the rapid transfer of agricultural technologies. This aspect could not get due attention in the past, and thus it continued as weak linkage in the agricultural production system. To fill this vital gap, Indian Council of Agricultural Research has evolved Krishi Vigyan Kendras which are committed to vocational training and thus preparing farmers for adopting newer and productive technologies. It is a grass root level, open, flexible and innovative institution .It operates on the principle of teaching by doing and learning by doing.. In view of the fact that the existing technologies could not reach the rural women due to the failure in recognition of their information needs and also their inability to access available information in the areas of farming, homestead and animal husbandry etc.

Exploratory research design was adopted for the conduct of the study. Andhra Pradesh was selected purposively, as the designed TOT calendar can be adopted in KVKs under the administrative control of ANGRAU in A.P state. Two adopted villages from KVK, Wyra, Khammam district and two adopted villages from KVK, Malyal,Warangal district were selected for the study. Total sample size is 120 farm women i.e.,30 women clientele from each adopted village of KVK. The information needs of the women clientele were collected through PRA tools- Transect walk, Resource map and Seasonal analysis map and needs were analyzed using RBQ formula. Based on the identified needs, 30 experts from different fields were selected to identify the suitable technologies with help of a “Technology Information Schedule” as well as personal interaction.

Results shows that women clientele from four villages had total 28 needs in different areas. The needs expressed by women clientele were categorized into eight
major categories. Among all the needs in all categories, “Knowledge on suitable paddy varieties, availability and selection” (FM6) scored highest RBQ value (89.6), while “early detection of viral infections in backyard poultry and their preventive and curative measures” (LM 3) scored the lowest RBQ value (13.6).

Among all the needs, Seed treatment of paddy (FM 8) has been given the highest with the highest RBQ value (77.3) by the women clientele of Pinapaka village of Khammam district. The reasons may be that women farmers lack knowledge and skills of the latest seed treatment technologies in paddy crop which is a major crop in the district. Gender bias in transmission of information is also another reason. “Storage of fruits and vegetables at home level” which is under RM received the least priority with low RBQ value (30.7). It might be because of their satisfaction with the storage practices and also availability of fruits and vegetables in the market. In Gollapudi the “Need for control of sheep mortality during rainy season” (LM 5) was prioritized as the highest with high RBQ value (73.3). As it is the secondary source of income, lack of awareness about the viral infections, disease identification and non availability of veterinary suggestions are the problems expressed by the women clientele for perceiving the above need. “Common pests and diseases on paddy and remedial measures” (FM 4) was perceived least with low RBQ value (33.3) by women clientele because it is mainly due to lack of knowledge, illiteracy, dependence on husband. suggestions and they did not feel that it is a necessary need for them.

Among all the needs expressed by women clientele of Kalval village, “Construction of low cost backyard poultry sheds and their maintenance for fowl hygiene and safety” (LM 1) received first rank with highest RBQ value (83.3). Lack of awareness, lack of hygienic conditions, lack of safety measures for backyard poultry and inadequate knowledge on construction of poultry sheds with locally available resources made them to express this need. “Land preparation practices for cultivation of crop” (FM 9) was prioritized as the least with low RBQ value (21.9) because majority of the women clientele didn't recognize it as the felt need because most of the land preparation work will be done by their husbands. Kesamudram village women clientele expressed top priority for the need “Knowledge on suitable paddy varieties, availability and selection” (FM6). The reason could be that the major occupation is agriculture and major crop in this district is paddy and also due to lack of knowledge on selection of paddy seed, bias in dissemination of information by the extension personnel, they are showing keen interest to acquire the knowledge on seed selection. “Early detection of viral infections in backyard poultry and their preventive and curative measures” (LM 3) was given the least priority by the women.

Women clientele of all four villages expressed that they need training and promotion of market oriented products (RBQ value 71.7-45.7). Based on locally available resources, high tamarind availability, high milk productivity, high yield of tomato, sheep rearing, cotton stock availability, medicinal plants availability and abundant availability of turmeric.

Women clientele of two districts expressed two needs in nutrition management. Those two needs are supplementary food for children and package of practices for
prevention and control of anemia among all age groups of women which is a perennial nutritional issue for generations.

The rank order of information needs vary from village to village, hence the TOT calendar was designed for each village separately. Based on the opinion of the experts the TOT calendar depicting the activities to be undertaken, to satisfy the information needs of women clientele in four villages was prepared in accordance with agricultural season i.e. Kharif, Rabi and lean period. Based on revealed results action plan was prepared for disseminating of technologies to satisfy the information needs of women clientele.

As per the results of the present study, women clientele has multi disciplinary information needs ranging from knowledge, skill and accessibility for adoption. In spite of many years of agro-based extension programmes, women who actively involved in farm activities for more than ten years are still in need of basic information like seed treatment, seed selection etc. On one hand the experience and research finding reveal that women play greater role of up to 80 percent in agricultural activities and on the other hand women are still in need of basic information. This envisages the changed roles of SMS of KVKs from treating women clientele with luke warm attitude to rationale participation.
The present investigation consists of the following objectives: To study the personality development of orphan children in children's homes run by governmental and non-governmental organizations, the differences in the personality development of orphan children from governmental and non-governmental organizations and the relationship of self and institutional factors on the personality development of orphan children. The sample consisted of 60 girl children in the age range of 8-11 years with one year minimum duration of stay in the institution. Among these 60 girls, 30 girls from governmental and 30 girls from non-governmental institutions were selected purposively from Hyderabad city and the tools used were as follows. Children's personality questionnaire (CPQ) Form A was used to assess the personality dimensions of institutionalized children. An interview schedule was prepared and used to collect the general information of the children and their perceptions about institutional environment. A questionnaire was developed and used to collect the information of the personnel working with these children and to measure their personal qualities. An observational checklist was developed and used to collect the information about organizational facilities. The data obtained from the study was coded, consolidated, tabulated and analyzed by using appropriate statistical methods.

The major findings of the study are as follows: All the children were distributed almost equally among three age groups. Majority of the children (92%) had no serious health problems. Forty per cent of the children were in the III standard followed by II standard (30%). Seventy per cent of the children were staying in the institution for a period of 1-5 years. Sixty five per cent of the children had high perceptions about the institutional environment. Sixty percent of the caretakers belonged to the age group of 31-40 years, did not have any special training, had experience of 1-10 years and moderately had favorable personal qualities. Forty percent of the caretakers completed secondary education. The non-governmental institutions belonged to moderate category in terms of infrastructure, educational and recreational facilities and belonged to high category in terms of diet pattern, health facilities, monitoring and supervision. In all most all the organizational facilities like infrastructure, health, educational, recreational facilities,
monitoring and supervision, the governmental institution fell under low category except the diet pattern, which had fallen under moderate category.

In governmental institution, all children belonged to the low and moderate categories in personality dimensions like „Reserved vs Warm hearted., „Dull vs Bright., „Expedient vs Conscientious. and „Undisciplined self-conflict vs Controlled. and in the personality dimensions like „Phlegmatic vs Excitable., „Sober vs Enthusiastic., „Shy vs Venture some., „Zestful vs Circum spect individualism., „Forthright vs Shrewd., „Self assured vs Guilt prone. and „Relaxed vs Tensed. all children belonged to the moderate and high categories. But in personality dimensions like „Affected by feelings vs Emotionally stable. and „Tough-minded vs Tender-minded. all children belonged to the moderate category and similarly all children belonged to high category in the personality dimension „Obedient vs Dominant.. Overall, many children belonged to the moderate category in all most all personality dimensions.

In case of non-governmental institutions, all children belonged to the low and moderate categories in personality dimensions like „Reserved vs Warm hearted., „Dull vs Bright., „Expedient vs Conscientious. and „Undisciplined self-conflict vs Controlled. and in the personality dimensions like „Phlegmatic vs Excitable., „Obedient vs Dominant., „Sober vs Enthusiastic., „Shy vs Venture some., „Tough-minded vs Tender minded., „Zestful vs Circum spect individualism., „Forth right vs Shrewd., „Self assured vs Guilt prone. and „Relaxed vs Tensed. all children belonged to the moderate and high categories. But in personality dimension like „Affected by feelings vs Emotionally stable. all children belonged to the moderate category. Overall, many children belonged to the moderate category in all most all personality dimensions.

There was a significant difference between the children from governmental and non-governmental institutions in some of the personality dimensions. Children from non-governmental institutions were more emotionally stable, dominant, enthusiastic, shrewd and guilt prone compared to the children from governmental institution. Children from governmental institution were more excitable, expedient and undisciplined compared to their counterparts. Children from both governmental and non-governmental institutions were almost equally reserved, dull, venture some, ten deminded, individualistic and tensed as there was no significant difference between the two groups.

As age of the children increased they became brighter, emotionally more stable, dominant, conscientious, venture some, shrewder, guilt prone, tensed, tough-minded and zestful. Health of the children was found to be non-significant to all the personality dimensions. As grade level of the children increased they became more warm hearted, brighter, dominant, conscientious, venture some, shrewder, guilt prone, tensed and tough-minded. Long duration of stay in the institution made children brighter, more dominant and guilt prone. Children who had good perceptions about the institutional environment were more conscientious and shrewd. Age and experience of the caretakers were found to be non-significant with the personality of the children. Education, special training and favorable personality characters of the caretakers were found to be significantly and positively correlated to the personality of the children i.e. these three factors made children to become more warm hearted, bright, emotionally stable, excitable, dominant,
enthusiastic, conscientious, venturesome, tender-minded, individualistic, shrewd and controlled.

Infrastructure was found to be non-significant with the personality of the children. Diet pattern, health, educational, recreational and monitoring & supervision were found to be significantly and positively correlated to the personality of the children. i.e. good quality of food, good health, educational, recreational and monitoring & supervision facilities made children to become more warm hearted, bright, emotionally stable, excitable, dominant, enthusiastic, conscientious, venturesome, tender-minded, individualistic, shrewd and controlled.
RESOURCES MANAGEMENT AND CONSUMER SCIENCES

Author : HARSHITA JAIN
Title of the thesis : PREPARATION OF BRIQUETTES USING BIOMASS COMBINATION AND TESTING ITS EFFICACY
Major Advisor : Dr. (Mrs.) Y. VIJAYALAKSHMI
Degree : M.Sc. (Home Science)
College : COLLEGE OF HOME SCIENCE, HYDERABAD
Accession Number : D 8925

Adequate supply of energy at a reasonable cost is a key factor in the economic development of country. Biomass is the third largest primary energy resource in the world, after coal and oil. In all its forms, biomass currently provides about 1250 million tonnes oil equivalent (MTOE) of primary energy. In India plenty of biomass is available due to vast agricultural production. An overall potential of 17,000 MW of power generation through the use of various types of biomass materials has been estimated (Bhattacharya 2003). It is observed that several kinds of agricultural residues are available and are not ready to be utilized as fuel directly. As compared to other kinds of fuels, agricultural residues have lower energy density. Besides, the low density and dusty characteristics of biomass also cause problems in transportation, handling, storage, entrained particulate emission control and direct combustion.

The technology of briquetting is defined as the densification process for improving the biomass fuel characteristics. Substitution of wood and charcoal by biomass briquette, which is prepared from agricultural and forestry residues, appears to be an attractive option to alleviate the traditional fuel crisis faced by many developing countries (Hall et al. 1991). Biomass briquettes are eco-friendly renewable source of energy and avoid adding fossil carbon to the atmosphere. They have various advantages like saving the consumption and dependency on fuel wood, easy handing, transportation and storage; uniformity in volume and quality. Present study was undertaken to develop a standardized procedure to develop fuel from all available biomass materials which provides an alternative source of energy in rural areas and enhances the quality of life in the rural areas.

An experimental research design was adopted for present research. Six biomass materials charcoal dust, saw dust, rice husk, dry leaves, wood chips, groundnut shells and two binders cow dung and starch were selected on the basis of availability. All selected materials were made into briquettes with different standardized combinations. The physical characteristics, calorific value and efficacy were studied. The data obtained was analysed by using averages, standard deviations, correlation and ANOVA test.

Findings of the study:
Total fifteen combinations of briquettes were produced based on different biomass and binder combinations which were grouped into three major combinations i.e.: Group 1 = Saw dust + rice husk/dry leaves/ wood chips / groundnut shells + cow dung (binder), Group 2 = Charcoal dust + rice husk/dry leaves/ wood chips / groundnut shells + cow dung (binder) and Group 3 = Charcoal dust + rice husk/dry leaves/ wood chips / groundnut shells + starch (binder) + water.
The volume of the different types of the briquettes produced ranging between 219.80-282.60 cm³. The mean heights of the different varieties of briquettes were found to be in the range of 200-300 g, except one briquette i.e. combination of charcoal + starch (C-S-W) was found to be more in weight i.e. 550 g.

On the basis of physical characteristics i.e. texture, cohesiveness, moisture, shape, evenness of surface and appearance of surface the briquettes belonging to Group 3 scored the highest i.e. 12.33-14.83 and found to be the best.

The overall calorific value of briquettes belonging to Group 2 was found to be the highest i.e. 3468.6-3793.30 kcal.

Among the fifteen varieties of briquettes four briquettes were selected based on calorific value for efficacy test. The combination having lowest calorific value i.e. saw dust + rice husk + dry leaves + cow dung (S-RH-D-CD) and saw dust + rice husk + cow dung (S-RH-CD) were compared with the combinations having the highest calorific value i.e. saw dust + groundnut shells + cow dung (S-GS-CD) and charcoal dust + wood chips + starch + water (C-WC-S-W).

Two commercial briquettes made exclusively from saw dust (ComB1) and saw dust + groundnut shells + rice husk (ComB2) were also taken for standard references for comparison.

Water Boiling Test (WBT) was conducted to test the efficacy of briquettes in the conventional portable iron stove in controlled laboratory conditions.

The efficacy of briquette saw dust + rice husk + dry leaves + cow dung (S-RH-D-CD) was found to be the highest i.e. 23.17 per cent whereas briquette combination of charcoal dust + wood chips + starch + water (C-WC-S-W) got the lowest efficacy i.e. 14.57 per cent.

The results of efficacy test indicate that the sample briquettes were comparable to commercial briquettes in terms of efficacy.

The results indicate that correlation cannot be confirmed in efficiency and fuel combustion parameters.

The results revealed that efficiency was significantly and inversely correlated to heat absorbed by water and directly correlated to specific heat utilization.
RESOURCES MANAGEMENT AND CONSUMER SCIENCES

Author : MARIYA SULTANA
Title of the thesis : DESIGNING KITCHEN FOR THE VISUALLY CHALLENGED
Major Advisor : Dr. (Mrs.) D. RATNA KUMARI
Degree : M.Sc. (Home Science)
College : COLLEGE OF HOME SCIENCE, HYDERABAD
Accession Number : D 8916

The kitchen is an environment or place where women whether normal or visually challenged spend considerable amount of time. The kitchen environment includes various internal and physical environment variables like lighting, ventilation, temperature, noise, and equipment and soon which have an effect on the safety, speed and comfort of cooking activity.

A visually challenged person has greatly reduced vision. The term visually challenged refers to anyone who is blind or low vision. It is broadly defined as a limitation in one or more functions of the eye. A visually challenged person encounters serious difficulties in conducting an independent life, which are inherent to the nature of their impairment. Many people have some type of visual problem at some point in their lives. A visually challenged person may have lost their vision but most haven't lost their appetites or their desire to remain independent in their own kitchen. They would like to continue preparing meals for themselves, their families and friends. Considering the requirements of visually challenged people in designing interiors will make them have an independent life and also improve the quality of life, as Visual impairment makes living alone difficult. Making some adaptations to the home or getting extra support will help them to live independently.

The study was taken up in twin cities of Hyderabad and Secunderabad in Andhra Pradesh. An ex-post facto research design was planned. An interview schedule and observation sheet was used to collect information on tools and equipment used and problems being faced by visually challenged women while carrying out different activities in the kitchen. Sample was selected using purposive sampling technique and total of 60 respondents were selected for this research, of which 20 were totally blind and 40 were low vision. Findings of the study indicated that from the 20 totally blind women selected, 5 of them did cooking and other 15 did other activities like washing of vegetables, washing of utensils etc. All the 40 low vision women selected for the study did cooking but had numerous problems and had difficulties in performing different kitchen activities like identifying the spices containers, difficulty in cutting the vegetables, putting / taking out plug from the socket etc. To explore the facilities in the existing kitchen design, and problems faced by respondents while performing kitchen related activities, six houses i.e two of totally blind and six of low vision, were selected for observation of layout of kitchen, presence of hazards, colour contrast between the different features, kitchen lighting, illumination level, switches, window covering, visual appearance of appliances, material and finishes used in the kitchen interiors.
The information collected during the survey analysis revealed that most of the totally blind respondents used the click on burners and 2 burners stove. They had very simple kitchen design. They placed stove at ground level for convenience. Their style of cooking differed very much from normal people. Kitchen design and aesthetics were not seen to be a priority for these totally blind women but they need a simple layout without any barriers. For them keeping all the items at particular place was of almost importance. It was found that most of the kitchen of low vision women had inadequate lighting, absence of task lighting, presence of glare, uncovered windows, less counter space to work and open shelves. Low vision kitchen interiors did not have contrasting colour between different elements which was being made making a difficult task for them to perform and also equipments used for cooking do not have clear controls and contrast From the detailed observation made for six kitchens of low vision it was found that out of six kitchens one had marble flooring, three had vitrified flooring and one had mosaic flooring, three had wall care putty finished walls, two had simple painted wall and one had tiles around kitchen platform. All respondents had granite counter. Majority of the Low Vision women preferred white coloured ceiling, flooring of vitrified tiles, wall care putty as a wall finish. L-Shaped counter of white colour granite, sliding type doors and windows, open storage and base storage with sliding shutters, they want to have good contrast between all kitchen elements like walls, floor and cabinets for ease of seeing and adequate glare free lighting.

From the problems stated by the respondents in their homes, preferences and suggestions and guidelines proposed by different authors like Meera et.al (2001), Kent (2002), Anne and Alan2005) Geoff et al (2005) and Robert Null (2009) and research centers for blind like The Housing Assistive Technology Research (2003), Royal Victorian Institute for The Blind (2005, 2008 and2011), Royal National Institute of Blind People guide and Vision Australia Blindness and low vision service (2007) were used to frame design guidelines to overcome the problems expressed by the respondents. Design solutions suggested were wall care putty/lupum or plain white painted wall with smooth finish, dark blue/black coloured skirting to distinguish one area from other, white vitrified tiles for flooring, white coloured granite counter, sliding doors/shutters for doors and windows, storage provision, freestanding stand and wall mounted stands for keeping plates, bowls etc, minimal use of stainless steel as its glossy and reflective, adequate glare free lighting, fluorescent /recessed and compact fluorescent lamps for general lighting with dimmer switch to control light and task lighting over the work counter to facilitate in better seeing. These design solutions were presented in the form of computer graphical drawings in AutoCAD 2007. Low vision kitchen perspectives plans were evolved by incorporating the design solutions in 3Ds Max.

From the present study it can be concluded that accessible kitchen design contributes to inter dependent living when it is designed to suit to low vision women needs. The present study found out that the low vision kitchen had improper design, with no or less colour contrast, had inadequate lighting and equipment controls did not have clear numbering and colour contrast. The kitchen design for the Low Vision was developed with due consideration to the users needs to overcome their problems. Suggestions proposed can be of great use for low vision women to cook conveniently and can be help to live an independently life.
Flowers have a universal appeal and they are never out of fashion. Exotic flowers that thrive naturally in tropical climatic conditions hold a special place due to their unique colours, form and exquisite beauty. Exotic flowers and plants add that extra special touch to gardens, homes, and all occasions - weddings, celebrations. There is an increasing demand all over the world for the decoration of living and working places with eco-friendly things like fresh foliages and flowers. Flowers play an important role in enriching the interiors of a home or an office.

Fresh flowers need special and continuous effort to avoid their premature wilting, while they eventually fade out over a short period of time. Freeze-drying is a process that retains the colour, form, texture and appearance of any perishables. While frozen, the moisture is removed by way of vacuum. Preservation of flowers in freeze drying process retains its pigment (colour) and structural parts (cells) and thus remains as fresh bloom for years. This study was taken up to explore the effect of selected preservation treatments on the quality of exotic flowers in floral freeze dryer.

Experimental research design was adopted for conducting the study. Floral freeze dryer available in the department was used for this research. Five varieties of exotic flowers *viz.*, Anthurium, Bird of Paradise, Asiatic Lily, Orchid and Statice were selected through purposeful sampling method. Fresh and fully bloomed flowers suitable for freeze drying process were chemically treated with five basic and five improved compositions. Flowers were transferred to freezer chamber and were allowed to freeze dry under vacuum. Processed flower were analyzed before and after experiments to know the effect of these treatments on colour, form, texture and appearance of freeze dried flowers.

It was found that the each of the chemical tested on fresh flowers reacted differently on colour, texture and appearance of flower petals. Citric acid, Sodium citrate, Cupric Sulphate and Sodium formaldehyde Sulphoxylate retained colour pigments while harsh and mild alcohols dissolved colour pigments and dehydrated the flowers. Silicone resin and fluid formed glossy shield on the surface. These outcomes proved the influence of chemicals on preservation qualities of flowers.

Experiments conducted with basic composition and improved composition on exotic flowers revealed that, each composition had different influence on flowers. Irrespective of flowers, each of the basic compositions influenced colour pigments but appeared dry and
brittle while the improved compositions had an influence on their texture, form and appearance of the flowers. Composition I and II which had only three chemicals with pH value of 5.0-5.5, consisting of harsh dehydrant, urea-compound and biological fixative, retained colour of flower petals, but flower texture, form and appearance needed improvement. Composition III and IV that had 6-7 chemicals with pH value of 6.0–6.5, consisting of mild dehydrant, urea-compound, biological or tissue preservatives and biological fixatives retained colour pigments and produced acceptable results in all flowers. But Composition V with pH value of 6.5-7.0, which had group of dehydrating alcohols, biological or tissue preservatives, environmental fixers, biological fixatives, buffers, mordants and modifiers were found to yield better results for retaining colour, form and appearance of all flowers. Texture which is one of the important qualities needed further improvement

Physical examination of freeze dried flowers by the experts complemented the above observations. ANOVA one way classification analysis proved the hypothesis of influence of treatments on the quality of flowers at 5% level of significance.

Flowers stored in air-tight plastic containers proved to be better than those stored by inserting in polythene covers and zip lock vacuum bags with respect to colour, form, texture and appearance of flowers. However, flowers immediately transferred to sealed display cases remained fresh and attractive. This proves the importance of proper after care for preserved flowers.

From the present study it can be concluded that there is an effect of preservation treatments on the quality of exotic flowers when freeze dried. Further research to improve the textural quality can result in near-real quality to natural flowers.
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