PROCEEDINGS
OF THE

NINETY EIGHTH SESSION OF THE

INDIAN SCIENCE CONGRESS

CHENNAI, 2011

PART II

SECTION OF
AGRICULTURE AND FORESTRY SCIENCES

President : **Dr. T. K. Adhya**

CONTENTS

98th Indian Science Congress
January 3-7, 2011, Chennai

I

ABSTRACTS OF PRESIDENTIAL ADDRESS

Dr. T. K. Adhya

PRESIDENTIAL ADDRESS

Microbes and Climate Change

Tapan Kumar Adhya*

Key words : *Global climate change, Greenhouse gases, Positive and negative feedback, Microbial ecology, Integrated climate model*

Soil microbes play key roles in the ecosystems and influence a large number of important ecosystem functions, including nutrient acquisition, N-cycling, C-cycling and soil formation. Moreover, microbes represent the unseen majority in soil and comprise a large portion of the genetic diversity on earth. Beginning with an environment consisting of exclusively methane (CH_4) and Carbon dioxide (CO_2), to the present day aerobic environment dominated by oxygen-breathing organisms, microbes have played a singular role as the drivers of the biogeochemical cycles of this planet. The cleaving of water and the release of oxygen by primitive light-harvesting cyanobacteria around ~3.5 billion years ago, in fact, initiated the beginning of evolution of aerobic life that had finally led to the emergence of higher organisms including plants and animals.

Ongoing global climate change caused by human-induced increases in green-house gases represents one of the biggest scientific and political challenges of the 21st century. Of these, perhaps the greatest is the need, to better understand the biological mechanisms regulating carbon and nitrogen exchanges between the land, oceans and atmosphere and how these exchanges will respond to climate change through climate-ecosystem feedback. Terrestrial ecosystems play a major role in such climate-feedbacks because they release as well as sequester greenhouse gases like CO_2, CH_4 and nitrous oxide (N_2O). Many interacting factors affect the sink activity of terrestrial ecosystems, including natural and anthropogenic distur-bances, agricultural land use, nitrogen enrichment, sulphur deposition and changes in the atmospheric ozone concentration. It is now widely accepted that microorgan-isms have played a key part in influencing the atmospheric concentrations of greenhouse gases with greatest impact on radiative forcing of the earth. What is now emerging as the point of interest is the role to be played by the microbes in

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the coming decades and centuries on climate feedbacks and how they can be manipulated to manage the climate change. The feedback responses of microbes to climate change in terms of increase in greenhouse gas fluxes that may either amplify (positive feedback) or reduce (negative feedback) the rate of climate change require to be understood.

It is obvious that like their feedback (positive or negative) on climate change related impacts on the ecosystem and the environment, the microorganisms themselves are exposed to climatic influences. However, the response of the microbial communities in the environment including soils to climate change including warming and altered moisture status is less understood. Admittedly, understanding the responses of microbial communities to climate change is complicated by the vast and largely unexplored diversity of microorganisms and this is further complicated by the effects of land use and land management practices and different biogeographical patterns including spatial and temporal distribution of microorganisms. It is thus a dire necessity to make efforts to understand the direct and indirect effect of climate change on terrestrial microbial communities and the biogeochemical process that they drive.

Understanding the physiology and dynamics of microbial communities is essential to increase our knowledge of the control mechanisms involved in greenhouse gas fluxes. While the role of microorganisms in the production and consumption of greenhouse gases are now comparatively clear, the control mechanisms involved in the greenhouse gas fluxes are not clear as far as the microbial activity is concerned. While photosynthesis and respiration are two major modulators of CO_2 concentrations in the environment, a substantial portion of newly fixed C by photosynthesis form a major source of energy for soil heterotrophs returning this pool of C to the atmosphere through heterotrophic respiration. The CH_4 cycle involves the conversion of organic-C into CH_4 under anaerobic conditions, by methanogenesis carried out by a group of archaea called methanogens. However, a major portion of the CH_4 produced is oxidized by methanotrophic bacteria using molecular oxygen as the electron acceptor and transferring the CO_2 produced, to the global CO_2 cycle. Methanotrophic bacteria belonging to either γ-proteobacteria ('low-affinity' methane oxidizers) or α-proteobacteria ('high-affinity' methane oxidizers) participate in the process. Another greenhouse gas N_2O, is produced from ammonium (NH_4^+) and nitrate (NO_3^-), their major source being land-use including agricultural fertilizers and manures. Major part of N_2O originates from either oxidative conversion of NH_4^+ to NO_3^- by the process of nitrification mediated

by NH_4^+-oxidizing bacteria belonging to the class β-proteobacteria and also some archaea. The N_2O can also be formed by multistep reduction of NO_3^- to molecular N_2 by the process of denitrification, mediated by phylogenetically diverse group of bacteria broadly called as denitrifiers.

Initial research on climate change and feedback response centered around measuring the biogeochemical processes and determining the source-sink relationship to use the information on developing predictive climate models. However, our understanding of the microbial response to climate change remained limited and our knowledge on climate change and feedback responses by terrestrial microorganisms requires to be strengthened. There is an urgent need to generate information on the structure and bio-geographical patterns of microbial communities including the functional relationships between microorganisms and plant communities. Limited evidences suggest that climate change is expected to have both direct and indirect effects on microbial communities and their functions.

The relationship between climatic changes (altered temperature, CO_2 and moisture levels) and the rate of processes such as respiration and denitrification can change according to the responses of the microbial communities. There are a myriad of ways that soil microbes and their metabolic activity can influence land-atmospheric carbon and nitrogen exchanges, but these can broadly be divided into those that affect ecosystem CO_2 and CH_4 uptake, fixation of N_2 and those that control C and N loss from soil through respiration, methanogenesis and nitrification-denitrification. One of the most widely discussed contributions of soil microbes to climate change is their role in organic matter decomposition and the view that global warming will accelerate rates of heterotrophic microbial activity thereby increasing the efflux of CO_2 to the atmosphere and exports of dissolved organic carbon (DOC). Because, rates of soil respiration are considered to be more sensitive to temperature, it is predicted that climate warming will increase the net transfer of C from soil to atmosphere, thereby creating a positive feedback to climate change. While it is well established that temperature is an important determinant of rates of organic matter decomposition, the nature and relationship between temperature and heterotrophic microbial respiration and its exact potential to climate change feedback are far from clear.

Climate change can also have marked indirect effect on soil microbial communities and their activity through its influence on plant growth and vegetation composition. The first mechanism concerns the indirect effects of increased atmospheric CO_2 concentrations on soil microbes, through increased plant photo-

synthesis and related biomass increase. It is now well-known that elevated CO_2 increases plant photosynthesis and growth, especially under nutrient-rich conditions and this in turn increases the flux of C to roots, their symbionts and other heterotrophic microbes through rhizo-deposits of root exudation and root detritus. The consequences of increased C-flux from rhizosphere to soil for microbial communities and C-exchange are difficult to predict as they vary substantially with factors such as plant species, their density, soil food-web interactions, soil fertility and a host of other ecosystem services that integrate the plant-soil-microbe continuum. However, some potential outcomes for soil microbes and C-exchange include :

a. Increase in soil carbon loss by respiration and enhanced mineralization of soil C.

b. Stimulation of microbial biomass and immobilization of soil N, thereby restricting N availability creating a negative feedback that constrains further increases in plant growth and C-transfer to the soil.

c. Increased plant-microbial competition for N leading to reduced soil N availability and microbial activity and suppression of microbial decomposition and ultimately increased ecosystem C accumulation.

d. Increased growth of mycorrhizal fungi that receive C from photosynthate directly from the host plant and retain this carbon, leading to a negative feedback on soil C-cycling as well as enhanced stabilization of soil aggregation.

e. Changes in root exudation that are known to play a potentially important role in methanogenesis and hence C-loss from soil as CH_4.

Interestingly, manipulation of terrestrial ecosystems also offers a potentially powerful tool to mitigate anthropogenic climate change. It has been suggested that land-use can be effectively managed to sequester carbon. However, to manage the soil microbial communities to increase C sequestration, it is important to understand their ecology and function. While some recent studies are exploring evidences that bacteria can be grouped on the basis of their C-mineralization capacity and can be divided into copiotrophs and oligotrophs, the concept is far from clear. It is difficult to generalize a specific taxon on the basis of their C-minerlaization potential and is therefore essential that we use rapidly developing technologies like metagenomics, metatranscriptomics, metaproteomics and stable isotope probing (SIP) to examine the physiological abilities and the role played by individual taxon on an ecosystem

scale. On the contrary, while our knowledge on the microbiology of cycling of CH_4 and N_2O is more complete and theoretical possibilities exist for their manipulation in the environment either through their inhibition of production of their consumption depending upon the situation it is yet to be tested an ecosystem scale.

While global climate change is now an accepted fact, it is currently difficult to explain whether feedbacks to climate change are brought about by the effect of climate change on soil microbial communities, by changes in soil factors (abiotic) or interactions of both. The complexity of the soil microbial community and its multifarious roles coupled with the myriad of ways that climate and other global changes can affect soil microbes hinders our ability to draw definitive conclusions on this subject. Despite this uncertainty, progress can be made to understand the potential negative and positive feedbacks of soil microbes to global warming and associated climate change, through consideration of both direct and indirect impacts of climate change on microorganisms and the capacity of such effects to modulate the impacts. Such studies require intensive research to link microbial ecology to the level of ecosystem functioning. It is imperative to develop a framework to incorporate microbial data on biomass, community, diversity and function into ecosystem models to improve estimation and prediction of climate change. There is an urgent need to include microbial ecology, environmental genomics, soil-plant interaction and ecosystem modeling. Mercifully, there have been substantial advancements in the technologies that can examine microbial communities and relate them to ecosystem functioning. Microorganisms could either greatly help in climate change, as it did in the beginning of the journey of this planet, or prove disastrous by accelerating anthropogenic climatic change through positive feedback. Tropical ecosystem functions including agricultural productivity could be at stake and onus is on us to examine the whole issue with renewed endeavour.

98th Indian Science Congress

January 3-7, 2011, Chennai

II

ABSTRACTS OF PLATINUM JUBILEE LECTURE

PLATINUM JUBILEE LECTURE

Beyond Green Revolution : Way Forward

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Key words : *Genetic modification, Molecular tools, Green revolution, Crop design, Ag-biotechnology, System agriculture*

Genetic modification of plants probably began through selection of better types about 10,000 years ago when human agricultural activities began and useful results were often a product of random or chance events. With the elucidation of the laws of genetics, molecular tools in understanding plant biology, plant breeding became a deliberate and predictable activity and tailor made crops are now in place. Following Borlaug Legacy, the success of green revolution saved millions of people from hunger and death in developing countries including India. However, the benefit of this technology did not reach to all and now the crop yield has been stagnant for the last three decades. Ag-Biotechnology (Genetic engineering) as the next phase of 2nd Green Revolution provides the potential to develop the "CROP DESIGN" and enable plants to grow in adverse environment with multiple traits. Gene technology has revolutionized the concept of biological process and supplemented conventional plant breeding in crop improvement. The discovery of genome sequencing in several plant species including rice legumes, potato and model plants/ microbes etc. resulted better understanding of genes, traits and functional genomes. Apart from broadening the genetic base and diversity it has helped improve crop productivity, plant protection, nutrition and will address the issues of better adaptation of crop plants in response to climate change. The improved "seed", a product of Ag-biotechnology is needed for the farmers and the scientists may help the policy makers to lead the strategic planning for its development and available at an affordable price. Global science across the disciplines must integrate as System Agriculture thorough modernization of Agriculture-practice and must address the issues of local benefit with economic benefit.

98th Indian Science Congress
January 3-7, 2011, Chennai

III

ABSTRACT OF AWARD LECTURE / YOUNG SCIENTIST AWARD PROGRAMME

YOUNG SCIENTIST AWARD PROGRAMME

Influence of Tartaric Acid on Aluminum Dynamics and Speciation in Rice (*Oryza Sativa*) Rhizosphere and Amelioration of Aluminum toxicity in Acid Soil

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Key words : *Acid soils, Aluminium toxicity, Tartaric acid, Lime requirement, Toxicity amelioration*

The influence of tartaric acid on aluminum (Al) dynamics, speciation and toxicity amelioration was studied in a greenhouse pot culture experiment using rice (cv. Satabdi) as test crop. Strongly acid surface (0-15 cm depth) soil sample classified as Haplaquept was collected from the central research farm of Orissa University of Agriculture and Technology (OUAT), Bhubaneswar, Orissa. Plants were grown with four levels of aluminum (0, 15, 30 and 40 µmol per litre) and two levels of tartaric acid (0 and 100 ppm). The experiment was laid out in a completely randomised design with 3 replications. Destructive sampling was done to collect soil samples at 15, 30, 45 and plant samples at 45 days after germination of rice. Soil Solution was analysed for total, exchangeable, monomeric and complexed Al, Fe, Ca, Mg, P, Si and organic acid concentration. Identification of different Al species was done by computer program using Visual MINTEQ, Ver.2.32, 2005. Total dry weight, root volume of the plants and aluminum concentration in root and shoot tissues were also recorded.

It was concluded that the application of tartaric acid significantly improved dry matter and root volume of rice in acid soil by decreasing Al concentration in soil solution through formation of Al-tartaric acid complexes. The major phytotoxic forms of Al in case of rice are Al^{3+}, $Al_3(OH)_4^5$ and $Al_2(OH)_2^{+4}$. The study thus established that tartaric acid could complex Al and reduce its concentration in the soil solution. The research has laid the foundation to develop a potentially viable technology of rhizosphere manipulation by using tartaric acid to detoxify Al in acid

soil. The standard practice of liming involves a huge cost, which is very often not affordable by resource poor farmers. Addition of commercially available, low cost tartaric acid in standard dose will significantly reduce aluminum toxicity and increase crop production from acid soil. It will also save a huge cost of lime by reducing the lime requirement of soil. Rice is the most important staple food crop in the world and also it is a very commonly grown crop in acid soil. Thus, the research is a step towards development of a more effective amelioration strategy for increasing crop production from acid soil.

PROF. SK MUKHERJEE COMMEMORATION LECTURE

Managing Agriculture for Climate Change Mitigation and Adaptation

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Keywords : *Climate change, greenhouse gases, methane, nitrous oxide, mitigation, climate adaptation*

Climate change, caused by the increased concentration of greenhouse gases (GHGs) in the atmosphere, has emerged as the most prominent global environmental problem. This is likely to threaten the food security and livelihoods of millions of people in India. Simulation studies showed that increase in CO_2 to 550 ppm would increase yields of rice, wheat, legumes and oilseeds by 10-20%. A 1^{o}C increase in temperature may reduce yields of wheat, soybean, mustard, groundnut and potato by 3-7%. There would be much higher yield losses at higher temperatures. It further showed that productivity of most crops to decrease only marginally by 2020 but by 10-40% by 2100. However, there may be some improvement in the yields of chickpea, rabi maize, sorghum and millets; and coconut in west coast. There could also be less loss in potato, mustard and vegetables in north-western India due to reduced frost damage. Increased temperature would also affect quality of agricultural produce. Grain elongation ratio and length and breadth ratio of basmati rice is reduced as mean temperature during grain growth increased beyond 26 ^{o}C.

Indian agriculture (ruminants, rice cultivation, manure management, crop residue and soil) contributes 14.7 M ton of methane and 0.14 M ton of nitrous oxide with a global warming potential (GWP) of 386.1 M ton CO_2 equivalent. Ruminants are the largest contributor of GWP (65%) followed by rice cultivation (23%) and soil (10%). Emission of GHG from Indian agriculture may be reduced by adopting conservation agriculture such as direct seeded rice, aerobic rice, system of rice intensification, zero tillage and efficient management of N. Adaptation strategies to climate change in agriculture include crop diversification, assisting farmers in coping with current climatic risks, intensifying food production systems, improving land and water management, enabling policies and regional cooperation and strengthening research for enhancing adaptive capacity and mitigation potential.

We need to urgently take steps to increase adaptive capacity to mitigate climate change impact. This would require increased adaptation research, capacity building, development activities and changes in land-use management. A win-win solution is to start with such adaptation strategies that are needed for sustainable development. Policies and incentives should be evolved that would encourage farmers to sequester carbon in the soil and thus improve soil health, and use water and energy more efficiently.

PRAN VOHRA AWARD LECTURE

Soil Quality and Sustainability Issues of North-West Himalayan Soil

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Keywords : *Soil quality, Sustainable management practice, Vermicompost, microbial biomass, Soil enzymes, No tillage, Micronutrient enrichment*

Many of the issues of sustainability are related to soil quality and understanding the factors governing it is imperative for implementing sustainable management practices. Vermicompost was found better than cattle compost in transformation of phosphorous in soil. This fact is attributed to enhanced microbial biomass, available P, and acid phosphatase activity in earthworm cast applied soil. Compost prepared

from *Lantana* sp. was found to be toxic to soil biota at higher rates of applications. Most of the phosphatase activities were negatively correlated with available P. Other hydrolytic enzyme (Protease, Urease, β-glucosidase) activities were also negatively affected due to application of the compost at higher rates. Continuous application of mineral fertilizer resulted in adverse impact on soil phosphatase and urease activity in turn on soil quality of North-Western Himalayas. As mineral fertilizer showed negative impact on soil, half of NPK was found better than full NPK along with cattle manure in improving soil biological activity. No tillage practice may be most successful in Indian Himalayan condition by maintaining sustainability and improving soil biological properties along with improvement in carbon sequestration and low energy input. Under organic farming condition, cattle manure was found to be the best not only during transition from conventional to organic management, but also under organic management. In long run, organically managed plots were found to be comparable to mineral fertilized rice in terms of grain yield with enhancement in soil health especially biological activity. Results suggest that after building up of soil nutrient status in soil, comparable yield and better nutritional and functional quality of rice can be achieved in organically managed soils as compared to mineral fertilized soils. Cattle compost was also found better followed by vermicompost in improving the quality of produce especially enrichment in micronutrient.

98th Indian Science Congress
January 3-7, 2011, Chennai

IV

ABSTRACTS OF SYMPOSIUM / INVITED LECTURE

PROCEEDINGS
OF THE

NINETY EIGHTH SESSION OF THE

INDIAN SCIENCE CONGRESS

CHENNAI, 2011

PART II : Abstracts of Symposium/Invited Lecture

SECTION OF
AGRICULTURE AND FORESTRY SCIENCES

President : **Dr. T. K. Adhya**

Quality Education and excellence in Agricultural research in India for Enhanced Capability and Competitiveness

1. Higher Agricultural Education in India : Status, Challenges and Opportunities

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Key words : *Agricultural education and research, Investment in agricultural education, Successful university, Strengthening agricultural education*

Agricultural education and research system in the country largely comprises of Indian Council of Agricultural Research and the Agricultural Universities.

Agriculture is a state subject so is agricultural education. The intensity of agricultural research and education intensity was as low as 0.08% in Uttar Pradesh, 0.13% in Orissa to a high of 1.37% in Himachal Pradesh. In the recent periods, it has come to light that the establishment cost of agricultural universities has risen substantially to as high as 87 per cent while operational budget has reduced to about 13 per cent. Agri-education and R&D has grown in recent times but funding levels have not kept pace with the growth in number of programs, institutions, colleges and universities. Number of faculty has markedly declined resulting on an average 50% strength of total vacancies. Another problem is related with high inbreeding; about 51% faculty members having all degrees from same university, and 46% faculty has more than 15 years of service in same university. This situation clearly reflects that the universities are starved of operational funds which affect the quality of academics and the research and development. The problem is further accentuated with the creation of multiple universities in the states, bifurcation or sectoral division of universities which has added to the already increasing pressure of establishment costs of creating administrative infrastructure. Plan allocation for agriculture education and research needs substantial enhancement in terms of investment to make India a first rate country in agricultural research and education.

The key conditions for a successful university are : (i) well trained faculty, mostly leaders in their own areas; (ii) incentives and reward system for the faculty; (iii) international and national collaboration in research and higher education; and iv) least dependence on state funding and generating own resources. The paper proposes the following for strengthening higher agri-education in the country by: (i) higher allocation of resources; (ii) faculty upgradation; (iii) adopting ICT in teaching, such as concept of e-learning, distance and virtual education; (iv) think beyond agri-university and develop need-based curriculum and partnership with corporate sector; (v) promote networking in higher education and develop some pilot programs in selected discipline; (vi) reform agri-education system, and develop a National Agricultural Education Project (NAEP) on the lines of NATP and NAIP with support from government of India and the World bank; (vii) need to review center-state relations in higher agri-education, and setup a National Agri-education Council.

Sustaining Agricultural Productivity in the Tropics in the Face of Climate Change

2. Sustainable Agriculture and Plant disease Biocontrol–Challenges Ahead

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Key words : *Sustainable agriculture, Biological and ecological management, Trichoderma spp., Genome sequence, genetic improvement*

One of the main pillars of sustainable agriculture is "ecology", and therefore, biological or ecological management of plant pests and diseases are integral components of sustainable agriculture. Public awareness regarding the health and environmental hazards associated with chemical pesticides has forced ban on many of the synthetic chemical pesticides. Consequently, the demand for natural biopesticides is rising steadily all over the world. According to a recent survey, the chemical pesticides market is on the decline at the rate of 1.1% while the biopesticides market is growing at an annual rate of 9.9%. Among the biofungicides used for plant disease control, *Trichoderma*-based formulations dominate the market, accounting for about 60% of all registered biofungicides. *Trichoderma* spp., in addition to being biofungicides, alleviates abiotic and physiological stresses when applied to seeds. They are also known to mobilize plant nutrients in the rhizosphere and degrade xenobiotics. In addition to direct effects on plant pathogens, these species also induce resistance in plants through production of elicitor molecules. Even though these formulations are effective against a wide range of plant pathogens, their efficacy is very often not comparable with the chemical fungicides. The greatest challenge is to improve their bioefficacy to the level obtained by chemicals. The recent completion of sequencing of the genome of three species of *Trichoderma* would come in handy in understanding the molecular mechanisms of biocontrol. This, in turn, would help in genetic improvement of biocontrol strains. The global climate change is already affecting plant disease scenario with new diseases emerging and new epidemics taking birth. In a scenario where less and less chemicals will be available for pest and disease control coupled with newer pest/disease problems, biological control is expected to play a greater role in sustaining the crop productivity.

98th Indian Science Congress

January 3-7, 2011, Chennai

V

ABSTRACTS OF ORAL/POSTER PRESENTATION

PROCEEDINGS
OF THE

NINETY EIGHTH SESSION OF THE

INDIAN SCIENCE CONGRESS

CHENNAI, 2011

PART II

SECTION OF
AGRICULTURE AND FORESTRY SCIENCES

President : **Dr. T. K. Adhya**

CONTENTS

PROCEEDINGS
OF THE

NINETY EIGHTH SESSION OF THE

INDIAN SCIENCE CONGRESS

CHENNAI, 2011

PART II : (Abstracts)

SECTION OF
AGRICULTURE AND FORESTRY SCIENCES

President : **Dr. T. K. Adhya**

I. CROP IMPROVEMENT

1. Rice genetic Biodiversity in Malkangiri District, Orissa as Affected by Modern Agriculture

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Key words : *Rice, Biodiversity, Germplasm, Conservation and preservation, Gene bank*

Rice (*Oryza sativa* L.) genetic biodiversity study in Malkangiri district iw worth field investigation as it is inhabited by two very important ethnic tribal people ‘Koya’ and ‘Bonda’ besides some other minor groups like ‘Gudava’, ‘Paraja’ and

'Bhumia' etc. The objective of this research was to identify the vanishing germplasms of rice and recommend for their conservation and preservation in the gene bank. Methodology followed on the investigation was to collect the paddy grains from the local marginal adivasi farmers and after study of their agronomic characters kept in the suitable containers for deposit in the Gene Bank. It was observed that many rice varieties have already been vanished and many are on the verge of extinction. The varieties may be preserved in the Gene Bank for future use in plant breeding.

2. Dimethyl Sulfoxide Induced Tall Mutants in Jute (*Corchorus olitorius* L.)

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Key words : *Dimethyl sulfoxide, Corchosur olitorius L., Tall mutant*

Presoaked seeds of jute (*Corchorus olitorius* L. *cv.* JRO-632) were treated with 2% dimethyl sulfoxide (DMS) for 24 h. Tall mutants were screened in M3 in contrast to the normal plants. Palmate leaf mutants otherwise looked normal excepting the nature of plamate leaf habit. A number of yield component growth parameters were recorded like plant height, basal diameter, plant spread, root length, pod per plant, seeds per pod, pod length/breadth ratio, number of primary branches per plant, number of secondary branches per plant, leaf angle, branching angle, first flowering date, 100% flowering date, total duration, percengae of pollen sterility and weight of 100 seeds which were found to vary from the control plant. Chromosome analysis revealed a number of aberrations like stickiness, fragmentation, clumping, polyloidy and laggard and bridge formation at very low frequency. This tall mutant gives more fibre yield than the control plants with superior quality.

3. Effect of Indole Acetic Acid on Chromosomes of Shoot Derived Callus Tissues of Jute (*Corchorus olitorius* L. variety JRO-632)

P. K. Ghosh[1,2] and A. Chatterjee

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Key words : *Corchorus olitorius L., Shoot explants, Indole acetic acid*

Jute seeds (*Corchorus olitorius* L. *cv.* JRO-632) were grown *in vitro* in White's medium. The root explants wee collected from *in vitro* grown seedlings and were cultured asceptically in both Murashige and Skoog's (MS) and Schenk and Hildebrandt's (SH) media with different combinations and concentrations of auxins and cytokinins whreas in other cases no auxins was utilized. Callus tissues were obtained from the epicotyls explants in MS basal medium supplemented with indole acetic acid (IAA) and coconut milk. When the concentration of IAA was gradually increased, vigorous growth of the callus tissues was observed. IAA also enhanced rapid growth of the callus tissues. Cytological analysis revealed that the callus tissues are mixoploid, diploid or polyploid in nature. The present investigation indicates that IAA plays an important role *in vitro* culture of shoot derived callus tissues and its role in chromosomal change during *in vitro* growth of callus tissue.

4. Evaluation of Herbicide (2,4-D) as Male Gametocide on *Phaseolus mungo* and Salgare's Method of Plant Breeding – A Critical Review

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Key words : *Palynology, Toxicology, Environmental sciences, Herbicides, Genetics and Plant breeding*

Potentiality of the germinability of pollen of *Phaseolus mungo* Roxb. (var. T-9, urid) was noted in all the 4 series i.e. F, F-24, F-48, F-72 series investigated. Pollen of F-24 and F-48 series produced higher percentage of the germination with the longer tubes than those of F series. Foliar applications of all the concentrations of 2,4-dichlorophenoxyacetic acid above 100 $mg.ml^{-1}$ suppressed the flowering. None of the concentrations (5, 10, 25, 50, 100, 200-200-1000), 1000-1000-5000 $mg.ml^{-1}$) of 2,4-D could bring down the fertility of pollen to zero percent which is essential for the successful plant breeding program. Hence the existing method i.e. chemical induction of pollen sterility fails here. Hence we have to find out an alternative method of plant breeding. However, all the concentrations of 2,4-D above 25 $mg.ml^{-1}$ prevented the germination of pollen of all the 4 series. When there is no germination of pollen the question of the transfer of the male gametes to the female gametophyte does not arises and when there is no transfer of the male gametes to the female gametophyte the question of the fertilization and seed setting does not arise. Hence instead of suppressing the pollen fertility which is not possible even with such a high concentrations of 2,4-D we should suppress the germinability of pollen with such a low concentrations which give the birth to the new method of plant breeding – 'Salgare's method of plant breeding'.

5. Alien Gene Introgression in Cultivated Rice for Yellow Stem Borer (YSB) Resistance Through Wide Hybridization

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Key words : *Wide hybridization, Rice cv. Savitri, Oryza sativa, O. brachyantha, Embryo rescue*

Wild rice species serve as a vast reservoir of genes for various biotic and abiotic stresses which can be of use in widening the gene pool of cultivated rice. In the present investigation, an attempt was made to introgress yellow stemborer [YSB *Scirpophaga* incertulas (Walker)] resistance from the wild species of rice *O. brachyantha* A Chev.Et Rochr., to the cultivated species *O. sativa* L. *cv.* Savitri. Hormone combinations to overcome pre- and post-fertilization barriers involving naphthalene acetic acid (25 ppm) + sucrose (5000 ppm), gibberellic acid

(25-50 ppmn + naphthalene acetic acid (25 ppm) + 6-furfurylaminopurine (2-5 ppm) respectively were obtimized. The impasse of embryo development was overcome by suitable modifications of embryo rescue and embryo culture techniques. Populations of F_1, BC_1F_1 and BC_2F_1 progenies obtained were acclimatized, screenmed for YSB resistance and are regularly maintained through appropriate subculture techniques. Nine BC_2F_1 populations were finally obtained and are being studied for their morpho-cytological characterizations.

6. Morphological and Molecular Diversity Studies Reveal Wide Variability among Maldandi Landraces

Sujay Rakshit, S. S. Gomashe, K. N. Ganapathy, M. Elangovan, C. V. Ratnavathi, N. Seetharama and J. V. Patil

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Key words : *Sorghum, Maldandi, Diversity, Clustering, Dendrogram, SSR*

Diversity among 82 Maldandi accessions was investigated using morphological and SSR markers to study the closeness and distinctness among the Maldandi landraces collected by the National and International programmes. Euclidian distance based on 17 quantitative traits put the accessions in two clusters with two out layers. Data on 19 qualitative traits put the accessions in one big cluster with six out groups. Many accessions could not be differentiated based on qualitative data. Sixteen out of 18 SSR markers detected polymorphism among the accessions with average PIC values of 0.36. Un-weighted neighbor joining clustering put the accessions into three clusters with 20, 16, 28 and 18 members respectively. The standard check, M 35-1 (a selection from the original Maldandi) could not be differentiated from EP 98 (Bile Maldandi; IC 345187), LG 2 (Angoli Maldandi), LG 10 (Karal Maldandi), IS 4501 (Maldandi devgaon) and IS 40791(Maldandi from Talegaon) based on qualitative data, and EP 64 (Sedam Maldandi Gurang; IC 343563) and IS 33839 (Maladandi from Jamgaon) using SSR markers. Based on quantitative data IS 4710 (Shallu Maldandi) was closest to M 35-1. Thirteen promising Maldandi accessions have been selected for further evaluation and utilization in the rabi improvement programme for rabi adaptation traits.

7. Planned Generation of New *Gossypium arboreum* Genotypes and Applying the 'path of productivity' Method for their Further use

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Key words : *Chlorpyrifos, Toxicity, Chemical detoxification, Comet assay, Sensitive technique*

Planned generation of breeding material ad derivation of segregants better than the existing check varieties is a dream of every plant breeder. It requires a proper selection of the starting material which would then be involved in crosses followed by downward selection in every generation with an eye on productivity as well as ancillary traits like quality. The present work is one such effort in *Gossypium arboretum* L. spanning a period of eight years. In the present study segregants with high seed cotton yield and very good fibre properties were isolated and evaluated at ARS Dharwad during 2009-10. Further, a simple method is suggested where the top performing genotypes can again be involved in crosses depending on their 'path of productivity' to bring desirable gene combinations together again. Genotypes 136-2, A-1-20, 443-2, 421-1 and A-8-15 can be tested for yield stability across locations and years based upon their superior performance. On perusal of the genotypic deviations it was seen that there were genotypic differences. Crossing 136-2 with 421-1 or A-8-15 can yield segregants with good yield and fibre properties. Similarly, there were differences in the 'path of production' between A-1-20 and 421-1 and these two can also be crossed to derive better segregants which can help in further isolating and improving *G. arboretum* varieties. A definite improvement using conventional breeding principles can be achieved as shown by this planned endeavor.

8. Breeding Interspecific Bt Cotton Hybrids : A New Perspective Needed

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Key words : *Cotton hybrids, extra-long staple hybrids, hisrutum-barbadense cross, Bt and non-Bt cotton hybrids*

That the majority of more than 55 per cent cotton production in India comes from hybrids of various categories speaks about the hybrid revolution in India. The inter-specific extra-long staple hybrids of hirsutum-barbadense cross are known to have very high commercial value because of their superior fibre properties. Varalaxmi and DCH-22 are two hybrids which revolutionized cotton growing in India. The changed cotton environment with insect resistance build-up did not support the growing of inter-specific hybrids. The area started dwindling. In 2002, Bt cotton was permitted to be grown commercially in India. With this there was a sudden revival in the inter-specific hybrids. The present study is a private-public effort to identify good inter-specific hybrids. Seven new hybrids were compared with Bt and non-Bt check hybrids for performance and fibre properties at ARS Mundgod in Karnataka. Only two hybrids *viz.* NAMCOT-803 and KDCHH-407 were significantly better in seed cotton yield than the checks. The non-Bt check DCH-32 was higher yielding than six test hybrids. The fibre properties were mostly on par proving that Bt gene does not affect properties. The superiority of DCH-32 even now should serve as a direction to the private seed industry where *per se* performance of the new hybrids needs to be improved. The Bt gene can only help in realizing the full potential of a hybrid and not make it any more high-yielding than its true potential. There is an urgent need to improve the barbadense component of the hybrids as enough improvement of the hirsutum component has been done already. Making planned intra-barbadense crosses and isolating desirable segregants should be focused upon. A revitalized inter-specific hybrid breeding program can then take off.

9. Drought Regulated Annexin Transcriptome in Rice *Oryza sativa* group *indica* cv. IR64

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Key words : *Annexin, rice, drought*

The past two decades revealed a plethora of Ca (2+)-responsive proteins and downstream targets in plants and animals, of which several are unique to plants. Early responses to various stresses in plants involve calcium signalling; calcium binding proteins are important for transducing stress signals into adaptive responses. Included among these proteins are annexin group of multigene, multifunctional family of amphipathic protein.Transcriptome analysis of annexin family genes was carried out by RT-PCR after imposing drought condition in indica rice cultivar IR64.Results show differential regulation of this gene family under varying growth and developmental stages.

10. Identification of Restorers and Maintainers for Developing Medium Duration Hybrid Rice

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Key words : *Rice hybrids, Restorers and maintainers, Medium duration hybrids*

A study was conducted to identify prospective resptrers and amintainers for three CMS wild abortive lines *viz.* IR-68897A, IR-79156A and IR-80555A and 48 testers of upland rice germplasm (URG) were used in line x tester (3 x 48) mating design during *kharif*, 2008. The experiment was laid out in randomized block design with two replications consisiting F1s along with their parents during *kharif*, 2009. Observatins of pollen fertility and spikelet fertility were carried out for the identification of restorers and maintainer lines. Out of 48 testers, 13 genotypes behaved as restorer while 17 genotypes behaved as maintainer for all the CMS lines. URG-12 behaved as maintainer for two CMS lines, *viz.* IR-68897A and IR-79156A. URG-11 behaved as maintainer for two CMS lines *viz.* IR-79156A and IR-80555A. URG-14 behaved as maintainer for two CMS lines *viz.* IR-68897A and IR-80555A. URG-47 behaved as maintainer for two CMS lines *viz.* IR-79156A and IR-80555A. URG-13 behaved as maintainer for all the three CMS lines. The performance of restorers varied with the CMS lines. The potential restorers namely URG-2, URG-22, URG-25, URG-28, URG-30 and URG-42 can be used for developing medium duration rice hybrids, while effective maintainers like URG-11,

URG-13, URG-14 and URG-47 can be exploited for the development of new CMS lines in rice through recurrent back cross programme.

11. Identification of Basmati and Non-Basmati Restorers and Maintainers for CMS (WA) lines in rice (*Oryza sativa* L.)

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Key words : *Hybrid rice, Restorer, Maintainer, Cytoplasmic male sterility, Fertility restoration*

Twenty aromatic and twenty non-aromatic genotypes of rice were test-crossed with seven male sterile lines. Out of resultant F1s, 17 basmati and non-basmati genotypes were identified as potential restorers and 25 basmati and non-basmati genotypes showed maintainer reaction for different CMS lines. The frequency of restorers obtained for basmati was higher than the non-basmati types. The performance of restorers varied with the CMS lines. Based on the results, the potential restorers Taraori basmati, Sugandh-3, Pant dhan-10 and IC 343479 may be used for developing basmati and no-basmati hybrids, while effective maintainers like Pusa Basmati 1, HUR-PB 98 AR and IC 343490 may be exploited through recurrent back crossing programme for development of new basmati and non-basmati type CMS lines in rice.

12. Evaluation of Sweet Sorghum Genotypes for Stalk Yield, Biomass and Biofuel Traits Grown Under Diverse Agro-environment

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Key words : *Sweet sorghum, Bioethanol, Stalk yield, Brix, Total soluble sugars, Grain yields*

Sweet sorghum is the bio-energy crop which produce both food and biofuel and grown on dry lands .Sixteen sweet sorghum experimental genotypes including seven varieties and six hybrids along with three controls were evaluated at thirteen locations in *kharif*, with an objective of assessing the performance and adaptation across a range of agro-environments (latitudes) and identify superior genotypes for stalk yields, biomass and biofuel traits. Fresh biomass varied from 39 to 67 t/ha with a mean of 58 t/ha across the locations. Hybrids as a group produced 11.0 % more biomass than varieties. Fresh stalk yield ranged from 29.4 to 46.5t/ha with a mean of 40.2 t/ha. In varieties, SPSSV 20, SPSSV 27, SPSSV 28, and SPSSV 4 gave 11.0 to 13.5% more stalk yield than check CSV19 SS. Hybrids as a group had shown 8.0 % superiority over varieties. SPSSV 30 (19.6%) alone recorded significantly superior brix than rest of the test entries. Total Sugar yields ranged from 1.66 to 2.53 t/ha with a mean of 1.99 t/ha. Hybrids as group have recorded 10 % more sugar yields than varieties. Both total sugar yields and ethanol yields were positively related (0.996; p=0.01). Bioethanol yields ranged from 925 to 1440 L/ha with mean of 1123 L/ha across the locations. In hybrids, SPSSH 27 (27 %), PAC 52093 (17%) and SPSSH 24 (10%) gave high bioethanol yields than check CSH22 SS, while in varieties, SPSSV 15 (15%), SPSSV 20 (23%) and SPSSV 27 (14%) were superior. Hybrids as a group had recorded 18% higher bioethanol yields that varieties. Utilization of these genotypes with desirable biofuel traits is suggested to improve the sweet sorghum yields and quality further.

13. Allele-specific Primer based Identification of Dimeric Alpha-amylase Inhibitor Genes in Wheat using Allele-specific PCR

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Key words : *SNP-Based haplotype diversity, Dimeric alpha-amylase inhibitor gene, Multiple alignment, Abiotic and biotic stress*

Wheat is one of the most important staple food crops grown over 200 mha in the range of environment throughout the world with an annual production

likely to reach more than 630 million metric tons in 2009-10. Despite remarkable growth in food production, the risks were exposed by food crisis in the recent years. Therefore, wheat production must continue to increase by 2% annually, more particularly in developing world including south-east Asia. Besides increasing the inherent productivity of wheat, it is important to minimize the losses caused to the production by various abiotic and biotic factors. Alpha-amylase inhibitors are attractive candidates for the control of seed weevils as these insects are highly dependent on starch as the energy source. They play an important role in the carbohydrate metabolism of many heterotrophic and autotrophic organisms. For weevil control, alpha-amylase inhibitors and their genes could be used to genetically engineered weevil resistant seeds. In this study, we aimed to make sequence comparison and phylogenetic relationship among dimeric alpha-amylase inhibitor genes. These genes were clustered into two major groups based on phylogenetic analysis. Multiple alignments show at least 24 candidates single nucleotide polymorphisms in inhibitor genes, which could further be exploited for SNP-based haplotype diversity among recently released wheat genotypes. We have detected dimeric alpha-amylase inhibitor genes in cultivated and wild ancestors of wheat using genome specific primers. Genes encoding dimeric alpha-amylase belongs to the 24 kDa alpha-amylase inhibitor family. Under current study, specific primer pairs were designed based on SNPs of these genes and chromosome locations of inhibitor genes confirmed by amplification in accession of *T. urartu*, *A. tauschii* and *A. speltoides*. Results obtained support the hypothesis that inhibitor genes amplified with primer PSWDAIAF1/PSWDAIAF2 and PSWDAIBF1/PSWDAIBF2 are present on chromosome B. Results further support evidence at molecular level that dimeric alpha-amylase inhibitor in cultivated wheat is encoded by a multigene family.

14. Evalutaion of Genetic Diversity Among Heat Tolerant Wheat Genotypes as Assessed by Molecular Markers

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Key words : *Carbon sequestration, rainfed production systems, tropical India*

Global warming and limited winter rains in wheat growing season have became a matter of great concern affecting wheat production not only in India but also at the global level. Wheat crop faces early as well as terminal heat stress. However, terminal heat stress is more common in rice-wheat cropping system in India due to late sowings. The rising temperature and moisture stress during grain filling period is detrimental to crop yield. There is great need to develop wheat varieties which can help improving wheat productivity by tolerating high temperature stress. The objective of the present study was to estimate genetic variability in heat tolerance among the released wheat genotypes. A total of 40 ISSR markers were used to detect genetic diversity among 68 Indian wheat genotypes including 54 of *Triticum aestivum* and 14 hexaploid synthetic lines. The DNA was extracted from young leaves following CTAB protocol. The amplification products were separated on 2.0% agarose gel. The size of amplicon obtained ranged from 150 bp to 2000 bp and number of amplicons obtained ranged from 3 to 11. For all the genotypes, bands on ISSR gel were scored as present (1) or absent (0). Jaccard's similarity coefficient values for each pair wise comparison between accessions were calculated and a similarity coefficient matrix was constructed. The matrix was used to generate a dendrogram using NTSYS-pc software. The dendrogram constructed on the basis of the similarity matrix showed that the genotypes of wheat divided into two major clusters I and II. Cluster II further divided into 5 sub-cluster (IIa, IIb, IIc, IId and IIe). Sub-cluster IId contain all synthetic accessions including two genotypes HUW 510 and WH 542. The similarity indices showed that the most closely related cultivars were RAJ 3765 and WR 544 with the highest similarity index (0.905). On the other hand two most distantly cultivars were MACS 2496 and HS 375 with low similarity index (0.078). Sub-cluster IIe includes two genotypes UP 2338 and HD 2428, which are distantly related to rest of the genotypes. The information about broad genetic diversity of heat tolerant genotype could be usefully exploited in future wheat improvement programme. Identification of distinct markers and SCAR may help in categorizing the genotypes as well as to accelerate the breeding program.

15. Screening and Molecular Breeding for Iron Efficient Genotypes in Rice (*Oryza sativa* L.)

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Key words : *Diversity, iron, mineral content, genotype, molecular breeding, rice*

Realizing the scale of mineral deficiency and its adverse effects on human health and competence, "biofortification" of crops such as rice with high-Fe using conventional breeding and genetic engineering approaches has gained momentum. We assessed the variability for iron content in a collection of 220 rice genotypes. Seeds were collected, dehusked, dried, ground and the powder was used for iron determination using atomic absorption spectrophotometer. Iron concentration in the dehusked seeds differed significantly ($p = 0.001$) among the various rice genotypes, ranging between 5.1 – 441.5 $\mu g.g^{-1}$. Four of the rice genotypes, HKR 95-157 (441.5 $mg.g^{-1}$), Palman 579 (409.4 $mg.g^{-1}$), HKR 95-130 (408.6 $mg.g^{-1}$) and Taraori Basmati (207.5 and 55.5 $mg.g^{-1}$) had very high iron content; Genotypes with such high iron content have not been reported earlier. Crosses have been made between these Fe-rich and commercially important *indica* (HKR 47 and PAU 201) rice varieties. The hybrid status of the F_1 plants was confirmed by microsatellite marker analysis. F_1 hybrids were selfed as well as backcrossed with the recurrent parent to raise F_2 and BC_1F_1 generations, respectively, which are being analyzed for Fe content, physio-morphological traits and microsatellite profile.

16. Variation for Physio-morphological Traits and Microsatellite Profile in some Aerobic Indica and Basmati rice Varieties

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Key words : *Aerobic rice, Agronomic evaluation, Basmati rice, indica rice, Root traits, SSR*

Maintaining organic carbon is the most difficult challenge particularly in tropical regions where rapid decomposition of organic matter results in loss of carbon from soils due to high temperatures. An attempt was made to examine the effects of different nutrient management options on build up/depletion of organic carbon under rainfed production systems and to identify the best carbon management option under diverse climatic conditions and soil type. Soil samples were collected after 15 to 27 years of cropping from above treatments at 0-20, 20-40, 40-60, 60-80 and 80-100 cm depth from 6 long term manurial trials under All India Coordinated Research Project on Dryland Agriculture (AICRPDA). Under groundnut based production system at Anantapur (Andhra Pradesh), a positive buildup of organic carbon and organic carbon sequestration rate of 0.452 t ha^{-1} $year^{-1}$ was recorded in 50% RDF+FYM. At Bangalore (Karnataka), under groundnut-finger millet rotation, there was a net depletion (-3.58 t ha^{-1}) in control and build up of 6.26 t ha^{-1} in FYM 10 t ha^{-1} + 100% NPK. Under *rabi* sorghum production system at Solapur (Maharasthra), all the treatments showed positive buildup of organic carbon with highest organic carbon sequestration rate in 25 kg N (crop residue) + 25 kg N (Luecaena) after 21 years of cropping. Under pearlmillet production system at SK. Nagar (Gujarat), after 18 years of cropping, all the treatments showed the depletion of soil organic carbon to the extent of 4.54 t ha^{-1} in control treatment in top 20 cm depth. Lowest depletion was observed in 50% N (fertilizer) + 50% N (FYM). Under soybean production system at Indore (Madhya Pradesh), control and organic treatments showed depletion of organic carbon and INM and organic treatments showed buildup of carbon. Under rice based production system at Varanasi (Uttar Pradesh), after 21 years of cropping, control plots showed depletion, inorganic treatments maintained similar levels and organic treatments showed buildup of organic carbon.

17. Development of genic-SSR Markers by Deep Transcriptome Sequencing in Pigeonpea [*Cajanus Cajan* (L.) Millspaugh]

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Key words : *Pigeonpea, Molecular markers, Next generation sequencing, Crop improvement, genetic diversity, simple sequence repeat, Complementary DNA, Expressed sequence Tags*

Pigeonpea [*Cajanus cajan* (L.)Millspaugh] is one of the most important food legumes of the semi-arid tropics and subtropical regions but it has limited availability of genomic resources, particularly expressed sequence based (genic) markers. Here we report a comprehensive set of validated genic-SSR markers based on deep transcriptome sequencing and its application for genetic diversity analysis and mapping. In this study 43,324 unigene sequences were assembled from 1.696 million 454 GS-FLX sequence reads from two pools of cDNA libraries prepared from leaf, root, stem and immature seed of pigeonpea varieties Asha and UPAS 120. Total 3,771 genic-SSRs were identified and PCR primers were designed for 2,877 of these for marker development. Dinucleotides were the most common repeat motifs with a frequency of 60.41%, followed by tri- (34.52%), hexa- (2.62%), tetra- (1.67%) and pentanucleotides (0.76%) repeat motifs. Primers were synthesized and tested for 772 genic-SSR markers with repeat lengths of =18 bp. Of this 550 markers were validated for consistent amplification in 8 diverse pigeonpea varieties and 75 were found to be polymorphic. Genetic diversity analysis was done on 22 pigeonpea varieties and eight wild species using 20 most polymorphic genic-SSR markers. Number of alleles at these loci ranged from 4-10 and the polymorphic information content (PIC) values ranged from 0.46 to 0.72. Neighbor joining dendrogram based on Jaccard's similarity coefficient clearly separated different groups of pigeonpea cultivars and wild species. Deep transcriptome sequencing helped to develop

550 validated genic-SSR markers in pigeonpea and 20 most polymorphic markers from this were used to evaluate genetic relationship among the species of genus *Cajanus*. This provides a comprehensive set of genic-SSR markers as an important genomic resource for the genetic mapping and diversity analysis in pigeonpea.

18. Bee (*Apis mellifera* Linn.) Mediated Foraging Response for Genetic Regulation of Pollination Efficiency in Niger [*Guizotia abyssinica* (L.F.) Cass.]

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Key words : *Apis mellifera Linn., Foraging behaviour, Pollination Efficiency, Niger*

Pollination efficiency in niger [*Guizotia abyssinica* (L.F.)] gets modulated through genetic variability in foraging behaviour of Italian honey bee (*Apis mellifera* Linn.), which was reflected in terms of positive correlations pollen collecting activity with outgoing foraging activity (r^2=0.940, 0.920), incoming foraging activity (r^2=0.888, 0.896), total foraging activity (r^2= 0.970, 0.950) and foraging speed (r^2=0.683, 0.451). High heritability and high expected genetic advance for pollen collecting activity (74.8, 174.7; 86.7, 219.9), total foraging activities (84.1, 130.7; 86.4, 144.8), incoming foraging activity (73.3, 115.2; 85.7, 165.7), nectar collecting activity (72.0, 117.3; 83.1, 174.0) and outgoing foraging activity (81.9, 152.2; 69.9, 114.9) confirmed the involvement of additive genes in their expression. Based on the pollination efficiency selection criteria for the bees, the day hour 10.00 am fitted the best, which was followed by the day hour 09.00am and 11.00 am.

II. CROP PRODUCTION

19. On-farm Response of Maize-Wheat Cropping System to Applied Nutrients under Eastern and Central Plateau of India

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Key words : *Cropping System, Maize Grain Equivalent, Recommended NPK, Economic response, Food production*

A field experiment was conducted on maize-wheat cropping system during 2005-06, 2006-07 at two on-farm centres, Dumka and Udaipur of AICRP on Cropping System under the Project Directorate of Farming Systems Research, Modipuram. Recommended NPK level gave rise to an additional system yield of 4.7 t maize grain equivalent (MGE).ha^{-1} at Dumka and 1.3 t MGE.ha^{-1} at Udaipur over control. In terms of MGE there was an additional 0.4 $t.ha^{-1}$ or more system yield with NPK than with NK, 0.3 $t.ha^{-1}$ with NP than with NK and 0.3 $t.ha^{-1}$ with NK than only with N application. At Dumka, the average responses were 3.3 kg MGE per kg applied N, 9.3 kg MGE per kg of applied P and 19.2 kg MGE per kg of applied K. The average economic response was 3, 9.5 and 2.8 rupee per rupee invested on fertilizer N, P and K respectively. At Udaipur, average responses to applied nutrient were 2.4 kg MGE per kg applied N, 4 kg MGE per kg of applied P and 3.1 kg MGE per kg of applied K. Average economic responses were 1.6, 2.5 and 2.2 rupees per rupee invested on fertilizer N, P and K. Such responses have a lot of bearing on the food production in the country.

20. Jute Seed Production by Vegetative Means as Influenced by Irrigation Regimes and N-levels in Gangetic Alluvial Soils

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Key words : *Irrigation, Jute seed production, Nitrogen management, Water productivity*

A field experiment to study the Jute (*Corchorus olitorius*) seed production through vegetative means as influenced by different irrigation regimes and elvels of N was conducted at the central research farm of BCKVV, West Bengal during the rabi season. The experiment was laid out in a split-plot design with three main-plot and four sub-plot treatment replicated thrice. The treatment combinations included three irrigation treatments and three N treatments. Jute seed production by vegetative means is a very new addition and the crop for seed production was found sensitive to irrigation management. The experimental results revealed that the highest seed yield (3.59 $q.ha^{-1}$) was obtained with highest soil moisture regime with nitrogen levels (40 kg $N.ha^{-1}$). The wet moisture regime of -0.03 MPa at 30 cm soil depthcreated increase in yield by 62.38% over drier moisture regime. Highest water expenses wee obverved at higher levels of water application. The water expense efficiency was recorded highest at lower levels of irrigation in comparison to higher moisture levels due to more application of water. The results proved combined application of irrigation and fertilizers from different levels of N could be the better option in present day agriculture which could help in improving and sustaining soil health and maintenance of yield of the crop as well as water productivity.

21. An Observation on Integrated Organic Farming System Approach for Sustainable Agricultural Development – in Coastal Belts of West Bengal

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Key words : *Sustainable agriculture, Organic farming, Farming system approach (FSA), Land shaping, Coastal areas of Sunderbans*

Farming system represets an appropriate combination of farm enterprises, *viz.* cropping system, horticulture, forestry, livestock, fishery, poultry and the means

available to the farmers to raise them profitably. In West Bengal, some of the diversified organic agricultural practices have been reported to be operating. The aim at this juncture of agricultural development is to diversify farming and integrate or accommodate various subsystems by land shaping for the purpose of waste recycling, disaster resilience, minimization of external input and better energy flow within the farm. The sustainability of small factors attained through integrated farming system is observed in the coastal belts of West Bengal. Major impacts observed in farming system approach are better nutrition, security of income, efficient use of resources, reduction in migration, higher economic independence and sustainability of production.

22. Prospects of Onion (*Allium cepa* L.) Cultivation in Desert Soils of Bikaner District

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Key words : *Organic manure, Package of practices, Sandy soils, Desert area, Climatic conditions, Crop performance*

In the desert area of Bikaner district, onion crop was grown at a numer of cultivators' fields on sany soils. By and large, the cultivators followed the recommended package of practices except addition of organic matter. Some of the cultivators did not apply orgnic matter while others applied at varying amounts e.g. 200, 300, 400 and upto 500 $q.ha^{-1}$. Yield data clearly indicated the impact of organic matter. Average yield obtained was 300 $q.ha^{-1}$, while maximum yield obtained was 350 $q.ha^{-1}$. On an average the bulb size was large. The study clearly indicated that onion can be successfully grown in desert area with proper and soil water management practices.

23. Identification of Competitive and Allelopathic Interactions between Rice and *E. colona* in Rice Fields

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Key words : *Allelopathy, Competition, Oryza sativa, Echinochloa colona, Field experiments*

Allelopathy is an important component of crop-weed interaction and can be integrated with weed control technology. Field trials were conducted to ascertain the allelopathic influences between rice (*Oryza sativa* L. *cv.* Vandana) and its most problem weed *Echinochloa colona* (L.) Link, (EC) following standard agronomic practices including fertilizer application. In one field trial, rice and EC were grown in mono and mixed cultures of equal and varying densities (Rice : EC = 1 : 1. 1 : 2, and 1 : 4), keeping the total plant population fixed at 100 plants.m^2. In another one, rice and EC were grown in monocultures only with plant densities of 50, 200, 300 and 400 plant.m^2. Plant height and dry weight at 20, 30, 40 and 60 days after sowing were taken into consideration. Rice and EC in monocultures of varying densities showed no intraspecific interference. But in mixed culture there was adverse interspecific interference and each species became weaker than their counterparts in monocultures. The plant relative yield values of rice and EC were observed to be less than unit (<1) throughout the growth period. The relatie yield total values of rice and /EC wee also less than unit. These results left no room other than to interpret that the interspecific interference between rice 'Vandana' and EC was an antagonistic one and might be due to involvement of allelopathy.

24. Studies on Nutrient Uptake and Yield of Rice under System of Rice Intensification (SRI) Practices

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Key words : *System of Rice Intensification (SRI), Nutrient uptake, Yield attributes, Rice yield*

System of Rice Intensification (SRI), a method of rice cultivation developed in Madagascar has been found to reduce the water use besides increasing the yield. Four crop management factors, *viz.* seedling age, number of seedling.hill^{-1}, weed control and irrigation under SRI [14d old seedling, one seeling.hill^{-1}, mechanical weeding with a rotary weeder and shallow irrigation – 2.5 cm] were compared with conventional (recommended) cultivation practices [21 d old seedling, 3 seedling.hill^{-1}, weed management with herbicide plus hand weeding and recommended irrigation 95 cm) in all possible combinations. N uptake due to SRI practice was higher at panicle initiation stage (35.5 to 52.6%) than the other stages. Inclusion of any one of SRI factors along with other conventional factors was found to have a significant effect on the N uptake. K uptake was significantly higher with shallow irrigation. Inclusion of weeder factor with other conventional factors showed an increase of K uptake up to 37.3%. The management practices followed in SRI method of cultivation produced significantly more number of panicles.m^2 and number of grains.panicle^{-1}. Introduction of younger seedling in combination with all other conventional factors significantly increased the yield showed that use of yournger seedling alone can increase the yield. Inclusion of all the SRI components was found to increase the yield significantly by 18.6% when compared to conventional practice. The yield increase with SRI components was significant even under conventional irrigation, conventional weeding and three seedlings.hill^{-1}, but use of older seedlings with other SRI components did not have the positive effect on grain yield.

25. Wheat Productivity as affected by Nitrogen and *in situ* Paddy Residue Management

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Key words : *Zero tillage, Happy seeder, Nitrogen application, Grain yield, Residue management, Dry matter accumulation*

A field experiment was carried out at the Punjab Agricultural University, Ludhiana during the *rabi* season of 2009-10. The experiment was conducted in split plot design with four methods of planting (happy seeder, zero tillage, rotavator and conventional tillage) in main plots and four levels of N (control, 100, 125 and 150 kg $N.ha^{-1}$) in sub-plots in the combined harvested field of paddy. Wheat was planted with zero tillage after the removal of loose straw of paddy. In case of rotavator and conventional tillage it was planted in *in situ* residue of paddy. The soil of experimental site was loamy sand which was low in organic carbon and available nitrogen and medium in available phosphorus and potassium. The study revealed that zero tillage gave significantly higher grain yield and yield attributes of wheat. However, the grain yield increased with the increase in N upto 150 kg $N.ha^{-1}$. The interactive effect of planting methods and N was significant. The zero tillage and happy seeder gave the significantly higher grain and straw yield with the addition of 150 kg $N.ha^{-1}$ as compared to other treatment combination. The higher yield under these treatment combinations due to significantly higher growth attributing characters like periodic plant height, plant dry matter accumulation, tiller count and yield attributing characters like effective tillers, grains per ear. The results of the study showed that higher wheat productivity can be obtained by planting the wheat with zero tillage or happy seeder in the combined harvested field of paddy supplied with 25 mg $N.ha^{-1}$ more than recommended dose of 125 kg $N.ha^{-1}$.

26. G x E Interaction and Adaptability of Rice Cultivars in SRI and Normal Production System

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Key words : *G x E interaction, Adaptability, SRI, Grain yield, Stability, Rice (Oryza sativa L.)*

In any breeding program, it is necessary to screen and identify phenotypically stable genotypes that could perform uniformly under different environmental conditions. Such a breeding effort required basic information of G x E interaction. Twenty genotypes including hybrids and aromatic rice were evaluated in 8 environments under two production systems, *viz.* System of Rice Intensification (SRI) and normal cultivation during *kharif* season of 2009. Pooled analysis for stability revealed that G x E interaction was significant for all key components of SRI except tiller no. The stability parameters identified stable genotypes and those suitable for favorable environments for direct cultivation and for use in improvements of other cultivars.

27. Effect of Sulphuric Acid on the Seeds of *Cenchrus glaucus* (Blou buffel) cv. CO1

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Key words : *Cenchrus, Acid treatment, Storability*

Cenchrus is having chaffy seeds, light, bulky and do not flow freely, adding to the cost of cleaning, storage and transport. Here complete dehulling is more extreme option than trimming of chaffy seed units. Hence fluffs of *Cenchrus glaucus* cv. CO1 were treated with sulphurinc acid @100-500 $ml.kg^{-1}$ of fluffs

with different durations. At lower concentration the effect was nil and at higher doses naked caryopses were released. Treatment with 300 ml.kg^{-1} for 5 and 10 minutes duration greatly reduced the bristles without any change to caryopses. When both scarified fluffs and control seeds were assessed for their storability, initial germination of scarified seeds (44%) was more compared to control (23%). Under storage, germination and vigour of *C. glaucus* fluffs increased with adancing storage period to the tune of 73 and 48 per cent over the initial values in both conrol and acid scarified fluffs respectively. Scarification didn't affect the viability of seeds. The loss in vigour of the seeds was revealed by reduced seedling length and vigour index values and increasd electrical conductivity of seed leachate only after eight months of storage.

28. Agronomic Evaluation of OAT Varieties for Growth, Forage yield and quality with Varying Levels of Nitrogen under Semi Arid conditions

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Key words : *Physical properties, Aonla fruit, Sphericity, Surface area*

A field study was conducted at the Forage Research Farm of CCS Haryana Agricultural University, Hisar during *rabi* 2008-09 to study the effect of nitrogen application on growth, fodder yield and quality of oat. The soil of the experimental field was sandy loam, low in available N, medium in P and high in K content. The treatment combinations were comprised of five varieties (JO-03-91, OS-346, UPO-06-1, Kent and OS-6) and four levels of N (0, 40, 80 and 120 kg N.ha^{-1}). The treatments were replicated thrice in a factorial randomized block design. The results revealed that oat variety UPO-06-1 significantly out-yielded the other varieties for green fodder and dry matter yield. Lowest fodder yield was obtained from OS-6. The maximum crude protein content was recorded in variety Kent but UPO-06-1 gave highest crude protein yield. Likewise, variety JO-03-91 ranked first for *in vitro* dry matter digestibility whereas highest dry matter digestibility was recorded with variety UPO-96-1. Green fodder, dry matter, plant height and crude protein yield increased linearly up to 80 kg N.ha^{-1} while the crude protein content improved

up to 120 kg N.ha^{-1}. The number of tillers per running metre row length was observed to be increased only upt 40 kg N.ha^{-1}.

29. Evaluation of Farmers' applied N Management of Rice Crop based on Leaf Colour Chart and Red Edge Reflectance

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Key words : *Leaf color chart, N management, Red edge parameter*

Field experiments were carried out in the farmers' fields at Biswanathpur of Orissa in the Kharif season of 2008-09 and 2009-10 to study the effect of different N treatments and water depths (< 15 cm) on the yield of rice *cv.* Samrat and Puja. The treatments were farmers' applied dose (15 kg N ha^{-1} at one time for *cv.* Samrat and 45 kg.ha^{-1} twice for *cv.* Puja), recommended dose (60 kg N.ha^{-1}), leaf color chart based application (75 kg N.ha^{-1}) and N spray (32 kg N.ha^{-1}). The red edge mid point were calculated for leaf samples from extracted chlorophyll solutions by using a spectrophotometer through linear interpolation technique. Results showed that with the increase in 'red edge' there was s significant increase in total biomass content, grain and straw yield of rice (*cv.* Puja). The B:C ratio for leaf color chart based application, recommended dose and N spray were higher than farmers' applied dose (two).

30. Towards Organic Farming

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Key words : *IFOAM, Certified institutes, Compost, Vermicompost, Bio-fertilizers, Bio-control agents, Crop rotation, Nutrient contents*

Organic farming has become synonymous with farmers using the Reams fertility system having a sound basis of crop production. It is the most widely

recognized alternative farming system. It is a form of agriculture that relies upon crop-rotation, organic wastes, crop residues, animal manures, green manures, composts, biological pest control and mechanical cultivation to maintain soil productivity and tilth by sypplying plant nutrients. To control insects, weeds and pests the system avoids or largely excludes the use of chemicals and inorganic compounds. It emphasizes on maintaining the cycle of input-output with eco-friendly methods. For its implementation and adoption certain rules are required to be followed. However, it needs both time and money but get due recognition by the mother nature and in the market.

31. Morpho-physiological Variation in Grain yield of Rabi-sorghum Genotypes under Shallow Soils

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Key words : *Sorghum, Dry matter production, Harvest index*

A field experiment was conducted in shallow soils at Regional Agricultural Research Station, Bijapur (Karnataka) during *rabi* season of 2006-07. Among the genotypes RSLG 1119, RSLG 871, RSV 423 and Maulee gave higher yields compared to other genotypes. The factors that favored the higher yields were leaf area index, chlorophyll content, relative water content and panicle dry weight. The production of dry matter alone does not help in realizing higher yield. In case of higher yielder there was an efficient dry matter production as well as translocation from source to sinl. Less number of factors in moderate and only few factors have gavored the low yielders. It was observed that the differential performance of genotypes were due to difference in dry matter partitioning efficiency.

32. Allelopathic effects of Certain Medicinal Herbs on Growth and Yield of Coconut

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Key words : *Allelopathy, Medicinal herbs, Growth and yield of coconut*

An experiment was conducted in a 10 yr. old coconut garden with 20 d old seedlings of *Aloe barbensis*, *Andrographis paniculata*, *Ocimum sanctum* and *Ocimum bascilicum* were planted as intercrops. All cultural practices were followed. During the first year of experiment light intensity was measured between 12.00 noon and 2.00 PM at different canopy heights. The light intensity at ground and top level canopy was 806 and 1500 Lux respectively. The temperature of coconut garden as low in comparison to outside environment and may be due to plant transpiration. Medicinal plant identified for low light intensity is *Andrographis paniculata* with 750 Lux. Further, the result on effect of medicinal plants on growth and yield of medicinal plants revealed that plant biometrical character values were high in *Ocimum bascilicum* and low in *Aloe barbadensis*. In the third year of experiment, the coconut yield parameters were improved in the garden inter-cropped with *Ocimum bascilicum* and *Aloe barbadensis*.

33. Performance of Parents and Single cross hybrid of Maize

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Key words : *Single cross hybrid, combining ability, heterosis, yield component*

The experiment was conducted at the experimental plots of maize improvement project T.C.A., Dholi Farm of Rajendra Agricultural University, Pusa, Samastipur. The investigation was based on mean performance, combining ability

and heterosis of diverse inbred lines and their crosses with a view to know the performance of parents and F_1 hybrid of maize. The line x tester mating design was carried out involving 8 diverse imbred lines and 5 testers viz. CML-107, CML-90, CML-100, CML-137, CML-81. Each imbred lines were crossed with three testers during Kharif 2008. A complete set of experimental material consisted of 8 lines, 5 testers and 40 F_1s with two check hybrids CM 400 x CM 300 and CM 202 x CM 111 were evaluated in randomized block design with 3 replications during rabi 2008-09. Observations were recorded on 10 quantitative characters including grain yield. Analysis of variance for design of experiments was significant for all the characters under study. The estimate of variance component revealed that variance due to SCA was pronounced than variance due to GCA for all the characters, indicating the importance of non-additive type of gene action for expression of these characters. The estimates of GCA effect and mean performance for grain yield and other yield contribute traits, showed the line AB(W)-S_4-4-3#, AB(w)-S_4-4-2# and AB (w)-S_4-5-2 # tester CML-90 and CML-100# were good parents. Taking into consideration the *per se* performance, GCA effect of the parent SCA effect of crosses and heterosis AB(w)-S_4-4-3# x CML-100#, POP44 pob 44 C_4 HC 33-2-1- B # # # and Jogia S_3-22-1 39# x CML 81 # #, Pool 32 G 32 C 19 MH-256-1-1- 1 # was the best hybrid yielding 42.5 percent more grain yield over the Superior check CM 400 x CM 300. Crosses between high x low GCA parents exhibited greater heterosis. Heterosis for yield was generally accompanied by heterosis for yield component.

34. Response of Winter Maize (zea maize) Varieties to Sowing Dates for Study of Phenology, Yield and Heat Unit Requirement

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Key words : *Winter maize, Phenology, Heat requirement*

An experiment was carried out on sandy loam soil at Research Farm of Rajendra Agricultural University, Bihar, Pusa (Samastipur) during rabi season of

2005-06 to find out effect of winter maize (*Zea mays L.*) varieties to sowing dates for phenological behaviour, yield and heat unit requirement. The treatment consisted of combinations of four maize varieties, ('Laxmi', 'Dewki' 'Suwan', and 'Shaktiman-1') and three dates of sowing *i.e.* 15th and 30th October and 14th November. Each treatment was replicated thrice in factorial randomized block design. After critical analysis of data, it was observed that 15th October sown seeds germinated in 7.15 days as against 10.73 days and 14.48 days required by the 30th October and 14th November sown crops respectively. Varieties did not influence the germination time. 14th November sown plants were the tallest and the 15th October sown plants the shortest. Up to the milk stage 14th November sown crop took the maximum time in arriving at various phenophases. However, the 30th October sown crop over took the other dates in coming to dough stage and physiological maturity. The most striking feature observed was that the 14th November sown crop had the longest vegetative phase (105.0 days) but the shortest reproductive phase (45.5 days) as against 75.3 and 82.5 days vegetative and reproductive phase respectively in 15th October sown crop. The varieties 'Laxmi' and 'Deoki' had comparatively longer vegetative phases but their reproductive phases were similar to those of 'Shaktiman-1' and 'Suvan'. Yield, net return and benefit:- cost ratio got their best expression in 30th October sowing followed by 15th October and 14th November sowings. When crop was sown on 15th October, the heat requirement of the varieties was alike. But in 30th October and the 14th November sowings the varieties 'Laxmi' and 'Deoki' showed marginally higher demand for heat units. The 30th October sown crop had higher heat unit needs than the 14th November and the 15th October sowings, but had equality between themselves in this regards.

35. Performance of High Density Planting of Guava (*Psidium guava* L)

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Key words : *Guava, planting densities, growth, canopy development, varieties, light penetration, yield*

The present experiment was conducted during 2006 with the objectives of identifying suitable spacing and variety of guava for better growth and yield in the northern plains. Trees of guava *cv.* Lucknow -49, Allahabad Safeda and Pant Prabhat were planted in August 2006 at a spacing of 3.0 x 3.0, 4.0 x 4.0 and 5.0 x 5.0m in 3 replicates to determine the effect of planting distance on tree growth, yield, fruit quality and light penetration. Tree growth was significantly influenced by different tree densities when measured in August, 2010, 4 years after planting. The tree height was highest (3.70 m) at the planting distance of 3.0 × 3.0 m (1111 trees ha^{-1}). Trunk circumference was highest (0.64 m) at 5.0 × 5.0 m than the planting distances of 4.0 × 4.0 and 3.0 × 3.0 m. A marked variation was also noticed among different planting densities on canopy spread (NS/EW). The canopy spread was 3.61/3.48 m in NS/EW directions at planting distance of 5.0 × 5.0 m in comparison to 3.45 m / 3.31 m in closely spaced trees (3.0 × 3.0 m) in the variety Pant Prabhat. However, the lowest canopy (3.25 m/ 3.18 m) was noted in Allahabad Safeda. The maximum fruit length (8.5 cm) was recorded in Pant Prabhat variety spaced at 5.0 × 5.0 m apart while the lowest fruit length (6.3 cm) was found in Lucknow-49 spaced at 3.0 × 3.0 m apart. Maximum fruit diameter (8.4 cm) was noted in the variety Pant Prabhat at 5.0 × 5.0 m planting whereas the lowest (6.3 cm) was found in Lucknow-49 at 3.0 × 3.0 m apart. Maximum fruit weight (232.33 g) was recorded in Pant Prabhat whereas the lowest fruit weight (178.33 g) was noted in Lucknow-49 variety planted at 3.0 × 3.0 m apart. The maximum fruit number (186.00) was recorded in Pant Prabhat variety planted at 5.0 × 5.0 m apart while it was lowest (142.00) at 3.0 × 3.0 m. Trees spaced at 5.0 × 5.0 m and 4.0 × 4.0 m produced fruits of more weight with better TSS in all the varieties of guava. Better light penetration was observed in the trees planted at 5.0 × 5.0 and 4.0 × 4.0 m than the other distance (3.0 × 3.0 m) at NS/EW canopy edge, inside tree centre, centre between tree in the rows and centre between rows. The total yield was highest (43.30 kg $tree^{-1}$) from Pant Prabhat planted at the distance of 5.0 × 5.0 m, while it was only 25.43 kg $tree^{-1}$ from the planting distance of 3.0 × 3.0 m. However, the yield of per unit area was more (1.09 kg) at the planting distance of 3.0 × 3.0 m (1111 trees ha^{-1}).

36. Effect of Weed Control on Growth and Yield Attributing Characters of Upland Drilled Paddy under the Lateritic Conditions of Konkan

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Key words : *Upland drilled rice, Weed control, Weed control efficiency*

An experiment was conducted to study the effect of various weed control measures on growth and yield of upland rice under lateritic soil conditions. The performance of rice was not influenced by introducing cowpea, as an intercrop in direct seeded upland rice for 30-35 days. It was also ineffective in controlling the weeds. For effective weed control and higher yields as well as higher net returns from the direct seeded *kharif* upland rice, Oxydiargyl @ 0.1 kg.$^{ha-}$1 should be sprayed 5-6 days after sowing of the crop and it should be followed by hand weeding 20-25 days after sowing.

37. Integrated application of P and Green Manure on Yield of Rice

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Key words : *Rice, Available P. Grain yield*

An investigation was carried out at Rice Research Station, Ambasamudram during Pishanum ’05, ’06 and Kar ’06 in ASD 16 rice variety to study the effect of integrated application of P and green manure on growth and yield of rice. The experiment was laid out in split plot design with two main plots, *viz.* green manure application and without green manure application. In the sub plots, phosphorus was applied through Mussorie Rock Phosphate @ 25, 50 and 75 kg.ha^{-1} with or without

phosphobacteria through seedling dip and soil application at recommended level; N and K were applied at recommended levels. Application of P through Mussorie Rock Phosphate @ 75 kg ha^{-1} along with green manure @6.25 $t.ha^{-1}$ and phosphorus solubilizing bacteria through soil application @ $2kg.ha^{-1}$ was found to increase the available P status and different forms of P contributing to the soil labile P pool. The yield of the crop also improved (7,600, 9,000 and 8,800 $kg.ha^{-1}$ in Pishanum '05, Kar '06 and Pishanum '06 respectively) due to the application of Mussorie Rock Phosphate along with green manure and Phosphobacteria due to increased mineralization and availability of P.

38. Comparative Analysis of Biotech, Conventional and Organic Cotton Production Systems in India

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Key words : *Bt cotton, Organic cotton, Conventional cotton, Comparative analysis*

A research study on the status and potential of various production systems in cotton with empirical evidences from Tamil Nadu revealed that the biotech cotton production system is the farmer friendly system in terms of yield, economic return and less plant protection cost. Primary data were collected from 120, 30 and 45 farmers respectively from biotech, conventional and organic cotton growers of Tamil Nadu using constructed interview schedules. The respondents were selected using multi stage random sampling method. Survey among the 120 Bt growers revealed that the major Bt cotton hybrids prevailed in the fields were RCH 20 Bt, RCH 2 Bt BG II, RCH 708 Bt and Bunny Bt. The average area under Bt cotton area was 1.79 acres and 23 per cent of the respondents only adhered refuge practice. The attitude towards cultivating Bt cotton was highly favorable and they were willing to continue Bt cotton in next season too. The average cost of cultivation for one acre Bt cotton was Rs.16730/- and average yield was 9.30 q/ acre. The major problems faced by them were high seed cost, spurious seeds, less knowledge on location suitability of hybrids, susceptibility to sucking pests, lack of transgenic in popular varieties and practical difficulties in adopting refuge crop.

Empirical evidences from 30 conventional growers revealed that the major cotton varieties hybrids prevailed in the fields were DCH 32, MCU 5 and Surabhi. The average area under conventional cotton area was 1.02 acres. The attitude towards continuing conventional cotton was highly unfavorable and they were willing to continue Bt cotton in next season. The average cost of cultivation for one acre conventional cotton was Rs.17404/- and average yield was 7.20 q/acre. The problems faced by the growers were non availability and poor quality of seeds, high cost for plant protection, poor adoption of IPM and lack of tolerant varieties and hybrids in the market. Survey among the 45 organic cotton growers revealed that the major cotton varieties prevailed in the fields were MCU 5 and Surabhi. The average area under organic cotton area was 1.62 acres. The attitude towards continuing organic cotton was highly favorable and they were willing to continue organic cotton in next season too. The average cost of cultivation for one acre organic cotton was Rs.14338/- and average yield was 8.35q/acre. The problems faced by the growers were non availability and poor quality of seeds, non availability of organic materials, high cost of inputs, inadequate agencies to guide in getting organic certificates and poor market facilities.

39. Response of Cassava to Graded Dilution of Liquid Distillery Effluent on yield, yield attributes and quality *var* MVD1

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Key words : *Cassava, Spentwash, Tuber yield, Starch and protein*

A field experiment was conducted in Research and Development Farm at M/s Sakthi Sugars Limited, Appakudal in the year 2006-2007 to find out the effect of spentwash application on yield and quality of cassava variety MVD 1.The results revealed that among the doses of spentwash application application of 0.50 lakh litres ha^{-1} and above was found to increase the top yield as well as tuber yield. Among the methods of spentwash application, the application of spentwash at 90^{th}

DAP registered higher tuber yield to the tune of 6.1% over the application DSW before planting. Highest B: C ratio was recorded in S_7 wherein this treatment registered 2.49 and 2.66 in M_1 and M_2 respectively. The quality parameters like starch and protein content was found to be higher in the same treatments while the control recorded the lowest.

40. Enhancement of Wheat Grains with Manganese Through Ferti-Fortification

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Key words : *Ferti-fortification, foliar sprays, Human health, Manganese fertilizer, Copper fertilizer, Wheat cultivars*

Among the different strategies, ferti-fortification is considered more sustainable and less cost effective approach used to alleviate Mn concentrations in wheat grains. With this prime objective the present nutrient enrichment investigation was carried out for two consecutive years (2007-08 and 2008-09) at research farm of Department of Soils, Punjab Agricultural University, Ludhiana on a loamy sand (*Typic Ustochrept*) soil to enhance Mn content in wheat grains through ferti-fortification (foliar sprays). For enrichment of Mn in grains, six wheat cultivars, including aestivum (PBW 550, PBW 502 and PBW 343) and durum (PDW 291, PDW 274 and PDW 233) were selected for experimental study. Four foliar sprays of Ms @ 0.5 per cent were applied at different stages of wheat growth starting from maximum tillering, flower initiation, milk and dough stages. Foliar sprays of Mn significantly increased the yield of wheat grains varying from 1.4-5.2% with minimum increase in PDW 233 cultivar. The concentration of Mn in wheat grain showed that four foliar sprays of 0.5% of Mn significantly increased the concentration of Mn in wheat grains. The concentration of Mn in wheat grains ranged from 24.3-26.3 $mg.kg^1$ without foliar sprays of Mn whereas, the concentration of

Mn in wheat grain ranged from 33.3-35.8 $mg.kg^{-1}$ with foliar sprays of Mn. Foliar sprays of Mn raised its maximum concentration to 35.8 $mg.kg^{-1}$ (PDW 233) and 34.7 $mg.kg^{-1}$ (PDW 274), which were 28.3 and 26.3% higher over control. Per cent increase in concentration of Mn in different cultivars of wheat varied from 24.0-28.3 per cent. All the durum cultivars reported higher content of Mn that aestivum cultivars. In all, foliar sprays of Mn reported almost 5 times higher average enrichment of wheat grain. Irrespective of cultivars, 24-28% enrichment with Mn is possible through foliar sprays of $MnSO_4$,H_2O. Foliar sprays of 0.5% Mn significantly increased the grain yield of wheat and the maximum grain yield of 5.2 $t.ha^{-1}$ (PBW 550) followed by 5.1 $t.ha^{-1}$ (PBW 502) were reported with Mn which were 1.9 and 4.6 per cent higher respectively, over control. All the six wheat cultivars showed significant increase in Mn concentrations over control. Our results further reported that in all the wheat cultivars studied, the grain yield was not much affected with Mn foliar sprays whereas, their content in wheat grains showed significant increase in their enrichment.

41. Enhancing Yield and Quality of Pigeon pea [*Cajanas cajan* (L.) Millsp.] Through Varietal Screening and Agronomic Approaches

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Key words : *Pigeon pea, Varietal screening, Agronomical approaches, Yield, Grain quality, Bio-fortification, Grain Fe enrichment*

An experiment was undertaken to screen genetic variation present in 20 diverse genotypes of pigeon pea for grain Fe content as influenced by Fe application. All the genotypes were tested under field conditions with three Fe treatments, *viz.* no Fe, 20 kg Fe ha^{-1} as soil application alone and in combination with 0.5% $FeSO_4$ foliar spray at three different physiological growth stages. The grain of pigeon pea was analyzed for total Fe content in grain and classified into two different groups based on grain yield and uptake efficiency index *viz.* Fe-most efficient and Fe-least efficient group to understand the mechanisms of Fe enrichment. The iron content of pigeon pea grain ranged from 31.3 to 39.5 $\mu g.g^{-1}$ in

different genotypes. Among the genotypes studied, DT-23, BDN-2 and PKV-Trombay were grouped under Fe-most efficient genotypes whereas AAUT-2007-8, BP-1-96 and C-11 were grouped under Fe-least efficient genotypes based on both yield and uptake efficiency indices.

The mean yield of Fe-most efficient group of genotype was 2656 $kg.ha^{1}$ which was about 300 $kg.ha^{1}$ higher than the Fe-least efficient group (2334 $kg.ha^{-1}$). The mean Fe content of pigeon pea grain in the Fe-least efficient varieties was 34.0 $\mu g.g^{-1}$ that was close to Fe-most efficient genotypes 33.0 $\mu g.g^{-1}$ under control treatment. However, the grain content of Fe-least efficient genotypes increased by 18 per cent than only 4 per cent increase in case of Fe-most efficient groups due to Fe application. The maximum enrichment in Fe content in grain as influenced by Fe soil + spray treatment over control was from 34 to 40 $mg.kg^{-1}$ in Fe-least efficient varieties. Similarly, the maximum enhancement in Fe uptake due to Fe Soil + spray treatment over control varied from 69 to 102 $mg.kg^{-1}$ in Fe-least efficient varieties. This has confirmed the effectiveness of Fe-most efficient group of genotypes for their efficient utilization of Fe from native Fe-source in the soil.

The study indicate the existence of potential for improving yield and grain quality with regard to Fe contents in pigeon pea genotypes through genetic improvement and agronomical approaches.

42. Influence of Intercropping and Weed Management Practices on Weed and Yields of Maize

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Key words : *Intercropping, weed management, soil solarization, weed control, weed smothering efficiency, equivalent yield*

Weed control approach involving intercropping, herbicides and non-chemical method in maize and maize-based intercropping system is very important to provide effective and acceptable weed control for realizing high production. A field

experiment was conducted on loamy sand soil at Anand to study the influence of intercropping and weed management practices on growth and yield of maize during the year 2007 and 2008. Maize grain and straw yields were noted higher under maize sole treatment, while intercropping of maize + green gram recorded significantly highest maize equivalent yield followed by maize + soybean intercropping system. In weed management practice, significantly higher grain and straw yields of maize as well as maize equivalent yield was recorded under the soil solarization treatment followed by pre-emergence application of pendimethalin at 0.5 kg.ha^{-1} + hand weeding at 45 days after sowing (DAS), and alachlor at 1.0 kg.ha^{-1} + hand weeding at 45 DAS. Weed smothering efficiency (%) calculated at 20 and 45 DAS and at harvest clearly indicated that intercropping of maize with soybean having higher weed smothering efficiency than maize with green gram. Highest weed control efficiency at 78.22 and 58.60% was observed under the treatment of soil solarization at 20 and 45 DAS. At harvest, weed control efficiency was higher with the pre-emergence application of pendimethalin at 0.5 kg.ha^{-1} coupled with hand weeding at 45 DAS followed by pre-emergence application of alachlor at 1.0 kg.ha^{-1} followed by hand weeding at 45 DAS.

Highest net return of Rs. 20,482 ha^{-1} was recorded in maize + green gram intercropping system while in case of weed management practice, the highest net return of Rs. 24,903 ha^{-1} was recorded with the application of pedimethalin at 0.5 kg.ha^{-1} plus hand weeding at 45 DAS. The lowest net return of Rs. 13,690 ha^{-1} was recorded with control treatment.

43. Regression Analysis of Apple Yield on the Basis of some Morphological and Nutritional Parameters

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Key words : *Apple, regression coefficient, nutrients, yield, morphological parameters, spur*

Studies were conducted on the age groups (15-20, 21-25 and > 25 years) of Royal Delicious apple orchards at Jubbal, Mashobra, Seobagh and Bajaura locations. Yield was influenced significantly by growth, volume, secondary spurs, flowering and fruit set at Mashobra location i.e. the increase in these plant parameter proportionally increased the yield but primary spur has no effect on yield. 73 per cent of the total variation in yield was explained by variables included in the function. At Jubbal yield was influenced significantly by all the parameters except primary spur and flowering. 64 per cent of the total variation in yield was explained by variable included in the function. 62 and 55 per cent of the total variation in yield was explained by variables included in the function at Seobagh and Bajaura, respectively. The yield was affected by proportion of reproductive buds in spur categories S_2 and S_4 under Mashobra and Jubbal locations. Explanatory variable (the variable which influences the value of dependent variable, used for prediction and also known as regression or independent variable) included in the function have explained about 65% and 71 % of total variation in the yield at Mashobra and Jubbal; respectively. At Seobagh, variables included in the function have explained about 76% of total variation in yield. At Bajaura, variables have explained 62% of total variation in the yield. Yield was affected significantly by leaf N, P, K, Ca and Mg at Jubbal and Seobagh and the explanatory variable included in the function have explained about 81 % (Jubbal) and 89% (Seobagh) of total variation in the yield. Under Mashobra and Bajaura conditions, explanatory variables have explained 78% and 74% of the total variation in the yield.

44. Physiological Basis for Growth and Tield Variation in Bt and non Bt Cotton Hybrids

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Key words : *Bt cotton, Non-Bt cotton, Date of sowing*

A field experiment was conducted under rainfed condition at Agriculture Research Station, Dharwad to compare the morpho-physiological characters and

yield potential of different Bt and non-Bt cotton hybrids. The experiment consisted of four Bt hybrids and their non-Bt counter parts and one check hybrid laid out in a split-plot design with two dates of sowing as the main plot and nine genotypes as subplots with three replications each. There ws no significant difference between the dates of sowing for many of the growth and yield. Among the Bt hybrids, NHH-44 produced significantly higher seed cotton yield (2256 kg.ha^{-1}) and among the non-Bt hybrids MRC-6322 had the highest (1641 kg.ha^{-1}) production. This was mainly attributed to its close association with number of bolls per plant and boll weight per plant. Bt hybrids recorded less plant height, less LAI than non-Bt hybrids. Genotypes differed significantly in their growth pattern, morphological characters and phonological characters. Among the genotypes, non-Bt hybrids recorded more plant height, number of leaves and LAI compared to Bt cotton hybrids indicating their more vegetative growth. Bt hybrids matured five to eight days early compared to non-Bt hybrids. Bt hybrids recorded less boll damage than non-Bt hybrids.

45. Response of Chick Pea to Applied P Levels in Black Cotton Soils

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Key words : *Chick pea, P response, Black cotton soil, Mean yield*

A field experiment was conducted at RARS, Lam, Guntur to study the response of chick pea to applied P levels in black cotton soils during r*abi* 2008-09 and 2009-10 with variety JG 11 in randomized block design with five treatments replicated four times. The experimental soil was non saline, slightly alkaline, medium in organic C and available P, low in available N and high in available K_2O contents. The treatment details included i) absolute control (Zero N and P) ii) Zero P (N alone) iii) Recommended dose of P (50 kg/ha), iv) STCR based P application (76 kg/ha) and v) 70% recommended dose of P. At flowering stage data on plant growth parameters, soil nutrient status, nutrient composition and uptake in plant were recorded. Yield components and yield, nutrient composition and uptake in grain and nutrient status in post harvest soils were recorded at harvest.

The results indicated that application of recommemded dose of P (50 kg/ha) in the black cotton soils containing medium level of available P_2O_5 gave significantly higher mean yield (25.13 q/ha) than the absolute control and zero P (N alone) treatments which recorded 20.26 and 21.32 q/ha respectively. The mean yield (24.96 q /ha) obtained in the STCR based P (76 kg/ha) application treatment was at par with the application of recommended dose of P treatment. Application of 70% recommended dose of P resulted in lower mean yield (22.33 q/ha) than other two P application treatments. P and K contents in shoot at flowering stage were significantly different in different treatments. Variations in soil nutrient status at flowering stage were not significant. P content and uptake in grain and available P_2O_5 in soil at harvest were significantly high in P applied plots when compared to control plots.

III. NATURAL RESOURCE MANAGEMENT

46. Sorption of Tetracycline and Chlorotetracycline on Na-, K- and Ca-Saturated Clays, Humic Substances and Clay-Humic Complexes

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Key words : *Physical properties, Aonla fruit, Sphericity, Surface area*

To elucidate the environmental fate of two antibiotics, tetracycline (TC) and chlortetracycline (CTC) extensively used for growth promotion and therapeutic purposes in livestock, sorption of these antiobiotics was studied on clays, humic substances and clay-humic complexes derived from three agricultural Indian soils using dilute NaCl or CaCl2 as background solutions. The sorption in all the systems was 76-97% of added amount. Strongest adsorption was observed for clays followed by humic substances and then caly-humic compleses. The sorption of CTC was more than TC and followed the order Na-saturated > Ca-saturated. The sorption was more at pH 5.7 than at pH

7.0. Desorption data provided evidence for a partly chemisorptions and partly physical adsorption. X-ray diffraction analysis showed that CTC and TC wee sorbed in the interlayer of clays and the presence of humic substance reduced interlayer sorption of abtibiotics in lay-humic complexes. The results also denoted that studied antibiotics were dominantly sorbet on soil clays and that humic substace in clay humic complexes either mask sorption sites on clay surfaces or inhibit interlayer diffusion. These results supported the inference regarding sorption of studied antibiotics *viz.* protonation and/or co-ordination of metallic cations on soil clays/humic substance to the carbonyl group of amide of antibiotics.

47. Vegetation Indices based Analysis of Salinity Areas of South-West Punjab through Remote Sensing and GIS

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Key words : *LISS III, GIS, GPS, Vegetation indices, False color composite*

The study area lies in Eco region 2 (M9E1), between geo-coordinates $30^0$00’ to $30^0$15’ N and $76^0$30’ to $76^0$45’E. It is located in south-western part of Punjab. Wheat crop is the only agricultural crop grown in *rabi* season. In March month, wheat crop attain its maximum growth. The RV1 image was generated and the values ranged from 0.92 to 4.39 for the vegetation in the area. In the Normalized Difference Vegetation Index image value ranges from 0.36 to 0.70. High vegetation density has maximum value of 0.70 and lowest/poor vegetation density has value of 0.36. NDV1 measures chlorophyll absorption in the red portion of the spectrum relative to reflectance or radiance in the near infrared. The NDV1 range values for various classes were obtained considering NDV1 value of location based on field observation. It is emphasized that waterlogging and salinity in the villages of Muktsar and Bhatinda have reached a critical situation.

48. Plant Mediated Nitrous Oxide Emission from Wheat Agriculture

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Key words : *Nitrous oxide, Irrigated wheat, Morpho-physiological characteristics, anatomical characteristics*

Experiments were conducted in the alluvial soils of North Bank Plain Agroclimatic zone of Assam in order to assess the role of plants in Nitrous oxide (N_2O) emission from soil to the atmosphere. During an investigation with four varieties of wheat (*Triticum aertivum* Linn.), *viz.* Sonalika, HUW 468, HUW234 and DBW 14, plant growth parameters [tiller numer, leaf area, leaf number, plant height, root length, root volume, shoot dry weight and root dry weight], physiological parameters [rate of photosynthesis and transpiration], anatomical parameters [stomatal frequency of leaf and leaf sheath] were analyzed to find out a relationship with N_2O flux. Nitrous oxide emission from the varieties were recorded at weekly interval and the cumulative N_2O flux over the entire crop growing season for the varieties were worked out in the forma of seasonal integrated flux (E_{sif}). Nitrous oxide meission was found to increase with increasing plant growth in terms of plant height, leaf area, root volume and root dry weight. A positive correlation, though not significant, was found between N_2O emission and crop photosynthetic rate. The rate of transpiration recorded from the wheat vrieties shoed a significant correlation with N_2O emission suggesting that the movement of N_2O emission through wheat plants. Anatomical investigation by Scanning Electron Microscope (SEM) showed a positive correlation of stomatal frequency of leaf and leaf sheaths with N_2O emission. Significant variation in E_{sif} values were recorded within the varieties.

49. Distribution of Arbuscular Mycorrhiza (AMs) in some Selected Soils of Visakhapatnam : A Case Study

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Key words : *Arbuscular mycorrhizae (AM), Glomus, Polluted and non-polluted soil*

The aim of this study was to find out the potential and distribution of Arbuscular Mycorrhiza (AM) fungi in some polluted soils of Visakhapatnam. The spore density of *Glomus morphotypes* (r = 0.9295) was significant and strongly correlated and compared with other AM fungi. *Scutellospora* (r = 0.47) had moderate correlation in the non-polluted area, whereas in polluted area *Glomus morphotypes* (r = 0.96) was significant and not well correlated to others like *Scutellospora* (r = 0.54) and *Acaulospora* (r = 0.07). Thus, it is important to screen indigenous and pollution tolerant AM isolated in order to gurantee the effectiveness of AMs for restoration of contaminated soils.

50. Effect of PSB and VAM with different Sources of Phosphatic Fertilizer on Growth Attributes, Chlorophyll Content and Yield of Wheat

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Key words : *Phosphsate source, Growth attributes, Chlorophyll content, Wheat yield*

Field experiments were conducted to see the response of various phosphate sources in the form of chemical fertilizers and biofertilizers on growth attributes -

chlorophyll content and yield of wheat (*cv*. HD 2285). The twelve treatments where various phosphate sources wee applied either singly or in combination with nitrogen were replicated thrice. The treatments $N_{120}SSP_{30}VAM$, $N_{120}RP_{30}PSB$ were able to out perform $N_{120}P_{60}$. Dry matter and chlorophyll content was higher in treatments $N_{120}SSP_{30}VAM$ and $N_{120}RP_{30}VAM$. Higher yields wee also observed in $N_{120}SSP_{30}VAM$ and $N_{120}RP_{30}PSB$. Thus it can be concluded that the treatments $N_{120}SSP_{30}VAM$ and $N_{120}RP_{30}PSB$ favorably affected the growth parameters and yield of wheat.

51. Effect of application Silicon solubilizing liquid bio-inoculants added through different Silicate sources on Sugarcane

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Key words : *Silicon solubilizing microorganisms*

The purpose of application of a silicon source is to provide soluble silicon to plants. Therefore, a good source must have much of its silicon readily soluble in the soil solution. Bacteria are plentiful in soil and a few of them have the capacity to solubilize silicate minerals, releasing silica. Importance of silicon and silicon solubilizing microorganisms (SSM) in agriculture is well-known. Present studies of isolation, identification and screening of isolates have been carried out in order to select efficient strains of silicon solubilizing bacteria for mass production of the bio-inoculant in liquid formulation.

52. Status of Microbial Biomass Carbon under Organic Land use systems in Wardha district, Maharashtra

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Key words : *Organic land use systems, Conventional land use systems, Soil microbial biomass C*

Soil microbial biomass carbon (SMB-C) and soil properties were estimated for five profiles under organic and conventional land use systems in Wardha district, Maharashtra following standard procedures. The fraction of SMB-C showed wide variation (137.80 to 404.20 $mg.g^{-1}$ soil). Surface soils contained more biomass carbon. Soils under organic land use system recorded the highest content of SMB-C, whereas that under conventional land use system contained the lowest. The SMB-C accounted for 3.4 to 5.5 per cent of the soil organic carbon. A strong positive correlation (r = 0.97) was observed between SOC and SMBC. The results indicate that regular addition of organic residues through organic land use system considerably elevated the microbial population and hence biomass-C in soil.

53. Enhancing Plant Growth by Application of Vegetable Wastes and Growth Promoting Rhizobacteria – *Rhizobium, Azotobacter* and *Lactobacillus*

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Key words : *Rhizobium, Azotobacter, Lactobacillus, Biofertilizer, Vegetable waste, Green gram*

A comparative study was undertaken to evaluate the efficiency of the rhizobacteria *Rhizobium* (R), *Azotobacter* (A) and *Lactobacillus* (L) in different combinations to convert the vegetable waste into a biofertilizer and in enhancing the growth of green gram plants. The study consisted of five treatments including one control and different other combinations. Treatment 1 contained the combination of three bacteria (R + A + L), treatment 2 contained R + A, treatment 3 contained R + L, treatment 4 contained A + L while treatment 5 was uninoculated control. Mixture of vegetable waste and soil (1:1 on a dry weight basis) combination was inoculated with 1ml (1×10^9) of each organism. The resultant compost from treatment 1, when used for plant growth with green gram (*Cicer arietinum*) as the test plant, had greater impact on the germination, shoot length and root length when compared with compost produced with other combinations of bacteria and the control.

54. Effectiveness of Various Biofertilizers on the Growth and Biomass production of Selected Vegetables

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Key words : *Biofertilizer, Azospirillum, Pseudomonas, leaf amaranth, field pea*

The present study investigated the effect of different biofertilizers on the growth and biomass production of leaf amaranth (*Amaranthus gangeticus*) and field pea (*Pisum sativum*). There were altogether five treatments including two sets of control – one without biofertilizer application and the other with chemical fertilizer. *Azospirillum* sp. and *Pseudomonas* sp. isolated locally on N-free Bromothymol blue medium (NFB) and King's medium respectively. A biomanure treatment of vermicompost was also included. The biofertilizers were applied individually as well as in combination. Results indicate that combined application of all the biofertilizers as well as biomanure was superior and enhanced plant growth much better than applied individually.

55. Performance of Wheat as Influenced by Tillage Options and Nutrient Levels under Limited Irrigation

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Key words : *Wheat, Tillage options, nutrients management, varieties, yield, root parameters and economics*

A field experiment was conducted during 2004-05 and 2005-06 at IARI, New Delhi to find out the performance of wheat varieties under various tillage options and nutrient levels. Four irrigations were applied to wheat crop. Highest root volume, root length density, higher yield attributes, grain and straw yields, net returns and B:C ratio were recorded from FIRBS planting. The net returns were

higher with the application of 100% recommended dose of NPK along with 5 t FYM.ha^{-1}. However, B:C ratio was higher with the application of 75% recommended dose of NPK along with 5 t FYM.ha^{-1}.

56. Nitrification Inhibitors : Effect on Gaseous and Soil N in a Rice Field

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Key words : *Nitrification inhibitors, Rice field, CH_4 flux, N_2O flux, Seasonal variation*

An experiment was conducted in the experimental fields of the Central Rice Research Institute, Cuttack to study the effect of different organic and inorganic nitrification inhibitors on N_2O from soil vis-a-vis soil physico-chemical properties during wet and dry season of rice with urea as the source of N. Three nitrification inhibitors were used for the study, i) Dicyandiamide (DCD), ii) Nimin and iii) Karanja oil with three replication each in a completely randomized design. Urea alone was used as the control. During the dry season, N_2O emission ranged from -74.62 to 251.85 μg.m^{-2}.h^{-1} and that during the wet season as -79.88 to 191.30 μg.m^{-2}.h^{-1} with seasonal flux of 1.97 kg.ha^{-1} during the dry season and 1.86 kg.ha^{-1} during the wet season. Seasonal N_2O flux followed the order control > urea + DCD > urea + karanja oil > urea + Nimin during both the seasons. However, per cent decrease of N_2O flux over control in DCD amended plots was significantly higher during the wet season. NH_4^+ concentration in soil was higher in plots with karanja oil and nimin at the early growth stages. NH_4^+ content of the soil was significantly hgiher during the wet season. Nitrification inhibitors like nimin and karanha oil does not affect the conversion of NO_2^- to NO_3^- in the soil, the NO_3^- concentration in soil during the early stages of crop was higher but decreased significantly as the crop reaches the maturity. Soil ninhydrin reactive nitrogen (NRN) content, an indicator of available N, was higher 10 days after transplantation of rice and decreases

simultaneously upto 60 days and then starts increasing towards maturity. Rice grain yield was recorded significantly higher from nimin amended plots during both the seasons.

57. Ammonia Emission from Agricultural Soil during Winter Wheat Crop

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Key words : *Atmospheric NH_3, NO, NO_2, Chemiluminescence method, Wheat crop*

Concentration of atmospheric NH_3, NO and NO_2 were measured before sowing, harvesting and during different growth stages of wheat crop over research farm of Indian Agricultural Research Institute, New Delhi during 2009-10. NH_3, NO and NO_2 were measured precisely using NH_3- and NO_x-analyzer operating in chemiluminescence method with higher estimation efficiency (>90%) than the chemical trap method. Before sowing of *rabi* crops, all the fields in and around the measurement site were prepared and the wheat crop was fertilizerd with 120 kg $N.ha^{-1}$ as urea. The average concentration of NH_3, NO, NO_2 just before sowing of wheat were recorded as 60.57 ± 13.10 $\mu g.m^3$, 79.84 ± 23.78 μg ,m^{-3} and 55.42 ± 8.81 $\mu g.m^{-3}$ respectively. Significant diurnal and day-to-day variations in concentrations of NH_3, NO and NO_2 emission were recorded during the study. Average day and night time concentration of atmospheric NH_3 was recorded as 65.71 ± 17.38 $\mu g.m^{-3}$ and 55.42 ± 8.81 $\mu g.m^{-3}$ respectively. Day time increase in ambient temperature attributes to increase in soil temperature which leads to increase in N-volatilization loss or soil ammonification which is further release of NH_3 from soil. Results reveals that the concentration of atmospheric NH_3 is positively correlated with the ambient temperature (r^2 = 0.79). The emission of atmospheric NH_3, NO and NO_2 werer recorded less during and before harvesting of wheat crop when compared with just before sowing of wheat.

58. Spatial Spread and Structural Change of Groundwater Markets and Irrigation Services in India : An Inter-regional Analysis

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Key words : *Water markets, Irrigation services, Spatial spread+-*

Study was conducted to assess scale and spread of water markets and irrigation services in India. NSS data used for analysis indicated that area irrigated through pump irrigation services has increased from 1.0 million ha to 20.0 million ha. Further, there are 21 million pump owners and another 24 million farmers who report hiring of irrigation services. Of these, there are some 11 million electric pumps which service at least 12-13 million buyers. This means that the benefit of electricity subsidy percolates to 23-24 million farmers of india. Thus, the role played by hired irrigation services and groundwater markets needs attention, and will also go a long way in sustainable management of groundwater resources.

59. Carbon Sequestration Strategies in Tropical India : Experiences from Several Long Term Manurial Trials under Rainfed Conditions

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Key words : *Carbon sequestration, rainfed production systems, tropical India*

Maintaining organic carbon is the most difficult challenge particularly in tropical regions where rapid decomposition of organic matter results in loss of carbon from soils due to high temperatures. An attempt was made to examine the effects of different nutrient management options on build up/depletion of organic carbon under rainfed production systems and to identify the best carbon management option under diverse climatic conditions and soil type. Soil samples were collected after 15 to 27 years of cropping from above treatments at 0-20, 20-40, 40-60, 60-80 and 80-100 cm depth from 6 long term manurial trials under All India

Coordinated Research Project on Dryland Agriculture (AICRPDA). Under groundnut based production system at Anantapur (Andhra Pradesh), a positive buildup of organic carbon and organic carbon sequestration rate of 0.452 t ha^{-1} $year^{-1}$ was recorded in 50% RDF+FYM. At Bangalore (Karnataka), under groundnut-finger millet rotation, there was a net depletion (-3.58 t ha^{-1}) in control and build up of 6.26 t ha^{-1} in FYM 10 t ha^{-1} + 100% NPK. Under *rabi* sorghum production system at Solapur (Maharasthra), all the treatments showed positive buildup of organic carbon with highest organic carbon sequestration rate in 25 kg N (crop residue) + 25 kg N (Luecaena) after 21 years of cropping. Under pearlmillet production system at SK. Nagar (Gujarat), after 18 years of cropping, all the treatments showed the depletion of soil organic carbon to the extent of 4.54 t ha^{-1} in control treatment in top 20 cm depth. Lowest depletion was observed in 50% N (fertilizer) + 50% N (FYM). Under soybean production system at Indore (Madhya Pradesh), control and organic treatments showed depletion of organic carbon and INM and organic treatments showed buildup of carbon. Under rice based production system at Varanasi (Uttar Pradesh), after 21 years of cropping, control plots showed depletion, inorganic treatments maintained similar levels and organic treatments showed buildup of organic carbon.

60. Soil Application of Cow Urine, Butter Milk and Blue-green Algae (cyanobacteria) to decrease the Salinity and Improvement of Soil Environment

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Key words : *Traditional approach, Scientific empowerment, Reclamation, hypersaline and hyperacidic areas*

Bhavnagar district in Gujarat is sharply affected by hypersalinity and hyperacidity. Traditional approach with the scientific empowerment improved the structure of acidic soils in the coastal areas. Traditional approach include application of blue-green algae with yoghurt, butter milk, cow urine, coconut waste materials and gypsum to solve the problem of salinity in the area.

61. Response of Banana to Micro-irrigation System and their Scheduling

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Key words : *Drip irrigation, Microjet, Irrigation scheduling, Banana*

Growth attributes *viz.* plant height, plant girth, length of leaf and yield attributes *viz.* weight of first hand, number of fingers in first hand, average girth of finger and fruit yield (55.77 $t.ha^{-1}$) of banana significantly superior with microjet irrigation, scheduled at 55% of evapo-transpiration with highest net returns (Rs. 130,578 ha^{-1}) and B:C ratio (1.5) which saved 42.45 per cent irrigation water in comparison with check basin irrigation under lateritic soils of Konkan. Irrigation water supplied to above treatment was 120.84 ha-cm. Highest water use efficiency (0.8 $t.ha\text{-}cm^{-1}$) was recorded by the treatment drip irrigation scheduled at 55 per cent of evapo-transpiration.

62. Indigenous Nutrient Supply and Nutrient Requirement of Rice in Reclaimed Alkali Soils

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Key words : *Irrigated lowland rice, Reclamation of sodic soil, Nutrient requirement, Indigenous nutrient supply*

Field experiments were conducted during *Samba* (September-February) season of 2004 and 2005 in alkali soils with pH 8.6 and ESP 16 with amendments @ 50% GR or distillery spent wash (DSW) @ 5 lakh $litres.ha^{-1}$. By adopting the recommended DSW technology for the reclamation of alkali soils, i.e. one month time gap after application and leaching with good quality water, DSW apart from

reclaiming alkali soils also recorded significantly higher rice grain yield of 6.5 $Mg.ha^{-1}$ over gypsum @ 50 GR. In moderately alkali soils (pH <8.7 and ESP <20) growing alkali toerant rice cultivars, *viz.* TRY 1 or BPT 5204 recorded average rice yield of 5.8 $Mg.ha^{-1}$. The total factor productivity and partial factor productivity for N, P and K of rice increased by reclamation of alkali soils either with DSW or gypsum @ 50% GR, improved the recovery efficiency of N and P and decreased the recovery efficiency of K. Reclaiming through DSW application recorded significantly higher N and Na uptake. Reclaiming alkali soil with gypsum increased the N and P requirement of rice to produce one ton of grain while decreased K requirement. But DSW reclamation increased the N, P and K requirement of rice. The nutrient requirement to produce one ton of rice is higher in reclaimed alkali soils than normal soil. The indigenous nutrient supply *viz.* INS, IPS and IKS increased with DSW application while it is almost comparable with no amendment or gypsum reclaimed alkali soil.

63. Influence of Continuous application of Organic Manures and Chemical Fertilizers on Rice Yield and Fertility Status of Soil

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Key words : *Rice grain yield, Available nutrients, nutrient uptake*

With the changeover of the cropping pattern and the adoption of scientific production technology, modern farming achieved a breakthrough in agricultural production. The nutrient requirement has also increased severalfold with the introduction of high yielding and nutrient responsive crop varieties resulting in a rapid depletion of nutrients. This would naturally have much greater impact on soil and crop environment than ever concerned before. The practice of fertilization at higher doses through fertilizers without organic manures is found to deteriorate the soil properties and destroy the fertility status critically over a period of time. The best method to assess the influence of manures and fertilizers on soil properties and fertility status would be by conducting permanent manurial experiments. A permanent manorial experiment on rice is being conducted at the Agricultural College and

Research Institue, Madurai, Tamil Nadu since 1975 with rice as a test crop under monoculture condition. In this four main plot treatments consisting of organic manures (control, FYM @ 12.5 $t.ha^{-1}$, green leaf manure @12.5 $t.ha^{-1}$ and urban compost @ 12.5 $t.ha^{-1}$) and eight sub-plot treatments (control, N, P, K, NP, PK, NK and NPK). Before this investigation 50 rice crops had been harvested. The present study was taken up on 51st and 52nd rice crops grown during the year 2008 and 2009 respectively. The soil samples were collected before transplanting and after harvest of the rice crop and analyzed for available N, P, K, S and organic C. The yields of grain and straw were recorded and the grain and straw samples were analyzed for their nutrient contents. The two year pooled data revealed that grain and straw yields were higher in green leaf manure treatment in combination with NPK which is statistically at par with green leaf manure with NK. Uptake of N, P, K and S were also found to be higher in the treatment that received green leaf manure NPK. Among the organics, the green leaf manure performed better in supplying the nutrients at optimum period of time. Available N, P, K and S were found to be higher in the treatment that received any one of the manures in combination with N, P and K. Soil organic C content increased in the urban compost than green leaf manure and FYM.

64. Nutrient Optimization of Sugarcane in Periya-Vaigai Command Area of Tamil Nadu

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Key words : *IPNM, Nutrient optimization, sugarcane, Mitcherlich-Bray equation*

For optimization of N, P, K, Zn and Fe for sugarcane, a field experiment was conducted during 2005-06 at P.C. Patty village of Theni district with the variety Co 86032 by employing treatment combinations of four levels of N, P and K at 0, 75, 100 and 125 per cent recommended dose of fertilizer without and with recommended level of $ZnSO_4$, $FeSO_4$, vermicompost and *Azophos*. Graded levels of

NPK application with IPNM practices favorably influenced the cane yield. The yield obtained ranged from 76.5 to 142.0 $t.ha^{-1}$. The highest cane yield was recorded in the treatment that received N @ 340 $kg.ha^{-1}$along with the recommended dose of P, K, $ZnSO_4$, $FeSO_4$ and *Azophos*. Biometric characteristics *viz.* number of millable cane, length and girth of millable cane, number of internodes and length of internodes in millable cane were higher in 340 kg N ha^{-1} application which ws on par with the recommended dose of N (275 $kg.ha^{-1}$). The N, P, K, Zn and Fe contents increased with increasing levels of N, P and K along with the recommended dose of $ZnSO_4$ and $FeSO_4$, vermicompost and *Azophos*. With the advancement of crop growth stages, the nutrient contents decreased progressively. The major fertilizer nutrient levels were obtimized using Mitcherlich-Bray equation and targeted yield concept. The maximum yield (A) of 160 $t.ha^{-1}$ was arrived through least square function using the yield data. N, P and K requirement at different soil test values for achieving the target yield of 155 $t.ha^{-1}$ was estimated by fertilizer prescription equation using CI (soil efficiency) and C (fertilizer efficiency) values. By using the Mitcherlich-Bray equation, physical and economic optimum of N, P and K were computed and the results revealed that the applied N and K levels were found to be equal to that of recommended dose. However, it seems to be higher for P as compared to recommended dose. The fertilizer recommendations by fertilizer prescription equation for 155 $t.ha^{-1}$ of yield target were found to be more than that of blanket fertilizer recommendation.

65. Development of Talc Formulation of a Drought Tolerant *Pseudomonas putida* strain for Plant Growth Promotion and Integrated Nutrient Management in Rainfed Crops of India

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Key words : *Rainfed Agro-ecosystem, Drought Tolerance, Pseudomonas putida, Plant Growth Promotion*

The rainfed agro ecosystem in India covers arid, semi arid and sub humid zones which represents more than 70% of the geographical area. The use of Plant

Growth Promoting Rhizobacteria (PGPR) to increase crop yield has been limited due to the variability and inconsistency of results between laboratory, greenhouse and field conditions. The problem is further compounded with various abiotic stresses that affect microbial growth in rainfed agro-ecosystems. Out of 75 fluorescent *Pseudomonas* spp. P17 strain which was identified as *Pseudomonas putida* has given promising results in green house and glass house studies towards plant growth promotion and nutrient uptake in jowar (*Sorghum bicolour*) and pigeonpea (*Cajanus cajan*) plants. The strain has been formulated in talc and the formulation has been studied over a period of 6 months for various standard parameters. At the end of 6 months the formulation had a cell count of $3.2X10^7$ CFU/ mL, pH of 6.98 and the moisture content was 9.8%. The organism has also retained all the PGPR traits it was previously screened for in the formulation. This bio-formulation is meant to enhance the plant growth by 20% and saves 25% of fertilizers usage.

66. Methane and Nitrous Oxide Emission in System of Rice Intensification with Basmati and Non-basmati Rice Cultivar

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Key words : *Methane, Nitrous oxide, SRI, Transplanted rice, Mitigation, Basmati and non-basmati rice*

System of rice intensification (SRI) is supposed to be an alternate method for higher yield, water saving, increased farmers' income and has a potential for GHG mitigation. A field experiment was conducted with three planting methods; conventional (TPR), SRI with 12 days seedling (SRI-12) and SRI with 18 days seedling (SRI-18) and two cultivars of rice – basmati and non-basmati, to study their effect on methane and nitrous oxide emission. Methane flux varied significantly with planting methods. SRI reduced the methane emission by 62.5% and increased N_2O-N emission by 22.5% as compared to conventional method. The global warming potential (GWP) of SRI was reduced by 29% over conventional

method. A 44% of water saving was observed with system of rice intensification without any significant decrease in grain yield as compared to the TPR. Methane and nitrous oxide emission from basmati cultivar (Pusa 1121) was 12.7% and 3.5% higher than the non-basmati cultivar (Pusa 44), respectively. The GWP in basmati rice was 7.5% higher than non-basmati rice. The study concludes that the SRI method can reduce GHG emission and saves water without any yield penalty.

67. On-Farm Assessment of Integrated Nutrient Management in Rice-Wheat and Maiz-Wheat cropping Systems in Indo-Gangetic Alluvial Soil

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Key words : *Rice-Wheat, Maize-Wheat, Grain yield, Nutrient uptake*

Continuous use of high levels of chemical fertilizers over long period can lead to soil degradation and environmental pollution. Although the use of chemical fertilizers has and will continue to play an important role in achieving higher crop yield, but the integration of organic and inorganic fertilizers is highly desirable to sustain higher crop yields and to maintain soil fertility. Keeping this point in mind six field experiments were conducted in rice-wheat and maize-wheat cropping system in different agro-ecological zones of the Punjab state. Before sowing soil samples were collected from various sites and analyzed for pH, EC, organic carbon and available N, P and K. All the fields tested low in available N, high available P and low to medium in available K. The grain yields of rice and maize increased significantly in plots where organic and inorganic fertilizers were applied conjunctively than other treatments, also the grain yield of following wheat increased significantly in these plots indicating the residual effect of farm manure at most of the sites. Uptake of N, P and K increased significantly in rice and wheat in organic and chemically fertilized plots than other treatments whereas it was insignificant in the following wheat. From the present investigation it can be concluded that integration of organics and chemical fertilizers is necessary for sustaining crop production.

68. Effect of Post Methanated Distillery Spentwash in Crops on Ground Water Quality using Piezometers

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Key words : *Piezometer, Leachate, Cations, Anions, Distillery spentwash*

The piezometer study was conducted in Research and Development Farm at M/s Sakthi Sugars Limited, Appakudal in the year 2006-2007 to find out the effect of spentwash application on ground water leaching. The piezometers were installed in the turmeric, sugarcane and cassava fields to assess if any ground water pollution due to the application of spentwash. The results revealed that EC of the leachate was found to decrease with increase in the number of leachings and it got reduced from 2.81 to 1.56 dS m^{-1}, 2.96 to 1.93 dS m^{-1} and 1.75 to 1.35 dS m^{-1} in turmeric, sugarcane and cassava field experiments where the distillery effluent was applied @ 1.0 lakh litres ha^{-1}. The pH values of the leachate within the range of 7.51 to 8.24, 7.50 to 7.82 and 7.57 to 8.36 in the three test crops respectively. Application of distillery spentwash resulted in a build up of considerable amounts of cations like Ca, Mg, Na and K in the leachate. However, there was a marked decrease in the levels of anions with increasing number of leachings. The SAR values of the leachate were within the safer limits of <3. The RSC values of the leachate collected in all the leachings were found to be negative indicating that the application of spentwash would not induce sodium hazard in the groundwater.

69. Comparative Evaluation of Three Methods of Saturated Hydraulic Conductivity Measurement

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Key words : *Hydraulic conductivity, Positive-head tension infiltrometer, Single-ring pressure infiltrometer, Soil core method, Soil tyoe, Land management*

For successful soil and water management practices, knowledge of saturated hydraulic conductivity (*Ks*) is essential. Positive-head tension infiltrometer (TI) and single-ring pressure infiltrometer (PI) methods have potential for measuring *Ks*. However, these methods are not widely tested and compared with the commonly used methods. The TI, PI, and classical undisturbed soil core (SC) methods for measuring *Ks* were compared on three soils (sandy loam, clay loam, and clay) under three land use managements (conventional tillage (CT), no-tillage (NT), and native vegetation (NV)). Of the 27 between-method correlations, only four were statistically significant ($P<0.05$). The TI method yielded lower *Ks* values under high-permeability conditions ($Ks = 1.2 \times 10^{-4}$ ms^{-1}) relative to the other methods, as evidenced by lower geometric mean *Ks* (K_{gm}), lower maximum *Ks* (K_{max}), and lower minimum *Ks* (K_{min}) values. The 0.10-m diameter by 0.10-m long SC method cores may have been too small to yield representative estimates of *Ks* in the clay and in the NT and NV managements of the sandy loam and clay loam, as indicated by high coefficients of variation (CVs), inconsistent K_{gm} values, or high K_{max} values. The TI, PI, and SC methods tested in this study yielded different measures of *Ks* under CT, NT and NV managements. Only 4 of the 27 correlations were significant at $P < 0.05$; and in only two of the nine soil type management combinations (CT and NT) all three methods yielded statistically equivalent ($P < 0.05$) K_{gm} values. The TI method yielded estimates of K_{gm} that were comparable to those of one or both of the other methods when *Ks* was less than about 1.2×10^{-4} ms^{-1}. Under higher permeability conditions, the TI method gave lower K_{gm}, K_{max}, and K_{min} values than the other two methods. The TI produced the most representative estimates of *Ks* in the CT and NT managements of the cracking clay because it gave substantially lower CV values. The SC method produced representative estimates of K_{gm} in the sandy loam and clay loam soils. Erratic K_{max} and K_{min} values, as well as high CV values obtained by PI method suggest that it may not have yielded representative K_{gm} values in the CT and NT treatments of the cracking clay soil. The K_{gm}, K_{max}, K_{min}, and CV values obtained by the PI method for all other soil type and land management combinations were comparable with one or both of the other methods.

70. Pink Pigmented Facultative Methylotroph (PPFM) – A New Potential Bio-inoculant for Cotton Nutrition

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Key words : *Pink Pigmented Facultative Methylotrophs, Cotton nutrition, Seed cotton yield*

Pink Pigmented Facultative Methylotroph (PPFM), a novel growth promoting bacterium isolated from the leaves of cotton plant at CICR has been proved to enhance the vigour index of cotton cv.LRA 5166 when used along with *Azospirillum lipoferum*. The cross streak assay to test the compatibility of *Methylobacterium* sp with *Azospirillum lipoferum*, *Bacillus megatherium* var *phosphaticum* and *B. thuringiencis* var *Kursataki* proved that *Methylobacterium* can be mixed with other bio-inoculats and bio-agents for promoting vigour , crop growth, N and P nutrition and for pest and disease management in cotton. In vitro sulphur oxidation and P solubilization have also been confirmed for CICR isolate of *Methylobacterium*. Field study was conducted consecutively for two years during 2004 and 2005 to standardize the phyllosphere application of PPFM for enhancing the yield of Cotton and to study its compatibility with N fixers and P solubilizers under winter (August – February) irrigated condition. The experiment was conducted in sandy clay loam soil with low (163.5 kg/ha), medium (18.4 kg/ha) and high (595.6 kg/ha) in available N, P and K with the pH 8.15 and EC 0.45 $dS.m^{-1}$. The PPFM was mass multiplied in ammonium mineral salt medium until the population load reached to 10^9 cfu/ml in broth and sprayed using knap sack sprayer. Application of 75% of recommended N, P fertilizers (K 100%) with seed dressing of microbial consortia, ***Azophosmet*** (20 g each of *Azospirillum*, Phosphobacteria and *Methylobacterium* per kg of seeds) and soil application of 800 g each of these $cultures.ha^{-1}$ mixed with 500 kg of finely powdered FYM and spread uniformly on soil before sowing along with two phyllosphere spraying of PPFM (45 to 90 DAS) enhanced the yield of cotton to the tune of 7.1 to 15.9 per cent over no foliar spraying of PPFM suggesting the potential use of PPFM in Cotton nutrition for sustaining higher seed cotton yield at moderate level of chemical fertilizers.

71. Role of Cyanobacterial Systems (Blue Green Algae) in Minimizing Methane Emission from Paddy Cultivation

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Key words : *Cyanobacteria, Dissolved oxygen, Methane, Rice*

Cyanobacteria and the water fern *Azolla* have been identified as eco-friendly natural nitrogen fixers in the rice field ecosystem. The present study was aimed to find out the role of these biofertilizers as a dual crop in indirectly minimizing global warming potential from flooded paddy apart from their ability to fix atmospheric nitrogen. The rice fields inoculated with composite culture of cyanobacterial systems (*Nostoc, Anaebaena* and *Westiellopsis*) recorded a dissolved oxygen content of 7.4 ppm as against 4.3 ppm in the uninoculated plot. Redox status of the flooded soil is an indirect indicator of methane flux pattern from rice ecosystem and application of Cyanobacteria altered the redox potential leading to low methane flux. The redox status affects not only methanogens but also gas transfer through the plant. The higher dissolved oxygen and redox potential resulted in minimum methane flux in cyanobacteria applied plots (6.20 mg CH_4 $m^{-2}h^{-1}$). Cyanobacteria that grow on the soil surface and also as a floating mass act as live aerators in paddy field ecosystem and oxygen released during the photosynthetic activity got liberated as minute air bubbles and consequently aerate the water impounded in paddy field that resulted in increased dissolved oxygen content which ultimately decreased the methane flux. Hence, these Nitrogen fixing biological systems can be used to reduce methane flux from flooded rice ecosystem and this technology can also be promoted to develop carbon off sets.

72. Study of ENSO Effects on Hydrology and Rice Productivity in Cauvery Basin using SWAT

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Key words : *Cauvery basin, ENSO, Rice, SWAT*

A study was taken up to understand the variations in hydrology and rice crop productivity during different observed ENSO in the Cauvery river basin of Tamil Nadu, India using Soil and Water Assessment Tool that was continuously run from 1970 to 2008 and a composite for El Nino, La Nina and Normal years was made for understanding its influence on hydrology and rice crop productivity of the study area. From the analysis, it was clear that El-Nino episode has a good linkage with rainfall, hydrology and rice productivity in the Cauvery river basin. Validation of SWAT model showed that the model predicted rice productivity close to the observed data under normal situations compared to the extreme weather conditions such as drought and flood. From the analysis, it was evident that the inter annual rainfall variability was high (809.3 mm to 2366 mm) during El-Nino years, but, the quantum of rainfall was also more compared to other two situations (La-Nina and normal years). Inter annual variability of rice productivity in Cauvery basin was very high and ranged between 1137 and 7865 kg $ha^{-1}$with a mean productivity of 3955 kg ha^{-1}. The coefficient of variation in rice productivity was higher during La-Nina years compared to El-Nino and Normal years. Analysis of hydrological data and rice productivity indicated that the risk of failure was much lesser during the El-

Nino years compared to normal or La-Nina years. This behavior could be well utilized for forecasting the rice crop productivity under different ENSO conditions and can help the policy makers to decide on the water allocation as well as import / export policies.

73. Maximizing Productivity and Energy Utilization through Pigeon pea + Kalmegh Intercropping System

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Key words : *Intercropping, Row proportion, Absorbed PAR, Equivalent yield, Pigeon pea, Kalmegh*

An investigation was conducted during 2009-10 to assess the effect of row proportion on productivity and energy utilization of pigeon pea [*Cajanas cajan* (L.) Millspaugh] and kalmegh (*Andrographis paniculata* L.) intercropping so as to harvest maximum returns from unit area. Results revealed that row proportion of pigeon pea and kalmegh 4:2 row proportion produced higher yields and economic returns. The utilization of land was more in 2:2 row proportions. The energy utilization (absorbed PAR) was more in intercropping compared to sole cultivation. Positive correlation of morning relative humidity was observed with pigeon pea and evening relative humidity with kalmegh.

74. Effect of Light Interception on Yield and Yield Contributing Character of Ginger

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Key words : *Ginger, Light interception, Shade, Yield*

Ginger (*Zingiber officinale* Linn) of commerce or *Adrak* is the dried underground stem or rhizome of the Zingiberous herbaceous plant, which constitutes one of the five most important major spices of India. The spice stands third competing with chillies, depending upon fluctuation in world market prices and world demand and supply position. In fact, India enjoys the unique position of being the largest producer and exporter of ginger in the world. India's production alone constitutes about 50% of total world production. In India, about 70% of the total ginger production is confined to Kerala state alone which also produces the best quality of ginger. The major bottleneck in the production of ginger is its high cost of production. It is a shade loving crop and when grown beneath the shade of trees then it may achieve high yield. A field experiment was conducted at National Botanical Research Institute Rana Pratap Marg, Lucknow (U.P.) during *Kharif* seasons of 2005-06 with an object to ascertain the response of light interception on yield and yield contributing character of ginger. The experiment consisted of three treatments *viz*. T_1- 0% light interception, T_2-50% light interception and T_3-100% light interception with five replicates in randomized block design. Numerically all the observations were found maximum in T_1 (0% light interception) followed by T_2 and T_3. Different percentage of light interception treatment caused significant variations in plant height (cm), no of tillers plant^{-1}, no of leaves plant^{-1} and yield (q.ha^{-1}). Light interception of 0% recorded highest yield and yield contributing character as compared to other treatments

75. Impact of Reduced Tillage on Plant Diseases Under Rice-Wheat Systems in Northern Parts of West Bengal

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Key words : *Reduced tillage, Rice-Wheat, Occurrence, Severity, Disease*

Conservation agriculture has emerged as an effective strategy to achieve goals of sustainable agriculture which has the potential to protect our environment, soil and water resources while enhancing system productivity. But changing the tillage practice can lead to changes in the physical and chemical properties of soil which in turn is likely to influence the occurrence of plant diseases. A study was conducted to evaluate the influence of tillage systems on the incidences of major diseses of rice and wheat under rice-wheat system in northern parts of West Bengal. Results showed that zero tilled field had higher incidences and severity of sheath blight of rice and foliar blight of wheat than conventional tillage though the differences are not statistically significant.

76. Impact of Land-use Practices in a Hilly Catchment from Manipur – Management Option

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Key words : *Landuse, catchment, nutrient, run-off, sediment, management options*

In the hill eco-system of Manipur (latitude 23.80^{o} to 25.68^{o}N and longitude 93.03^{o} to 94.78^{o}E) overexploitation of forest resources due to pressures from both demographic and developmental angles, has resulted in large-scale deforestation resulting into loss of precious top soil and nutrients through runoff. The paper reports the impact of various land-use practices *viz*. sub-tropical forest, subtropical Pine and forest with shifting cultivation in a hilly catchment on runoff, sediment and nutrient losses. The study indicates that conversion of natural forest into other land uses including agro-systems leads to decline in soil-organic matter causing reduction in cation exchange capacity, thus becoming more vulnerable to leaching. However, supply of organic matter through suitable ground cover, litter layer, mulches etc. help in protecting soil and water resources. To mitigate the resource loss and to provide other alternatives of livelihood to the local population, an attempt is made in this study to suggest management options for shifting cultivation systems by traditional agro-forestry practices that need the attention of planners. Evidence is provided that such systems have potential for improving water use efficiency by reducing run-off, bind soil nutrients and enhance yields.

77. Carbon Sink Potential of Various Soil Types under different Land use Systems in Tamil Nadu

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Key words : *Soil organic carbon, Soil types, land uses, agroforestry*

Measuring soil organic carbon is essential for accurately estimating carbon inventories in different landscapes and ecosystems. A more complete understanding of terrestrial carbon cycle is a critical part of a sustainable carbon management strategy designed to enhance soil carbon. Further, estimates of carbon stocks within different land management and cropping systems are an important element in the design of land use systems that protect or sequester carbon. Assessment of soil carbon stocks at micro level is the need of the hour as detailed studies are lacking in this regard. Hence, in the present study, organic carbon density was estimated in different soil types under different land uses in five agroclimatic zones of Tamil Nadu. In each zone, one district was selected as a representative of the zone and soil samples were collected from four land use systems namely agricultural field, horticultural field, agroforestry field and plantation for comparing their soil organic carbon density. Samples were collected for both black soil and red soil. For each land use type, three samples were collected as replicates from each agroclimatic zones. The result showed statistically significant difference in soil organic carbon among various land use types and the present study shows that agroforestry system has higher levels of soil organic carbon compared with other land use types. The study also showed that black soil had higher levels of soil organic carbon in comparison with red soil irrespective of land uses and zones.

III. CROP PROTECTION

78. Chemical Detoxification of Chlorpyrifos and Determination of its Toxicity by Comet Assay

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Key words : *Chlorpyrifos, Toxicity, Chemical detoxification, Comet assay, Sensitive technique*

Humans are constantly exposed to numerous chemical species present in the environment. Chlorpyrifos, a toxic organophosphorus insecticide, has extensive use and persistence. It inhibits acetyl cholinesterase and is a neurotoxin, suspected endocrine disruptor and associated with asthma. There is a need to explore ways to transform this stable compound to less toxic analogue.

Various chemicals were reacted with the pesticides and structures of various degraded products were identified by NMR, GC-MS and LC-MS. The work involved testing of toxicity of the transformed products by 'Comet assay', a sensitive technique for the detection of DNA damage at the level of the individual eukaryotic cell. Discovery of these reactions enables us to detoxify chlorpyrifos to less toxic compounds. Based on the work, residues of this pesticide could be brought below its MRL from edible commodities as well as water.

79. Role of Edaphic Factors in the Development of Black Scurf of Potato Tubers

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Key words : *Black scurf disease, High soil moisture, Shallow planting, Potato, T. viride, T. harzianum*

Black scurf is one of the important diseases of potato tubers in Haryana. A study was undertaken about the role of edaphic factors including biological one leading to reducing/suppressing the effect on black scurf incidence without using any xenobiotic under screenhouse conditions. High black scurf incidence was observed in loam soil dropped down in sandy-loam and minimum in sand. Sand and slandy-loam soils suppressed disease by providing aerated conditions which were not favoured by the fungus. The prolonged high soil moisture (I:CPE = 40.25) resulted in high disease and low tuber yield. Low soil moisture (I:CPE = 40.35) abated the disease but also lower the tuber yield (230.6 $q.ha^{-1}$). Shallow planting (6 cm) showed low disease in comparison to deep planting (18 cm). Application of *T. viride* and *T. harzianum* before planting in soil reduced disease intensity and promoted tuber yield.

80. Role of Bio-Product "Mazra-M" for Integrated Pest Management and Yield of Oyster Mushroom (*Pleurotus* sp.)

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Key words : *Physical properties, Aonla fruit, Sphericity, Surface area*

Although several pests routinely affect the quality of oyster mushroom (*Pleurotus* sp.), using chemical pesticides is not a feasible solution due to consumer conern and environmental safety. A bioproduct "Mazra-M" could effectively be

used to control different pests of oyster mushroom in an ecofriendly way. The bioproduct contains a potentiated mixture consisting of neem (*Azadirachta indica*) 60%, biranga (*Embelia ribes*) 15%, kadama (*Anthocephalus cadama*) 15%, tobacco (*Lobelia inflata*) 5% and Na_2HPO_4, 12 H_2O 5%. The bioproduct does not have insecticidal property rather, it acts as a repellant. Within two days of spraying the bioproduct, all the pests from a colony by the side of the mushroom cylinder adhering to polyethylene cover containing the mushroom spawn and substrate. The pest colony can then be removed mechanically by simply cutting the polyethylene cover. In a field trial using the bioproduct, conducted over four years from 2006-09 in different locations of 24-Pgs (S) districtof West Bengal, significant increase in the yield of fruiting bodies was observed.

81. Cashew Nut Shell Liquid (CNSL) – A New Component to Control Bruchids in Stored Blackgram Seeds

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Key words : *Pulses, Seed storage, Pulse beetle, Bruchids, CNSL*

Blackgram is one of the protein rich crops affected by the notorious storage pest, pulse beetle (*Callosobruchus chinensis* L.) also called as bruchids. Losses of 40-50% have been attributed to this beetle due to its short life cycle and high reproductive capacity. The control of this beetle is an important task to reduce the losses during seed storage. Therefore a study was conducted to assess the efficacy of cashew nut shell liquid (CNSL) on control of pulse beetle (bruchids) in blackgram seeds. The fresh seeds were treated with CNSL at different concentrations and stored for evaluation. The results showed that CNSL was an effective component to control pulse beetle in blackgram seeds. The liwuid had both a toxic and oviposition deterrence effect at a dosage of 4 $ml.kg^{-1}$ of seeds as it caused low adult emergence, egg laying and percentage seed infestation. In addition, the germination and seedling vifour of treated seeds were not affected during storage.

82. Status of Seed-borne Diseases of Paddy (bunt and false smut) in Haryana

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Key words : *Paddy, Tilletia barclayana, Ustilaginoidea virens, Bunt and False smut*

During two *kharif* seasons of 2008 and 2009, farmers' own saved seed samples (362) and unprocessed certified seed samples (200) of paddy were collected from major crop growing areas of Haryana. All the samples were analyzed for bunt [*Tilletia barclayana* (Bref) Sacc. & Syd.] and false smut [*Ustilaginoidea virens* (Cooke) Takahashi]. Among unprocessed certified seed, only two samples (1.00%) were found infected with bunt whereas the number was 40 (11.04%) in farmers' saved seed samples. The range of infection was 0.05-0.15 per cent in farmers' seed and 0.10-0.20 in unprocessed certified seed *i.e.* less than the certification standards (0.50%). No seed sample was rejected due to bunt of paddy disease. The range of infection of false smut was 0.05-0.85 per cent in farmers' own saved seed and 0.05-0.15 per cent in unprocessed certified seed.

83. Assessment of Integrated Pest Management Technology (IPM) for Sustainable Cotton Production in Punjab

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Key words : *Assessment, Cotton, Economic impact, IPM, Pesticides*

The study was undertaken to make cotton production in the state of Punjab globally competitive by reducing the cost of production at farmers' level through

adoption of new pest management technology namely Integrated Pest Management (IPM). A sample of 450 experimental and 100 control plots has been taken for each technology in 45 IPM and 10 non-IPM villages of the cotton belt of Punjab. The study has revealed that the adopters of IPM technology could get significantly higher yield as compared to that of non-adopters. This technology have been found cost-effective due to higher production by about 18% and could reduce the per quintal production cost by Rs. 324. These technologies have been found to generate more income and employment as the adopters could earn about 36 per cent more income per ha as compared to that by the non-adopters. The gain in human employment due to adoption of this technology has been of 11 man days.ha^{-1}. The IPM technologies have reduced the pesticides consumption by about half. The cost-benefit analysis has shown this technology to be economically viable. The study has suggested that these technologies should be propagated among the farmers in the cotton belt of Punjab. These technologies will reduce the chemical consumption and enhance the productivity of cotton on sustainable basis with lower cost of production which, in turn, would protect the environment, health and economic conditions of the debt-ridden cotton growers on a long-term basis.

84. Mass Production of *Trichogramma chilonis* for the Management of Maize Stem Borers

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Key words : *Physical properties, Aonla fruit, Sphericity, Surface area*

Trichogramma are the biological control agents or antagonists of the maize stem borers (*Corcyra* sp.) which it kills for its development into a free living adult. The female *Trichogramma* lays eggs inside or on an insect host. *Trichogramma* sp. are parasitoids which are mass produced and used for the management of a variety of Lepidopteran pests. The insects are released at a rate of 75,000. ha^{-1} to provide a population of 4 to 6 *Trichogramma* .m^{-2}. This had been released successfully in Punjab, Haryana, UP and Bihar. It has given 56-82% protection against the maize stem borers.

85. Fungal Associates of *Malus domestica* Borkh. (Apple)

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Key words : *Mycorrhiza, Rhizosphere, Endophytes, Fungi, Forestry*

Almost all plants in the terrestrial ecosystem are known to be associated with mycorrhizal fungi. Arbuscular mycorrhizal (AM) fungi are obligate symbionts with plant roots. In many ecosystems these symbiotic fungi play an important role in sustaining plant productivity by increasing its nutrients and water uptake, being able to explore more soil volume than plant roots alone by their extended extra-radial hyphal network. The range of benefits to the host plant includes improved yield and nutrition, enhanced resistance to soil borne pests and diseases, improved resistance to drought and tolerance to heavy metals and better soil structure. Since apple plants are an important component of the economy of Himachal Pradesh, an attempt was made to evaluate the presence and status of AM fungi in apple (*Malus domestica* Borkh.). Study revealed the presence of nine AM fungi belonging to four genera (*Acaulospora*, *Entrophospora*, *Gigaspora* and *Glomus*), twenty six rhizosphere fungi and six endophytic fungi (*Alternaria alternate*, *Cephalosporim acremonium*, *Fusarium oxysporum*, *Fusarium* sp., *Trichoderma* sp.) and one non-sporulating mycerkium from adhering soil and different plant parts of apple.

86. Evaluation of Tricho-XP (*Trichoderma viride* 1.15% WP) Against Seedling Rot of Cotton

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Key words : *Cotton, TRICHO-XP, Seedling rot, Disease incidence*

Field experiments were conducted during *kharif* 2008-09 and 2009-10 at Agricultural Research Station, Dharwad to evaluate the efficacy of TRICHO-XP (*Trichoderma viride* 1.15% WP) against seedling rots of cotton. Both soil application and seed treatment of testing chemical were studied in management of seedling rots of cotton which showed that seed treatment of TRICHO-XP was superior over soil application of the same product. Among all the treatments studied, seed treatment with TRICHO-XP @ 5 $mg.kg^{-1}$ seed was found to be effective in control of seedling rot and also significant increase in yield was observed followed by 4 $gm.kg^{-1}$ of same product. However, both the inoculated and non-inoculated control treatments showed high incidence of seedling rot with least yield.

87. Efficacy of Triazoles in Management of Powdery Mildew

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Key words : *Powdery mildew, Triazoles, Cost Benefit ratio*

A field trial was conducted for two consecutive years to find out the bio-efficacy of powdery mildew of chilli at Agricultural Research Station, Devihosur-Haveri, Karnataka. The study indicated that all triazoles under study were effective tin control of the powdery mildew disease that in turn reflected in more dry chilli yield. Among these triazoles, Penconazole followed by Triadimefon, Propiconazole, Hexaconazole and Difenconazole reduced the disease severity of powdery mildew effectively and also enhanced the yield. But three sprays of Hexaconazole (0.1%) are more useful not only in reducing the cost of protection but also gave higher benefits as compared to other treatments and can be recommended for the management of chilli powdery mildew.

88. Dynamics of Sucking Pests and Predatory Insect Populations in First and Second Generation Bt Transgenic Cottons

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Key words : *Sucking pest, Predatory insects, Bt transgenic cotton, Cotton aphids, Predators*

The dynamics of cotton aphids *Aphis* gossypii Glover and its predator *viz. Cheilomenes sexmaculata* Fab., *Chrysoperia carnea* Steph. and *Ischiodon scutellaris* Fab. Was studied in RCH-2Bt and non-Bt cotton hybrids. The mean incidence of aphids was 23.82 and 21.37 per leaf in RCH-2 Bt and non-Bt respectively indicating no significant variation. The dynamics of predators was density dependent on aphids in both Bt and non-Bt hybrids. Mean population of coccinellids, chrysoperia and syrphids was 0.89, 0.78 and 1.0 per plant in RCH-2 Bt which was almost similar to the incidence on RCh-2 non Bt. There was strong and positive correlation between incidence of predators and aphid on both Bt and non-Bt cotton. The 'r' value for syrphids v/s aphids was 0.94 in RCH-2 Bt and 0.96 in non-Bt. Laboratory beeding experiments using By and non-Bt cotton was carried out to study the effect of Bt fed aphids on predator *C. carnea* indicated no difference in incubation period, longevity of grubs and adults, fecundity and aphid consumption potential indicating safety of *Cry1Ac* to *C. carnea* through intoxicated aphid host.

89. Field Evaluation of Advanced Generation Bt Transgenic Cotton Hybrids in Rainfed Situation

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Key words : *New generation Bt cotton genotypes, Rainfed ecosystem, Cotton bollworm*

Field experiment was carried out for two seasons at Agricultural Research Station, Dharwad (Karnataka) to evaluate the performance of different new generation Bt cotton genotypes under rainfed ecosystem. Second generation genotypes MRC-7201 and MRC-6322 with *cry1Ac + cry2Ab* genes have shown high level of resistance to all the three species of bollworms. The incidence of bollworms did not cross economic threshold in BG-11 hybrids. First generation Bt genotypes with *cry1Ac* interspecific hybrids have received one spray and interspecific hybrids received two sprays. MRC-7201 recorded 0.13 larva of *H. Armigera* per plant and 4.98 per cent fruiting body damange. MRC-6322 BG-11 was on par with MRC-7201. RCH-368 Bt found better with 0.1 larva per plant of *E. Vitella* and 0.54 larva per plant of *H. armigera* with 5.73 per cent damange among genotypes with *cry1Ac*. Interspecific Bt hybrids MRC-6918 and RCH-708 performed better under protected condition. All Bt hybrids were effective in containing pink bollworm incidence. Seed cotton yield was 20.58 and 18.47 $q.ha^{-1}$ in MRC-7201 and MRC-6322 BG11 hybrids respectively, without any protection against bollworms.

90. Field Persistence of Combination Mix Formulations in/on Egg Plant Fruits and Soil

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Key words : *Pesticide residues, Dissipation, Rocket 44EC, Nagraj 505, Profenphos, Chlorpyrifos, Cypermethrin, Egg plant*

Egg plant (*Solanum melongena* L.) is an important vegetable crop of India which prone to attack from several insect pests and diseases, the most serious and destructive of which is the fruit and shoot borer (FSB) *Leucinodes orbonalis*. Several insecticides like endosulfan, fenvalerate, fluvalinate have been found to be effective control agents under field conditions but in a desperate bid to save the crop, farmers sometimes apply the pesticide at higher dose or even give more number of sprays, especially multiple sprays of synthetic pyrethroids.

In India, a number of ready mix formulations containing mixture of organophosphorus and synthetic pyrethroids are registered for use on various crops. Two such ready mix formulations are Rocket 44EC (Profenphos 40% + cypermethrin 4%) and Nagraj 505 (Chlorpyrifos 50% + cypermethrin 5%). These insecticides, separately or in combination mixture, have been found effective in controlling insect pests of vegetables. Hwever, very less information is availableon the dissipation behavior of individual component present in ready mix formulations in/on vegetables and soil, especially in egg plant crop. In the present investigation, dissipation kinetics and residue behavior of individual component of the ready mix formulations Rocket 44EC and Nagraj 505 as well as combination mix formulations of the insecticides were studied in/on egg plant fruit and soil, following spray application at recommended and double dose. In all the treatments, residues persisted beyond 7 days in eggplant fruits. Half-life values were calculated from first order dissipation kinetics. In case of Rocket 44EC, residues of cypermethrin on fruits dissipated with half-life of 1.94-3.55 days, wheres residues of profenphos dissipated with the half-life of 2.16-5.43 days. In soil, profenphos residues persisted for 7-15 days, while residues of cypermethrin were below detection limit even on 0 day.

91. Evaluation of Natural and Indigenous Products on Populations of Sucking Pests in Sesame

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Key words : *Bemisia tabaci, Nesidibocoris tenuis, Orosius albicinictus, Sucking pests*

The present study was conducted at the Research Farm of College of Agriculture, Tikamgarh (M.P.) during 2004 to 2006. Results revealed that incidence of nymph and adult population of sucking pest *viz.* jassids *Orosius albicinctus* (Dist.), mired bug *Nesidiocoris tenuis* (Rent.) and whitefly *Bemisia tabaci* (Gen.) decreased significantly by the use of natural and indigenous products such as Neem

oil (NO), Neem seed kernel extract (NSKE), Neem leaf extract (NLE), Garlic bud + Red pepper extract (GB + RPE), cow urine (CU) and cow buttermilk (CBM) respectively very closer to insecticide endosulfan. The efficacy of all the above compounds were in the following order : endosulfan > NSKE > NO > NLE > GB + RPE > CU > CBM. Grain yield and net profit were also closer in these products with the insecticide, endosulfan. However, cost and benefit (C:B) ratio was highest with NSKE, NLE and CU as compared to endosulfan.

92. Brinjal Fruit Borer Management through Neonicotinoids and Insecticides

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Key words : *Leucinodes orbonalis, neonicotinoids, deltamethrin, cartap*

Investigations were undertaken to evaluate seven insecticides including three neonicotinoids and one each from four other different groups of insecticides against shoot and fruit borer, *Leucinodes orbonalis* Guenee of brinjal. Three foliar sprays of each insecticide were given at fortnightly intervals. For assessing *L. orbonalis* infestation, fruits were picked up at ten days interval. The number and weight of healthy and damaged furits were recorded and per cent damange was calculated. On number basis, fruit borer damage in various treatments varied from 3.29-7.79% while it was 10.88% in control. As far as weight basis is concerned, per cent infestation ranged from 4.19-8.21% as compared to 9.93% in untreated check. Study revelaed that on weight basis, acetamiprid (4.19%), cartap (4.91%) along with deltamethrin (6.60%) gave minimum borer infestation while on number basis, two neonicotinoids *viz.* acetamiprid and thamethoxam and cartap were highly effective ($p < 0.01$). The present study reiterates the importance and usage of acetamiprid @ 25g a.i. ha^{-1}, thiamethoxam @ 25 g a.i. ha^{-1}, deltamethrin @15 g a.i. ha^{-1} and cartap @ 500 g a.i. ha^{-1} for effective management of shoot and fruit borer of brinjal.

93. Sources of Resistance in Banana Germplasm Against Sigatoka and *Fusarium* wilt diseases

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Key words : *Fusarium wilt of banana, Sigatoka leaf spot, Germplasm*

Fifty three banana germplasm were screened against Sigatoka and *Fusarium* wilt diseases. None of the germplasm screened showed immune reaction to Sigatoka leaf spot disease. Three germplasm *viz.* Aathiyakal (BB), Desi-Kachkal and Tulsimonohar (ABB) showed resistant reaction against Sigatoka leaf spot disease. Moderately resistant reaction was exhibited by fifteen germplasm *viz.* Amrit sagar, Basri dwart (AAA); Alpan, Ayurkha Rajthali, Chensali, Malbhog, Safed Velchi (AAB); Aktoman, Baratmani, Bhutmonohar, Bogimonohar, Monohar (ABB) and Changthir, Karalian-type and Wild Hill (Miscellaneous). In case of *Fusarium* wilt disease of banana, two germplasm *viz.* Malbhog and Rajthali were found highly susceptible against the disease while other germplasm were found resistant.

94. Biocontrol of Rice Root Knot of Rice Caused by *Meloidogyne graminicola* with Certain Soil Fungi and Bacteria

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Key words : *Rice root-knot nematode, Trichoderma harzianum, Aspergillus niger, Pochonia chlamydosporia, Bacillus subtilis, Pseudomonas fluorescens, Soil application, Root-tip treatment*

Effects of soil application and root-dip treatment with *Trichoderma harzianum*, *Aspergillus niger*, *Pochonia chlamydosporia*, *Bacillus subtilis* and

Pseudomonas fluorescens on root-knot caused by *Meloidogyne graminicola* on rice *cv*. Sugandh-5 were evaluated under pot condition. Pure cultures of the biocontrol agents were applied to seedlings as root dip and soil application (2 ml.pot^{-1}) in both nematode infested and non-infested soil with five modes of application *viz.* root-dip, single soil application, root-dip + one soil application (15 days) , two soil applications (15 and 30 days) and root-dip + two soil applications (15 and 30 days). Plants grown in non-infested soil and applied with biocontrol agents showed better growth in respect to improved fresh and dry weight of root and shoot. Maximum growth promoting effect was recorded with *P. fluorescens* applied by root dip + 1 or 2 soil applications ($p = 0.01$). In the nematode infested soil, terminal and spiral galls developed on the roots and plants suffered 20-31% decrease in the plant growth parameters. Application of *P. chlamydosporia* or *A. niger* as root dip + one soil application was found highly effective and suppressed the gall formation (22.4-25.8%), egg mass production (21.3-24.5%) and soil population (16.3-59.9%) or *M. graminicola* and subsequently increased all the plant growth variables by 15-18.4%. Effects of root dip + two soil applications relatively induced greater plant growth promotion but statistically it was at par with root dip + one soil application. Root dip treatment with *P. chlamydosporia* or *A. niger* also significantly suppressed the nematode population build-up and improved the plant growth.

95. Establishment of Symptomatology on Arabidopsis and Exploring the Possibilities in Controlling *Fusarium oxysporum* f.sp. *cubense* (banana wilt pathogen) using Antifungal Defensins (MtDef1 and MtDef4) under in Vitro Conditions

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Key words : *Arabidopsis, Banana wilt, Antifungal defensins*

Fusarium oxysporium f.sp.cubense causes vascular wilt and root rot in banana plantations at elevated temperatures. *F. oxysporum f.sp.cubense* can persist in affected fields for an extended period of time on plant stubbles as macroconidia or even survive on soils as dormant chlamydospores in the absence of a suitable host plant. Experiments were conducted to deelop symptoms on

Arabidopsis mutants with four different trains of *F. oxysporum f.sp.cubense* from different parts of the world which are growing banana. Among the strains, FGSC#8359 (Australia) producing typical symptoms *viz.* petiole and stem necrosis, rosetting of young leaves and chlorosis. Further investigations are underway to establish the regulatory pathways which are essential for developing resistance against this economically important pathogen of banana. An *in vitro* antifungal assay was conducted to find the efficacy of defensin (an antifungal protein) from *M. truncatula* against *F. oxysporum f.sp.cubense*. *In vitro* antifungal assay using twofold serial dilutions of each defensin (Def1 and Def4) were carried out and bright-field images were made using the transmitted light channel in a Zeiss LSM 510 META confocal microscope. Fungal growth inhibition was also quantified spectrophotometrically at 12, 24, 36 and 48h after the addition of each defensin (2-20 μM). Results indicate that the MtDef1 and MtDef4 have a biphasic effect on the membrane permeability of *F. oxysporum f.sp.cubense* depending upon the defensin dose.

96. DNA Barcoding of Endangered Softshell Turtles in Northeast India

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Key words : *Chelonian, Softshell turtle, COX1 gene, DNA barcodes, Conservation*

About 28 recognized turtle and Tortoise are widely distributed in different zones of India; among them six soft-shell turtle are found in Northeast India. In this study, barcode sequence of *COX1* gene for the four soft-shell turtle species, namely the Black soft-shell turtle (*Aspideretes nigricans*), Indian flap-shell turtle (*Lissemys punctata*), Indian peacock soft-shell turtle (*Aspideretes hurum*), and Indian soft-shell turtle (*Aspideretes gangeticus*) have been taken for amplification of the barcode region using universal fish barcode primers. Our research highlights the utility of molecular data in identifying issues and characterizing species-specific molecular marker as DNA barcode tags of each soft-shell turtle of above region to take important preventive measures for their conservation and relationship with other species.

97. Termite Fauna of Southern Tamil Nadu

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Key words : *Southern Tamil Nadu, Termite identification, Predominant species*

Survey was undertaken in different ecosystem of southern districts of Tamil Nadu. Termites were collected from seventy two locations and identified using mandibular morphometric characters. Totally 21 species belonging to twelve genera and five families were present in southern Tamil Nadu. The taxa identified belonged to Kalotermitidae, Rhinotermitidae, Stylotermitidae, Hodotermitidae and Termitidae. Family Termitidae was known to have eight genera and seventeen species in southern Tamil Nadu. *Odontotermes, Anacanthotermes, Macrotermes, Trinervitermes, Cryptotermes, Microcerotermes, Nasutitermes, Microtermes, Coptotermes, Stylotermes, Hypotermes* and *Eurytermes* were the genera present in areas surveyed. The genus *Odontotermes* was the predominant genus (present in 42 locations) followed by *Anacanthotermes* (11 locations) and Macrotermes (seven locations). *Trinervitermes* and *Cryptotermes* were next predominant genus followed by *Microcerotermes* and *Coptotermes*. The other genera observed were, *Microtermes Stylotermes, Nasutitermes, Hypotermes* and *Eurytermes*. Within the genus *Odontotermes,* eight species were recorded. Among these, *O. obesus* (Rambur) was more frequently observed followed by *O.assmuthi, O.feae, O.microdentatus O. kulkarnii* and *O. wallonensis*. The other species recorded were *O. brunneus* (Hagen) and *O. horni* (Wasmann).

98. Nitric Oxide Mediates the Systemic Resistance Induction in Pearl Millet during *Sclerospora graminicola* Infection

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Key words : *Nitric oxide, Pearl millet, Downy mildew disease, Defense responses*

Nitric oxide (NO) generation mediates the pathophysiological events leading to the induction of resistance in pearl millet [(*Pennisetum glaucum* L.) R. Br.] against the downy mildew pathogen *Sclerorospora graminicola* [(Sacc). Schroet]. Defense responses in response to pathogen infection to NO accumulation has been established by spectrofluorimetric assay of the NO levels using the NO-sensing dye, Diaminofluorescien (DAF-FM) wherein resistant and induced resistant seedlings recorded relatively higher NO levels of 12.5 nM and 9 nM at 24 h post inoculation (hpi) respectively during pathogenesis in comparison to the susceptible seedlings which was a mere 4.4 nM at 24 hpi. The NO localization at the sites of pathogen infection particularly, in periplasmic spaces and stomatal guard cells was found to be prominent. Whilst, structural defense responses of lignification, callose deposition and activation of the hyroxyprolone rich glycoprotein at posttranslational level showed an increasing trend starting at 4 hpi in resistant seedlings following the increase in the levels of NO with transcript abundance of PR3 and PR5.

99. Role of Biochemical Constituents in Imparting disease Resistance to Rapeseed Mustard against *Alternaria* Blight

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Key words : *Mustard, Alternaria blight, chlorophyll, carotenoids, sugars, proteins*

Alternaria blight of rapeseed-mustard caused by *Alternaria brassicae* (Berk) Sacc. is one of the important diseases of rapeseed-mustard in Jammu division of J&K. In the present investigation, different biochemical constituents *viz*. total sugars, total soluble proteins, total phenols, chlorophyll a, chlorophyll b, total chlorophyll and total carotenoids were evaluated in two highly susceptible (Kranti and Varuna) and two moderately resistant (PC-5 and RH-8113) genotypes at different stages to assess their possible role in imparting resistance to rapeseed-mustard against Alternaria blight. The biochemical estimation for healthy as well as diseased leaves and pods was done at three stages *viz*. pre-inoculation stage, post-inoculation stage and pre-harvest stage. Analysis of

biochemical constituents revealed that total sugar was highest in healthy samples of moderately resistant genotypes (47.22 mg/g F.wt in leaves, 31.68 mg/g F.wt. in pods) at pre-inoculation stage and minimum in diseased samples of highly susceptible genotypes (13.73 mg/g F.wt in leaves, 11.07 mg/g F.wt. in pods) at pre harvest stage. Total soluble proteins were maximum in healthy samples of highly susceptible genotypes (27.63 mg/g F.wt in leaves, 26.02 mg/g F.wt in pods) at pre harvest stage and minimum in diseased samples of moderately resistant genotypes (16.65 mg/g F.wt in leaves, 13.27 mg/g F.wt in pods) at pre-inoculation stage. Total phenols were maximum in diseased samples of moderately resistant genotypes (7.68 mg/g F.wt in leaves, 3.92 mg/g F.wt in pods) at pre harvest stage and minimum in healthy samples of highly susceptible genotypes (1.26 mg/g F.wt in leaves, 1.21 mg/g F.wt in pods)at pre-inoculation stage. Chlorophyll a, chlorophyll b and total chlorophyll were maximum in healthy samples of moderately resistant genotypes at pre-inoculation stage and minimum in the diseased samples of highly susceptible genotypes at pre harvest stage. Carotenoids were maximum in diseased samples of highly susceptible genotypes (1.17 mg/g F.wt in leaves and pods) at pre harvest stage and minimum in healthy samples of moderately resistant genotypes (0.33 mg/g F.wt) at pre-inoculation stage.

100. Efficiency of Various *Trichoderma* Isolates for Control of Chilli Wilt Pathogen in Jammu

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Key words : *Chilli wilt, Trichoderma harzianum, T. viride, T. hamatum*

Chilli wilt is one of the major disease problems of Jammu division of Jammu & Kashmir. It is a complex caused by a number of pathogens. In the present study, *Fusarium oxysporum* was found to be the main pathogen responsible for causing the disease. For control of disease, twenty resident isolates of *Trichoderma viridie, T.hamatum* and *T.harzianum* were taken and

studied for their efficiency in control of *F.oxysporum* under in vitro conditions. Of the various isolates tested it was found that isolate Tv4 of *T.viride* isolated from Akhnoor inhibited the mycelial growth by 79.2% followed by Th2 of *T.harzianum* isolated from Chatha which inhibited the growth upto 68%. Minimum control was showed by Tv4 isolate of *T.viride* isolated from Doda inhibiting only 26% of the growth.

101. A Study on the Occurrence of *Steinernema* species of Entomopathogenic Nematode from Coimbatore City in Tamil Nadu

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Key words : *Entomopathogenic, Steinernema, Xenorhabdus*

The soil from Coimbatore central area was surveyed for the presence of Entomopathogenic Nematodes (EPN), which is a biological control agent for several pests. Out of 10 samples surveyed, one sample was found to be harbouring Entomopathogenic Nematodes. The EPN belongs to the family *Steinernema* species since it had the bacteria *Xenorhabdus* species.

102. Biochemical Changes during Pathogenesis of Cotton Mealybug with *Metarhizium anisopliae*

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Key words : *Biochemicals, M. anisopliae, P. marginatus*

Biochemicals *viz.* total free sugar, protein and free amino acid content changes on cotton mealybug, *Paracoccus marginatus* and *Phenacoccus*

solenopsis during infection of *M. anisopliae* was analyzed quantitatively during 3rd, 4th, 5th, 6th and 7th day after inoculation of *M. anisopliae*. Free amino acid and protein content was low in infected insect compared to healthy insect and also decreased with disease development in the insect. Total free sugar content of the infected insect was high compared to healthy insect and also increased gradually with the advancement of the infection period. This result revealed that *M. anisopliae* during pathogenesis interferes with various physiological mechanisms of the host insect. The rapidity of this mechanism decides the success of mycosis.

103. Compatibility between Green Muscardine Fungus, *Metarhizium anisopliae* and Insecticides used in Cotton Ecosystem

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Key words : *Compatibility, M. anisopliae, insecticides, cotton*

Compatibiligy of Metarhizium anispliae was studied in the laboratory conditions with twelve commonly used insecticides for cotton post management by poisoned food technique. The results were expressed as percentage of growth inhibition of M. anisopliae colony on insecticide treated medium in comparison with untreated check. Among the insecticides tested for their compatibility, chlorpyrifos 20 EC and Econeem (1%) was rated as relatively less toxic to M. anisopliae, while spinosad (45% SC), quinalphos (25 EC), acetamprid (20%), endosulfan (35 EC) and thiodicarb (75 WP) were slightly toxic. Imidacloprid (17.80% SL) and triazophos ($) EC) were moderately toxic while profenophos (50 EC), indoxacarb (14.5% EC) and methyldemeton were highly toxic. Results of the present study suggest that except profenphos, indoxacarb and methyldemeton, the rest of the insecticides tested can be safely used along with the mycopathogen M. anisopliae. But field trials should be done with these insecticides for appropriate results and viability of combined application.

104. Histo-pathological Changes of Cotton Mealybug *Paracoccus marginatus* Infected by Four Native Emtomopathogenic Fungi

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Key words : *Mealy bug, Entomopathogenic fungi (EPF), Histopathology*

The infection process and pathological changes due to four native entomopathogenic fungi *viz. Lecanicillum lecanii*, *Metarhizium anisopliae*, *Beauvaria bassiana* and *Cladosporium cladosporioides* on *Paracoccus marginatus* (Williams and Garanara de Willink) were investigated. Adults were sprayed with conidial suspension of each fungi @ $1x10^9$ spores ml^{-1}. Infection process and associated pathological changes were recorded at 24 hours interval by light microscopy. Though all test fungi were found to be pathogenic to mealy bug, differences were observed in pathological changes. Infected insects become sluggish and failed to respond to external stimuli. Within 24 hrs. after inoculation, sparse fungal mycelium was observed on the surface of *L. lecanii*, *M. anisopliae* and *B. bassiana*. Ninetysix hrs after inoculation, entire insect was covered by mycelia and all insects were dead. In case of *Cladosporium cladosporioides*, complete removal of waxy coating was observed and 100% mortality was recorded at 96 hrs after inoculation. Based on this study, it is concluded that the bioassay combined with microscopical studies have been a useful tool to analyze interactions between four entomopathogenic fungi and mealy bug. This work has led to a better understanding of this pest and the possibilities of its control using entomopathogenic fungi.

105. Evaluation of *Lecanicillum lecanii* in Lab and Pot Culture Conditions, as a Potential Candidate for Bio-conrol of Mealy bug, *Phenococcus soleopsis*

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Key words : *Mealy bug, Lecanicillum lecani, Pathogenecity, lab and pot culture*

Pathogenicity of a native entomopathogenic fungi *Lecanicillum lecanii*, isolated from mealy bug, *Phenococcus solenopsis* was tested under lab and pot culture condition against *P. solenopsis*. Bioassay with *L. lecanii* was conducted using different dosages i.e. 1 x $10^{4,}$ $^{10}5$, $10^{6,}$ 10^7, 10^8, and 10^9 spores.ml^{-1} against nymphs and adults. Mortality (%), lethal concentration (LC_{50}) and Lethal time (LT_{50}) were calculated. Both nymphs and adults were susceptible to fungal infection and insect mortality was found to increase with increase in dose. Among two stages tested, nymphs were found to be more susceptible to fungal infection than adults. The LC_{50} values of *L. lecanii* against adult and nymphs were 2.1 x 10^7 (7.9 x 10^6 – 5.5 x 10^7) and 4.5 x 10^6 (1.8 x 10^6 – 1.1 x 10^7) spores.ml^{-1} respectively. The mean lethal time for adult and nymphs were 5.54 (4.47 – 7.26) and 4.80 (3.49 – 5.49) days respectively. The efficacy of *L. lecanii* was tested under pot culture conditions after two incubation time (3 and 7 days after inoculation). Significant reduction in mealy bug population was recorded in fungus treated plants. Among three treatments tested, treated check (Profenophos) ranked first followed by *L. lecanii*. The importance of speed of mortanlity following treatment and the potential of *L. lecanii* to be incorporated into an integrated pest management strategy for the biocontrol of *P. solenopsis* in Cotton are discussed.

106. Whitefly Diversity and Abundance in Himachal Pradesh

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Key words : *Whitefly, Bemisia tabaci, Dialeurodes sp,. Trialeurodes vaporariorum, abundance*

Systematic field surveys conducted in seventeen localities representing four agro-ecological zones of Himachal Pradesh during 2007 and 2008 revealed the presence of three whitefly species, namely, *Bemisia tabaci* (Gennadius), *Dialeurodes* sp. and *Trialeurodes vaporariorum* (Westwood) (Aleyrodidae: Homoptera). They

were recorded to infest 31 plant species comprising fifteen ornamentals, nine vegetable crops, three field crops, two weeds, and one fruit and medicinal plant each. *B. tabaci* was prevalent in sub-mountainous and low hills sub-tropical zone (240-1000 m asl; Zone-1) and was associated with seven plant species. Population level was low on all the recorded host plants with mean maximum population recorded on urdbean (4.0 adults/ three leaves). The pest remained prevalent throughout the year at Una except in winter season. Another aleurodid, *Dialeurodes* sp. was prevalent in a few locations in Zone I and Zone II (mid hills sub- humid zone; 1001-1500 m asl) and infested lemon (*Citrus limon*). *T. vaporariorum* was the most abundant of all the aleyrodids encountered and infested 30 plant species belonging to 15 plant families. Three plant species namely *Alstreomeria* spp., *Eriobotrya japonica* and *Withania somnifera* seems to be the new hosts of this aleurodid from India. *T. vaporariorum* was prevalent in Zone II both under protected and open environments. Whereas, in Zone III (wet temperate high hills; 1501-2500 m asl) the incidence was restricted only to protected environment. The pest was absent in the localities representing Zone IV (Dry temperate high hills; >2501 m asl).

107. Effect of Seed Dressing with Propionic Acid on Seed Health Parameters of *Phaseolus vulgaris* L.

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Key words : *Propionic acid, Phaseolus vulgaris, storage fungi, seed health*

Kidney bean is an important pulse crop of Himachal Pradesh. Seed health deteriorates during storage due to storage mycoflora and containers in which seeds are stored. Amongst various seed dressers, propionic acid is recommended specifically against storage fungi like *Aspergillus* and *Penicillium*, was combined with Bavistin with a view to have effective control of all seed borne fungi. When evaluated against kidney bean seeds it was found to have adverse effect on seed health as it decreased seed germination, vigour and seedling vigour index drastically. In Bavistin treated seeds, though a gradual decrease was observed but the values

were significantly higher than those observed with propionic acid treatment and untreated check. This effect was more pronounced on the seeds stored in polylined bags as compared to other containers. It was also not effective to check seed mycoflora. However, when it was combined with bavistin the seed health parameters got affected more adversely but mycoflora was controlled effectively than propionic acid alone.

V. CHEMISTRY/BIOCHEMISTRY/POST-HARVEST

108. Physiochemical Characterization and Chemical Modification of Isolated Rice Starch

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Key words : *Rice starch, Cross-linking starch, Acetylated starch, Physical and chemical characterization*

Starch is the most important carbohydrate in the human diet and is contained in such staple foods as potato, wheat, maize (corn), rice and cassava. In the development of food and medicine industry, more and more attentions have been paid on new starches with different properties. Insoluble rice starch obtained as a by-product of the sequential solvent extraction from discarded grains of rice was evaluated for physico-chemical properties. Chemical modifications like cross-linking and acetylation of rice starch were done to improve some properties which will be helpful for its inductrial application. Physico-chemical properties like moisture content, amylase content, swelling volume measurement, amylose leaching, leaching of carbodhydrate, reducing sugar of chemically modified rice starch were compared with native rice starch. Low swelling ability, moisture content development but high amylose content of chemically modified rice starch rather than native starch. Cross-linking decreased the swelling factor and amylase leaching but acetylated starch increased the swelling factor. Cross-linking starch has desirable functional properties providing a wider range of potential applications.

109. Influence of Different Substrates on Biochemical Composition of Milky Mushroom (*Calocybe indica* P&C)

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Key words : *Milky mushroom, Tryptophan, Methionine, Lysine, Total sugar, Reducing sugar*

Milky mushroom (*Calocybe* indica P&C) is one of the most potential species of mushroom being cultivated in tropical and subtropical parts of India. This mushroom is mostly cultivated on wheat straw. But in the present investigation other substrate such as sugarcane bagasse, paddy straw, mustard straw and lentil straw were also tested with spent wheat straw to determine the nutritive value of fruiting bodies. The total protein (25.23%) and essential amino acids like tryptophan (0.59%), methionine (0.19%) and lysine (7.92%) in dry fruiting bodies wee observed highest in wheat straw followed by sugarcane bagasse, paddy straw, mustanrd straw and lentil straw. The sugars such as total sugar (8.29%), reducing sugar (4.33%) and non-reducing sugar content (3.97%) wee reported maximum in wheat straw substrate followed by sugarcane straw, paddy straw, mustard strsw and lentil straw.

110. Biochemical Evaluation of Mango (Mangifera indica L.) Varieties at Various Stages of Fruit

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Key words : *Mango, β-Carotene, Crude fibre, Total sugar, Protein*

The present research work was conducted in four varieties of mango fruits namely, Dashehari, Langra, Chausa and Safeda. All the varieties were collected

from the orgchard of Devgaon, Faizabad (U.P.) to study the physical and biochemical characteristics of mango fruits at 30, 60 and 90 days after fruit set. Pre-mature, mature and ripened fruits were evaluated for total sugars, protein, β-carotene and crude fibre content. Highest amount of total sugars (20.84%) at 90 days, protein (0.91%) at 90 days, β-carotene (3052 υg.g^{-100}) at 90 days after fruit set were found in Dashehari while maximum crude fibre content was noticed in Safeda(1.26%) at 30 days. Minimum total sugar (17.33 µg.g^{-100}) at 30 days, protein (0.55%) at 30 days, b-carotene (99.33 µg.g^{-100}) at 30 days and crude fibre (0.62%) at 90 days were recorded in Safda variety. On the basis of physical and biochemical investigation, itcan be concluded that variety Dashehari was rated superior than Langra, Chausa and Safeda because it contains maximum amounts of sugar, protein, crude fibre and β-carotene.

111. India's Export and Import Scenarios of Natural Resins and Gums

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Key words : *Natural resins, Gums, Export and Import, Growth*

Selected physical properties of three varieties of 'Aonla' fruit were determined. Chakaiya, Kanchan and NA-7 varieties were selected for the study. Properties like size, shape, roundness, sphericity, surface area, density, pulp to seed ratio, mass of 1000 fruits and cutting force were studied. It was found that the geometric mean diameter of the fruit was maximum for the variety Chakaiya (40.7 mm) closely followed by Kanchan (39.5 mm) and NA-7 (36.5 mm). Based on the values of roundness and sphericity, the fruit shape was observed to range from round to oblate. The Chakaiya was more spherical (97.22%) as compared to Kanchan (96.98%) and NA-7 (93.79%). Kanchan was found to be more compact with a density of 1.16 g.cm^3, whereas the bulk density was found to be similar for all the three varieties. The mass of 1000 fruits was found to be highest for Kanchan at 32.25 kg and for Na-7 and Chakaiya at 30.41 and 30.1 kg respectively. The surface area was found to be highest for Chakaiya followed by Kanchan and NA-17. The cutting force was observed to be maximum when cut from the stem end side and NA-7 got higher value because of the presence of more fibres.

112. Development of Electronic Weight Grader for Sapota [*Manilkara achras* (Mill.) Fosberg]

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Key words : *Physical properties, Aonla fruit, Sphericity, Surface area*

The investigation was carried out to develop weight grader for sapota (*Manilkara achras* (Mill.) Fosberg]. Weight grader fitted with singulation unit is found to be more precise than any other. Since singulation unit will feed the fruits individually to electronic balance, single fruit grading can be achieved. Furits will be fed to load cell individually, wherein fruits weighed and carried to the grading unit, which consists two gates, operated electronically using the signal generated by the load cell depending on fruit weight. The overall separation efficiency of the grader was found to be 93.8%.

113. Some Physical Properties of Aonla Fruit Relevant to the Design of Processing Equipments

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Selected physical properties of three varieties of 'Aonla' fruit were determined. Chakaiya, Kanchan and NA-7 varieties were selected for the study.

Properties like size, shape, roundness, sphericity, surface area, density, pulp to seed ratio, mass of 1000 fruits and cutting force were studied. It was found that the geometric mean diameter of the fruit was maximum for the variety Chakaiya (40.7 mm) closely followed by Kanchan (39.5 mm) and NA-7 (36.5 mm). Based on the values of roundness and sphericity, the fruit shape was observed to range from round to oblate. The Chakaiya was more spherical (97.22%) as compared to Kanchan (96.98%) and NA-7 (93.79%). Kanchan was found to be more compact with a density of 1.16 $g.cm^3$, whereas the bulk density was found to be similar for all the three varieties. The mass of 1000 fruits was found to be highest for Kanchan at 32.25 kg and for Na-7 and Chakaiya at 30.41 and 30.1 kg respectively. The surface area was found to be highest for Chakaiya followed by Kanchan and NA-17. The cutting force was observed to be maximum when cut from the stem end side and NA-7 got higher value because of the presence of more fibres.

114. Role of Medicinal Plant Extracts in the Value Addition of Economic Characters of Mulberry Silkworm, *Bombyx mori* L.

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Key words : *Bombyx mori L., CSR2 x CSR4 hybrids, Mulberry leaves, Andrographis paniculata, Plumbago zeylanica, Plant extracts, Parameters*

The two hybrid CSR2 x CSR4 silkworms (*Bombyx mori* L.) were reared on the extract of two medicinal plants, *Andrographis paniculata* (whole plant without roots) and *Plumbago zeylanica* (roots). The silkworms were incubated and brushing was done in laboratory upto cocoon stage at temperature range of 24-28^0C with humidity range of 80-100% during august, 2007 in rainy season. The mulberry silkworm last instar larvae were fed on the mulberry leaves fortified with the aqueous extract (4 ml of test solution) at first feeding up to spinning stage and

its impact on the larval weight, mortality, cocoon weight, shell weight, shell ratio%, average filament length, average denier of filament were investigated. Although larval weight was higher (7.69-17.27%) in treated group over that of control, cocoon weight and silk ratio was low.

115. Kusmi Lac Yield in Winter Season as Affected by Weather and Directional Effect on Ber (*Zizyphus mauritiana*) Trees

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Key words : *Lac insect, Kusmi lac, Directional effect, Rainfall pattern, Ber trees, Canopy spread*

Lac insect (*Kerria* lacca kerr.) secrets resin for its own protection, but it is very important as a product of commerce. Traditionally, *ber* tree (*Zizyphus mauritiana*) are used for growing *rangeeni* lac insect in summer season (immature crop); but growing the winter season *kusmi* lac (July to February) is more profitable. Due to high rainfall in winter season, several biotic and baiotic factors lower the yield of *kusmi* lac. An experiment consisting of 96 trees was laid out during June, 2007 to February, 2010 to assess the influence of factors like directional effect of lac on *ber* trees (northern and southern halves) and rainfall pattern on lac yield and yield ratio. Average lac yield ratio in southern half was 26% higher than northern half in 2007-08 and the same was 21% higher in 2008-09. At the same time, mean lac yield ratio was 4.9 in first year as against 7.15 in the third year and was significantly different. Southern half of the trees are illuminated with more sunlight than the northern half during the growth period of winter season *kusmi* lac insect. More sunlight might have kept the tree canopy warmer boosting the growth and development of the lac isect in the southern half in the first two years. Due to meager rainfall in third year, sunlight was not a limiting factor influencing yield which possibly resulted in a non-significant difference. Intensity of rainfall was 75.5, 64.0 and 55.5 mm

per week in three different years respectively. Number of weeks with more than 50 mm rainfall was also highest in the first year and the least in the third year. Critical analysis of the pattern of rainfall in the three different years reveal that lac yield decreased significantly with the intensity of rainfall, number of consecutive weeks with 50 mm rain and the amount of rainfall recei9ved after sexual maturity. As a result, 31% reduction in lac yield ratio was observed in the first year compared to the third year. The study also suggest that lac yield from trees of smaller canopy spread are least affected due to adverse weather condition.

116. Enzymatic Extraction of Juice and Development of ready-to-serve Beverage from Jackfruit (*Artocarpus heterophyllus* L.)

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Key words : *Jackfruit, Enzymatic extraction, Juice yield, Ready-to-serve beverage*

Jackfruit is a tropical composite fruit with delicious and attractive golden yellow colored succulent and firmly textured bulbs. The edible fleshy pericarp is mucilaginous and pulpy which is usually prone to flavor loss, cut-surface browning and post-harvest decay. Inspite of high consumer liking of the fruit, there is lack of development of value added products from jackfruit. In the present study, response surface methodology was used to establish optimum conditions for enzymatic extraction of jackfruit juice through a three-factor central composite design. Jackfruit pulp was treated with pectinase enzyme at different incubation times (40-120 min), temperature (30-50^{0}C) and enzyme concentration (0.003-0.10%). The optimum condition for extracting maximum amount of juice from jackfruit pulp was 0.097 enzyme concentration, 49.1^{0}C and 80 min of incubation time. The extracted juice was further used to develop a ready-to-serve (RTS) beverage with high sensory quality which comprised of 17.5% juice, 15^0 brix total soluble acids and 0.1% acidity. Shelf-life of the beverage was found to be 6 months at ambient temperature. The developed RTS beverage has commercial potential to get promoted as well as realize revenue for jackfruit farmers.

117. Zero Energy Cool Chamber an Effective Storage structure for Banana and Tomato in Peak Summer

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Key words : *Banana, Tomato, ZECC*

In summer both banana (*Musa paradisiacal*) and tomato (*Lycopersicon esculentum*) become soft and shriveled due to high temperature and low humidity. Colour retention in banana and colour formation in tomato are the main problems. Both become unmarketable as banana becomes black and tomato remains yellow. Based on evaporative cooling, a low cost Zero Energy Cool Chamber (ZECC) was constructed with brick, sand, bamboo dry grass etc. and was found to be very useful not only for proper ripening of tomato but also in increasing the shelf-life of tomato and banana by reducing wet loss, retaining the colour and texture.

118. Process Standardization and Value Addition of Eggs

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Key words : *Egg chips, Ready to eat foods, Snacks, Flour, Protein rich foods, Hardness, Calorific value*

Ready to eat food is becoming increasingly popular in our country. Chips are considered as one of the most popular snack foods. But they are treated as junk foods. The value addition to eggs as chips by incorporation of various nutrients will have a great potential in the market. A value added egg chips was prepared from egg and optimized quantities of different ingredients by trial and error method. The dough was flattened to 2-3 mm thick sheet, and fried to 115^0C in refined sunflower oil. The cooled chips were packed in air tight

polyethylene bags and stored at ambient temperature (30 ± 2^0C) for 6 weeks. Various physic-chemical characteristics such as carbohydrate (46%), fat (27.5%), protein (13.2%), ash (5.5%), moisture content (5%) and total calorific value (490 kcal.gm^{-100}). Sensory analyses were evaluated by using 9-point Hedonic Scale, overall acceptability according to the panelist was 7.5. Similarly, rheological characteristics such as hardness, stickiness of dough and hardness, fracturability of fried chips were 27.56 N, -8.9826 N, 67.48 N.sec^{-1} and 78.58 N.sec^{-1} respectively. During storage period of 6 weeks time, pH value was decreased from 6.2 to 6.7 and moisture content was increased from 5.0 to 5.7% (wet basis). The microbial evaluation indicated that the product was sterile. The sensory scores were 7.2 in 9-point hedonic scale. The storage studies of fried chips were sensorily acceptable when packed in airtight polyester pouch and stored at ambient temperature (30 ± 2^0C). The fifth combinations out of ten combinations were highly recommended for adiption. That was pearl millet 5 gms, wheat flour 7.5 gms, rice flour 7.5 gms and gram flour 5 gms. Based on the results, it was concluded that fried egg chips as ready-to-eat snack food could successfully be prepared and increase the value added to the eggs.

119. Proximate Composition of Mushroom Powder and its Biscuits

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Key words : *Pleurotus florida, Fat, crude protein, crude fibre, mushroom powder, mushroom biscuit*

The present study was conducted on wheat straw grown oyster mushroom (*Pleurotus florida*). Powder of fresh and blanched fruit bodies was prepared by sun drying as well as oven drying. The results of proximate composition revealed that the moisture percentage in fruit bodies ranged from 88.35 to 90.02 percent and the values of fat, ash, crude fibre, crude protein and ascorbic acid ranged from 1.52 to 1.64, 5.32 to 7.70, 9.32 to 12.41, 24.22 to 26.98 and 0.01 to 0.06

mg / 100 mg respectively. Mushroom biscuits using different proportions of wheat flour and mushroom powder were also prepared and a significant increase in value of different parameters was observed with increase in proportion of mushroom powder in the biscuits. However, the biscuits having the ratio of 60:40:: wheat straw : mushroom powder was found to be highly acceptable.

VI. AGRICULTURAL ECONOMICS AND SOCIAL SCIENCES

120. Economic Analysis of Production of Groundnut (*Arachis hypogea* L.) in Bikaner District of Rajasthan

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Key words : *Cost of cultivation, cost of production, net income, production function analysis*

The per hectare cost of cultivation in groundnut varied from Rs. 21,863/- on small farmst to Rs. 25,084/- on large farms with an overall average of Rs. 23,084/-. Human labour cost accounted for the major share (25.13 per cent) in total cost. The other important cost were irrigation charges, machine labour, seed and rental value of owned land, plant protection chemicals, fertilizer, depreciation, interest on working capital, interest on fixed asset etc. Cost of production for groundnut varied from Rs. 665/- per quintal on large-sized farms to Rs. 706/- per quintal on small sized farms with an averall average of Rs. 692/- per quintal. Cultivation of groundnut crop has been a profitable proposition in the study area. Net income in the groundnut crop cultivated varied from Rs. 16,788/- to Rs. 21,119/- per hectare on different categories of farms and on an overall basis, net income was Rs. 18,293/-. Per rupee return from cultivation of groundnut crop was highest on large farms (1.84) and lowest on small farms (1.76) with an average of Rs. 1.78.

121. Role of Women in Young Age Silkworm (*Bombyx mori* L.) Rearing at Farmers' Fields at Malda District of West Bengal

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Key words : *Silkworm (Bombyx mori L.), Mulberry (Morus indica L.), Silk cocoon*

A detailed study showed that at Malda district of West Bengal, most of the farmers are doing sericulture at their house. It has been observed that the women in every farmer's house are undertaking major responsibility in the development of sericulture. The womenfolk in every household carry out the job of feeding the young silkworms (*Bombyx mori* L.) with mulberry leaves four time a day and also maintaining optimum temperature and humidity. The objective of the present investigation was to train the womenfolk to develop healthy worms at their young age so that they can produce superior quality of cocoons from which superior silk can be produced.

122. Improvement of Sericulture Industry Depends on Education of Women of Rural Area of Malda District of West Bengal

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Key words : *Sericulture, Rural economy, Women education*

An intensive investigation shows that most of the farmers of Malda district of West Bengal, India are practicing sericulture at their house regularly. The

educational status of the wormen is very poor. The new technologies developed by Central Sericultural Research and Training Institute, Central Silk Board, Ministry of Textiles, government of India, Berhampore (West Bengal) are not easily accepted by the rural women due to lack of education. It has been observed that, if the rural women are educated then the development of sericulture will be more effective at rural areas at Malda. The object of the present investigation is to develop skill of the women for adapting new technologies through training and education which ultimately develop quality cocoon from which production of quality silk for the international market and finally uplift their socio-economic status from the present condition.

123. The D-F Factors in Agricultural Development of Orissa

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Key words : *Orissa, Fluctuating agricultural production, Drought and floods, Global warming*

Orissa is an agricultural economy. About 85 per cent of people depend on agriculture. Rice is the main agricultural production. It fluctuates annually by drought and flood due to uncertain monsoon. The floods damage lives and property at a higher scale than in drought. Both affect the income of farmers. Scientist are warning about the global warming which is responsible for this. In Orissa the average annual rainfall is gradually coming down and maximum termperature in the sewa side towns are increasing. Global warming is evident in Orissa.

124. Food Security

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Key words : *Soil and land, Irrigation, Inputs, Post harvest technology*

The science of food security embraces many intriguing sciences, soil health and soil conservation, seed and planting material, water bodies and river maintenance, balanced organic and viable technology, scientific input management, remunerative price etc. together contribute to increased production if scientifically monitored and funded adequately in time. In view of the population reaching 1.3 billion in 2020, we have no alternative than to intensify all our efforts to ensure food security. In the public-private participation era when sparkles are seen in University trials with private innovations, it has to be absorbed in the main stream for the welfare of the country and people.

125. Implications of WTO on Indian Agriculture

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Key words : *Domestic market, Cost of production, International trade, Net subsidy, Unilateral liberalization, Agricultural commodities*

The World Trade Organization was established by an agreement between nation states with the objective of facilitating international trade both in terms

of rules of the game and practices. Indian is one of the original signatories to the trade agreement and as a consequence and otherwise, trade policy related to the agricultural sector in India has undergone a sea change during the last decade. The trade policy is now much more open and liberal. However, the process of liberalization of Indian agriculture has remained cautious and gradual throughout the nineties. Both pace and direction of liberalization also remained under intensive academic debate and a matter of policy dialogue during this period.

With a view to properly setting the stage for analysis of implications of WTO for Indian agriculture, it is imperative to begin from looking at arguments for and against globalization, genesis of how the world is responding to WTO, and apprehensions about agricultural liberalization. Since it has serious implications for the food security, employment and overall economy, particularly in several developing countries. The assessment of implications of liberalized trade in agricultural commodities should look into :

i) Response of different countries implementing the commitments made under AoA.

ii) Effect of liberalized imports and exports on the leels of domestic prices, and

iii) Distribution of gains and losses of globalization across countries and across the regions within a country.

Due to increase in the surplus, the share of agricultural exports in total exports has declined whereas the share of agricultural imports in total imports has increased after the coming in of WTO. Between 1990-91 and 2002-03, while the share of agricultural exports to the total national exports came down from 18.5 to 13.1 per cent, the share of agricultural imports in total national imports went up from 2.9 to 5.8 per cent. This implies that net exports of non-agricultural commodities have increased at a rate higher than that of agricultural commodities.

126. Agri-Business Management in India

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Key words : *Agri-business, Post-harvest management, Bio-control*

Agri-business is emerging as a specialized branch of knowledge in the field of management science related to agriculture. Commercialization of agriculture calls for specialized production, post-harvest management, expansion of processing, transportation and packaging activities. In case of fruits and vegetables the wastage is around 30% so also in floriculture, aquaculture and poultry. There is a huge scope for processing in the food sector for increasing the income, export and employment. There is also wide scope for production and promotion of bio-pesticides and bio-control agents for crop protection purposes. All these requires intensification of agri-business management skills.

127. Biodiversity, Agriculture and Food security

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Key words : *Biodiversity, agriculture, food security, climate change, adaptation, mitigation*

Agri-biodiversity or diversity in crops be they field crops, fodder, fruit crops or vegetables, has been the base of all improvements in these crops and the productivity of agriculture. Diversity is crucial for an element of risk insurance in

the rain-fed and vulnerable belts. Introduction of few novel genes such as in wheat and rice have revolutionized the agriculture. Recent use of Bt genes is bringing new revolution. Climate change is affecting biodiversity as well as agriculture and adaptation and mitigation measures are needed for sustainable agricultural production and to meet the food needs of the day and future.

128. Problems Faced by Sericulturists in Cocoon Marketing and Suggestions to Overcome the Problems – A Study in Andhra Pradesh

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Key words : *Sericulture, Cocoon marketing, Distress sale*

The thrust given to sericulture during the recent past has resulted in substantial changes in production of cocoons through introduction of high yielding Mulberry variety *i.e.* V1 and multivoltine silkworm hybrids namely PM x FC2 and bivoltine hybrids CSR2 x CSR4, CSR4 x CSR2 and CSR18 x CSR19. No doubt they have nearly doubled the productivity from 40 kg.dfl^{-100} to 60-75 kg.dfl^{-100} of cocoon yield. Unfortunately, this increase in cocoon production and leaf productivity of mulberry, instead of becoming a boon, is ending up as a curse to the growers in marketing the end product. The recent experiences of silkworm farmers in Andhra Pradesh showed that they had distress sales in cocoon marketing. A study was undertaken during 2008-2010 in Chittoor district of Andhra Pradesh by adopting *ex-post facto* research design to analyze the marketing problems faced by the sericulture farmers. Four farmers each from samll, medium and big catergores were selected from 10 villages by adopting

quota and proportionate random sampling methods, making a total sample size of 120. Big farmers expressed that price manipulations by reelers (92.50%), cocoon price fluctuations (90.00%), lack of transportation facilities (82.50%), lack of nearby cocoon markets (77.50%) and inadequate number of cocoon processing units (65.00%) as the major constraints in marketing of cocoons. On the contrary, the major constraints expressed by small farmers were lack of transportation (91.00%), cocoon price fluctuations (90.00%), price manipulation by reelers (85.50%), lack of nearby cocoon markets (82.00%) and non-availability of infrastructure facilites (67.80%). Most of the farmers suggested subsidies on inputs through Central Silk Board and Department of Sericulture as big (92.50%), medium (95.80%) and small (96.00%). The study revelaed that the silkworm farmers faced innumerable number of problems in marketing their produce and adequate attention is to be paid to save the enterprise.

129. Consultancy Pattern of Technology Adoption Influencing the Sericulture Development- A Case Study Conducted in Kuppam division of Andhra Pradesh

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Key words : *Consultancy pattern, Sericulture development, Technology adoption*

Chittoor and Anantapur districts of Rayalaseema region of Andhra Pradesh adjacent to Karnataka state contribute to more than 80% of total raw sinl production in Andhra Pradesh. The present study was conducted in Kuppam division of Chittoor district in Andhra Pradesh in 10 villages. A total of 120

sericulturists were interviewed using pre-tested schedule during 2007-2010. The information was collected regarding mulberry cultivation and silkworm rearing practices. The sources of information at each stage in the adoption processes *viz.* 1) neighbours and friends, 2) relatives, 3) progressive farmers, 4) television, 5) radio, 6) demonstrator and operator, 7) field/technical assistants, 8) sericulture service centre, 9) chawki rearing centres and 10) cocoon markets wee analyzed to assess the consultancy pattern. Neighbours and friends and government agencies evidently ranked higher as valid sources of information. The neighbours and friends (96.5, 96, 95.3, 95 and 94.8%) is the most consulted source of information followed by demonstrators and operators (87, 86, 85.2, 82.4 and 78%) in Alugumanapalle, Govindapalle, Gopi Nagar, Otikunta and Veeranamala respectivley, whereas in South Gollapalle, Sonepalle, Kongamapalle, Pedlabarmapalle and Settyballa, most of the respondents consulted demonstrators and operators (96, 97 and 97.4%) followed by field and technical assistants (94.8, 96 and 96.5%) respectively. The findings of the study brought out that the adoption of sericulturists about the practices in mulberry cultivaion such as mulberry vaiety and application of FYM shows full adoption (70 and 58.33%). Non-adoption was found more in soil testing (86.11%), bio-fertilizer (70%), chawki garden maintenance (38.88%) and plant protection (37.77%) and plant to plant spacing (11.11%). Full adoption by sericulturists were more in silkworm rearing practices such as disinfection of rearing house (82.22%), recommended brushing (87.22%), new silkworm races (80.00%). Non-daoption was found in shoot rearing and silkworm disease protection.

130. Water Quality Assessment and some Activity-based Students' Project Work with reference to Ecological Significance

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Key words : *Carbon sequestration, rainfed production systems, tropical India*

In order to develop activity-based communication aspects among primary and secondary school children with reference to ecological significance, programs were undertaken to make the children of Bhavnagar municipal corporation primary and secondary schools to make them aware about the quality of water. Pre- and post-test of field work done by children were conducted by the District Primary Education Program (DPEP), Sarva Siksha Abhyan (SSA) and Shala Vikas Sankul (SVS). The school children gain critical thinking and generate potential solutions to environmental issues.

131. Hurdles of Technology transfer at Farmers Level in Sericulture and Approaches – A Case Study

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Key words : *Sericulture, Technology transfer, Farmers' knowledge*

Sericulture, an agro-based industry provides gainful employment, contribute immensely to the rural upliftment, dominant feature of Indian economy and fits very well into the small farmers' livelihood and societal development. A study was undertaken to study the hurdles of technology transfer and to develop a suitable model approach. The study was divided into a three-phase program including hurdles of technology transfer and gap at farmers' level, development and implementation of model approach for technology transfer and impact on enhancement of knowledge and productivity at field level. A total of 269 trainees from four states participated in the training where 11 proven technologies were covered. Out of the lot a total of 15 farmers from each of the four states were randomly selected and the knowledge improvement, technology absorption/absorption level and hurdles thereto were assessed by conducting a pre- and post-training assessment. The main hurdles were variable trend of farmers, low

absorption and adoption level, belief in traditional system, ignorance of new technology including use of disinfectants, illiteracy, weak barrier and vague communication network, suitability of technology, transfer of technology mechanisms, less resources, specialists' involvement and unstable crop. The redesigned model for training and technology transfer so implemented in the field indicate an increase in average productivity of 23.25% and increased earning per farmer at 31.27% over pre-training period.

132. Economic analysis of Crop-livestock Integrated Farming system for the Small farmers of Eastern Uttar Pradesh

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Key words : *Cost returns, employment, land holding, mixed farming, module, income*

Investigations were carried out in Eastern region of Uttar Pradesh to find out a sustainable mixed farming model which is economically viable integrating the different component like crop, livestock, poultry and duck on 3.0 acre land holding. Different viable modules *viz.* (F_1) crops, (F_2) crop + 2 bullocks + 2 cow, (F_3) crop + 2 bullocks + 2 buffaloes, (F_4) crop + 2 bullocks + 2 cow + 2 buffaloes, and (F_5) crop + 2 bullocks + 2 cow + 2 buffaloes + 20 poultry were developed to find out the best package on the land holding of 3.0 are suitable for the region. A model having 2 bullocks + 2 cow + 2 buffaloes + 20 poultry along with crop cultivation was the best with a net income of Rs. 36,888 yr^{-1} against crop farming alone (Rs. 15,600 yr^{-1}) with a cost returns of 1:2.17 and employment generation of 461.4 man days. The integrated farming system with 2 bullocks + 2 cow + 2 buffaloes along with other subsidiaries like poultry is the most beneficial system which can augment the income of rural people to improve their socio-economic status. More emphasis is still required to generate a generalized model suited to various farm size holdings in different agro-climatic conditions.

133. Impact of Fruit and Vegetable Processing Training on the Economic Status of Tribal People – A Success Story

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Key words : *Fruit and vegetable processing, Tribal people, Economic upliftment*

Post-harvest technology of horticultural produces is the need of the day to reduce the losses fruits and vegetables after harvest. Production of fruits and vegetables is high in hill areas. Imparting skills on processing and preservation of fruits and vegetables to the tribal people will help to reduce the post-harvest losses. An agro-processing centre in tribal areas would provide easy access for the tribal people to a food processing unit to acquire the required skills and also process their horticultural produces. To meet this need an agro-processing centre was established at Thadiyankudisai near Kodaikanal by installing equipments such as mini boiler, pulper, steam jacketed kettle and the like. Training programmes on processing of fruits and vegetables into jam, jelly, squash, RTS beverages, pickle, sauces, leather (fruit bars), dehydrated products, preserves and fruit toffees were organized for the tribal people. The training included good manufacturing practices, HACCP concepts, FPO standards required in fruit and vegetable processing. The tribal people have been motivated to start commercial production of the processed foods utilizing the equipment at the agro-processing centre. Marker linkages were established for sale of fruit and vegetable products. The economic status of the tribal families improved through this entrepreneurial venture.

134. Is Road and Rail Network a Boon for Human but a Curse for Wildlife?

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Key words : *Human-wildlife conflict, Mortality, Darrah sanctuary, Sloth bear*

Human-wildlife conflict (HWC) is fast becoming a serious threat to the survival of many endangered species in the World. Case studies from countries all over the world demonstrate the conflict and suggest that greater in depth analysis of the conflict is needed in order to avoid overlooking the problem and undermining the conservation of threatened and potentially endangered species. This report provides an insight into the HWC issue, based on a selection of relevant case studies and gathers together the key lessons learned. Dense human populations in close vicinity to nature reserves seem to pose the greatest challenges in Darrah sanctuary and their adjacent areas. HWC has far reaching environmental impacts. Species most exposed to conflict are also shown to be more prone to extinction, that can be either accidental such as road traffic and railway accidents, capture in snares set for other species or from fall into farm wells. This could also be intentional caused by retaliatory shooting, poison or capture. Such human-induced mortality affects not only the population viability of some of the most endangered species, but also has broader environmental impacts on ecosystem equilibrium and biodiversity preservation. In Darrah sanctuary, incidence of straying of wild animals and accidents while crossing the NH-12 and railway line was observed. NH-12 and broad gauge railway line cuts across the sanctuary therefore bisecting the sanctuary in two parts. 16 accidents by road and train accidents were observed in the sanctuary. The wild animals while crossing the NH-12 and railway line had to face accidents. Loss of a single wild animal is a great loss for Indian wildlife.

135. Recent Trends of Agricultural Education and Extension

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Key words : *Agricultural education, Agricultural extension, State Agricultural Universities, Krishi Vigyan Kendra*

Growth in agriculture boosts economic growth in India. Majority of the Indian population directly or indirectly depends on agriculture. Therefore, realizing the importance of agricultural growth, the Govt. of India through successive plans supported development of agricultural education in the country. Development Grant of ICAR has made a significant impact on the overall quality of agricultural education in the country. Recommendations of the Fourth Deans' Committee particularly with regard to norms, standards, academic regulations and UG course curricula and syllabi have been adopted by the AUs. This has a continuing positive effect on enhancement of the quality, acceptability and relevance of education as well as employability of the graduates.

Education Division undertakes planning, development, coordination and quality assurance in higher agricultural education in the country and, thus, strives for maintaining and upgrading quality and relevance of higher agricultural education through partnership and efforts of the components of the ICAR-Agricultural Universities (AUs) System comprising State Agricultural Universities (SAUs), Deemed to be universities (DUs), Central Agricultural University (CAU) and Central Universities (CUs) with Agriculture Faculty.

The comfortable food grain situation that the country enjoys is the result of development of technology and their dissemination to the highly receptive farming community. To facilitate assessment, refinement and demonstration of technology/products, a total number of 570 KVKs have been established so far against the XI plan target of 667 KVKs in all the rural districts of the country. The knowledge, generated by research is disseminated through education / teaching and finally trickles down to farmers and practitioners through extension therefore, it is necessary that universities should reform their academic activities to strengthen the links between research, teaching and extension.

136. Gender Perspectives for Sustaining Field Crop Production System

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Key words : *Agricultural operations, sustainable development, AICRP on home sciences, Gender mainstreaming*

In 2004-05 women accounted for 34 percent of principal and 89 percent of subsidiary workers in agriculture, higher than any previous round of National Sample Survey. Gender issues assume great importance in Indian agricultural scenario due to the large diversity in the status of women which is influenced mostly by social and religious taboos, economic status and farm production systems. Apart from the type of participation measuring the access and control over farm related resources has rarely been addressed. These issues have been addressed under All India Coordinated Research Project on Home Science operating in nine states under nine State Agricultural Universities. The present paper highlights the gender activities, access and control over resources and there by implications and suggestions for sustainable development addressing both practical and strategic needs. it was found that female members played an important role along with their male counterparts in transplanting, weeding and

harvesting whereas access to and control over farm related resources only half of the male respondents had complete access to all the resources in comparison to the female members which was only 12.50% in the composite data. Based on the findings ways to enable poor women to benefit from new technologies for sustainable development and gender mainstreaming.

137. Impact of Intervention Programme on Production Technologies of Rural Women of Jorhat District of Assam

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Key words : *Vegetable in the diet, ICMR recommendation, Purposive-cum-stratified sampling, Nutritional management*

The present consumption of vegetables in the country is 135 gm per capita per day compared to 285 gm as recommended by ICMR for a balanced diet. However production does not meet the requirement of the population of our country. There is an urgent need for understanding the existing knowledge and skills on cultivation of horticultural crops so that we can achieve the target given by ICMR. Considering the above facts the present study was conducted on the existing knowledge of the rural women of Assam about scientifically validating existing production technologies and disseminating the same among the rural women. The study was conducted in three different agro-climatic zones of Assam. A multistage purposive-cum stratified random sampling design was followed covering 1500 respondents for data base. The majority of the rural women had a very low level of knowledge in all the aspects of cultivation of horticultural crops namely nursery production, nutritional management, Plant protection followed by production practices of horticultural crops, seed production, land preparation and harvesting. Intervention helped in improving the knowledge which was observed through feedback received from post training analysis after one month and participation in open forum discussion.

VII. FORESTRY AND AGRO-FORESTRY

138. Prospect of Propagation and Effective Distillation of Different Cultivars of Menthol-mint at Mungpoo Area of Darjeeling District

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Key words : *Physical properties, Aonla fruit, Sphericity, Surface area*

Three cultivars of menthol-mint (*Mentha* arvensis) *viz.* Shivalik-88, Himalaya and Kosi were test grown in experimental plots employing respective suckes at Mungpoo (1200 m above m.s.l. with an annual rainfall of 3000 mm) in the district of Darjeeling. The field plots grown to *cv*. Shivalik-88 and Himalaya were amended with 117.5 and 55.675 $t.ha^{-1}$ rspectively of FYM while the field plots grown to *cv*. Kosi were amended with 90 $t.ha^{-1}$ of leaf-soil compost. Suckers of *cv*. Shivalik-88, Himalaya and Kosi were planted at rates of 320, 261.25 and 617.5 $kg.ha^{-1}$ respectively. Different mint cultivars were top-dressed with chemical fertilizer (N:P:K ::20:20:20) at different rates. In case of 2^{nd} crop, a mixture of 2% urea and 0.25% micro-nutrient solution was foliar sprayed during 20^{th} and 40^{th} days after the first harvest. A patented modern distillation plant was used for complete distillation of the crops in only 51-69 minutes per batch. First and second crop of Shivalik-88 and Himalaya produced 122.25 and 91.60 $l.ha^{-1}$ of transparent oil with only 15-19% contribution from the second crop. Average oil contents of both the cultivars ranged ~0.5%. On the contrary, 1^{st} crop of *cv*. Kosi produced 145.5 $l.ha^{-1}$ of net oil with an average oil content of 0.7%. Results indicate that *cv*. Kosi was the best suited cultivar and can provide lucrative returns to the farmers.

139. Biology of Parasa Lepida Cramer [Lepidoptera : Limacodidae] – on Its New Host from India

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Key words : *Parasa lepida, Populus deltoids, Limacodidae, Life cycle*

Populus deltoids Bartr. is an important agroforestry species in India. *Parasa lepida* Cramer belonging to order Lepidoptera and family Limacodidae is an important pest of poplar. It causes damage to the foliage during monsoons in Uttarakhand. The est was reared in the laboratory and biology of this insect studed and described for the first ime on this host. This is a polyphagous pest and a major limacodid pest. Larvae of this pest have very irritant tuft of spines and moves like a slug. They generally prefer nature leaves and almost devour the leaves except the midrib. Females tend to be slightly larger than the males. The above study on its biology is decribed in details in the present paper.

140. Ethno-ecology of tribes inhabiting the forest of Hadoti region, Rajasthan

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Key words : *Ethno-ecology, Hadoti region, Forest dependency, Tribals of south-east Rajasthan*

In the present study, an attempt has been made to study the status of the tribals of south-east Rajasthan on the basis of their socio-economic index. Data were collected furing the year 2008-2010. All the populations showed an increase in the mean values in their living standard. Saharia tribe shows the least advancement than their counterparts in other tribes. Mina tribe exhibits the highest mean

value of growth and development in all aspects. High prevalence of agriculture was observed in almost all the tribes dwelling in the forest. Results clearly indicate a high prevalence of dependency on forest. However, lack of sound policy concerning ownership, accountability, integrated intervention and benefit and cost sharing mechanisms has left the remaining forest without effective management. On the positive side, most households realize that forests are important for climate regulation and rainfall.

141. Seed storability in *Dalbergia sissoo*

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Key words : *Dalbergia sissoo, Vigour index*

Properly sun-dried and cleaned pods (without extracting seeds), collected during January 2001 from Dehradun and Hisar, were stored at room temperature to find seed storability and loss of vigour index in storage. The germination per cent after storage of two years varied from 65.0 per cent in clone no. 85 from Hanumangarh to 79.0 per cent in clone no.19 from Kanpur with an average of 71.36 per cent. The storage period from July to December was found more deteriorating for germination, vigour index-I and vigour index-II. The reductions in germination per cent, vigour index-I and vigour index-II were observed higher with the advancement of storage period. The reduction in both vigour index-I and vigour index-II were observed higher than standard germination for all the clones during all the four intervals of storage. Clone no. 83 from Hanumangarh, Clone no. 19 from Kanpur and Clone no. 87 from Hanumangarh were found promising for storability as it was evident from comparatively less reduction for standard germination, vigour index-I and vigour index-II.

142. Effective Callus Induction and Organogenesis from Explants of *Withania somnifera* var. Poshita

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Key words : *Withania somnifera var. Poshita, Shoot tip, Leaf explant, Callus, TDZ, BAP, KIN, Micropropagation, in vitro flowering.*

In the hill eco-system of Manipur (latitude 23.80^{o} to 25.68^{o}N and longitude 93.03^{o} to 94.78^{o}E) overexploitation of forest resources due to pressures from both demographic and developmental angles, has resulted in large-scale deforestation resulting into loss of precious top soil and nutrients through runoff. The paper reports the impact of various land-use practices *viz*. sub-tropical forest, subtropical Pine and forest with shifting cultivation in a hilly catchment on runoff, sediment and nutrient losses. The study indicates that conversion of natural forest into other land uses including agro-systems leads to decline in soil-organic matter causing reduction in cation exchange capacity, thus becoming more vulnerable to leaching. However, supply of organic matter through suitable ground cover, litter layer, mulches etc. help in protecting soil and water resources. To mitigate the resource loss and to provide other alternatives of livelihood to the local population, an attempt is made in this study to suggest management options for shifting cultivation systems by traditional agro-forestry practices that need the attention of planners. Evidence is provided that such systems have potential for improving water use efficiency by reducing run-off, bind soil nutrients and enhance yields.

143. Efficient *in vitro* Regeneration of Eucalyptus *via* Direct Organogenesis cum Direct Somatic Embryogenesis

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Key words : *Organogenesis, Embryogenesis, Mass multiplication, Cytokinins, Somaclones, Eucalyptus camaldulensis.*

An efficient in vitro regeneration protocol forms the basis for mass multiplication and genetic transformation of forestry tree species. For the first time, we report an efficient tissue culture regeneration protocol that follows organogenesis- cum-embryogenesis pathways of eucalyptus regeneration. Using a single nodal stem segment from mature *Eucalyptus camaldulensis* trees, we could generate 60-148 shoot initials from 8 sub-cultures. In the present investigation, full strength MS fortified with cytokinins (BAP) in combination with a weak auxin (i.e. NAA) in the ratio of 21:1 favored direct organogenesis and direct somatic embryogenesis pathways. Further, the use of half strength MS basal media fosers shoot elongation and root formation. This protocol demands a total of four month duration towards plantlet formation enabling mass multiplication of desired, elite *E. camaldulensis* trees from stem segments. Absence of intervening callus phase minimizes the occurrence of somaclones and plant chimeras. For the first time in the genus *Eucalyptus*, we report direct organogenesis cum direct somatic embryogenesis pathways occurring simultaneously within the same explants of *E. camaldulensis*.

144. Eucalyptus Germplasm Improvement through Interspecific Hybridization and Polyploidy

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Key words : *Eucalyptus, Germplasm, Interspecific hybrids, Tetraploids, diallel mating, wet-lyophilization, Colchicine*

Eucalyptus is a native of Australia that has been introduced into India for fuel, timber and paper pulp. Following the introduction of this genus by Britishers, continuous inbreeding among the available genetic resources resulted in narrowing the germplasm base necessary for exploiting the traits for better utilization of this genus. In order to break the present day yield threshold and serve the

exploding Indian population, the germplasm needs to be broadened either through wide-interspecific hybridization or chemically induced polyploidy. Here, we report the successful generation of interspecific hybrids and tetraploids in eucalyptus. In interspecific hybridization, we developed 21 diverse families of hybrid progeny that resulted in generating new combinations of alleles. Following a partial diallel mating design and wet-lyophilization (WL) method of pollen isolation (PI), pollen from three commercially important species namely *Eucalyptus globules*, *E. pellita* and *E. urophylla* were used to cross pollinate India's elite colnes belonging to *E. camaldulensis*. A total of 1300 putative hybrid eucalyptus plants were generated. Further, colchicine induced autotetraploids were produced in *E. camaldulensis* and *E. tereticornis*. Among the 18 tetraploids that were generated, few showed altered morphological characteristics like thicker and larger leaves with undulating leaf morphology. Stomatal size and density in upper and lower epidermis from one-year-old plants were used for rapid screening of tetraploids. As these are plants generated from best parents, it is likely that these hybrids and tetraploids can break the yield and quality thresholds reached by the existing Indian resources.

145. Management of Insect Pests in Forest Nurseries for Profitable Tree Cultivation

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Key words : *Forest plantation, nursery, Integrated pest management*

Increased rate of tree planting is a necessity now-a-days to reclaim waste lands and to arrest further ecological degradation, besides meeting the needs of local communities by providing fuel wood and fodder for man and his cattle. Thus plantation forestry have grown phenomenally, accelerated by government departments and farmers as a commercial activity incorporating tree species of high commercial and industrial value. Establishment of tree species varies with different eco climatic conditions and the demand for such species being on the rise there is an urgent need to develop package of practices for all the pest problems for proper and timely implementation to avoid seedling loss or damage

particularly at the nursery level. Forest nurseries are an integral part and contribute significantly towards forest regeneration programme. Successful establishment of plantations is based on the development of a well-managed nursery providing quality planting material. The nursery insect pests are detrimental to the vigorous growth and health of planting stock which ultimately affect the survival of out planted seedlings in the field. Development of pest management practices is an important priority area in forestry so as to produce healthy seedlings for attaining improved productivity. Timely and proper utilisation of the developed pest management package of practices could keep the pests at an innocuous level and reduce the high cost of containing the pest in outbreak situations and loss of planting material could be avoided. A package of practices to be adopted for management of selected key nursery insect pests of *Albizia lebbeck, Aegle marmelos, Ailanthus excelsa, Azadirachta indica, Mimusops elengi, Phylanthus emblica, Pongamia pinnata, Syzygium cumini,* and *Tectona grandis* is discussed in this paper. Proper integration of various ecofriendly control methods could help to avoid extensive use of chemicals and therefore it will improve the quality of the environment. State Forest Departments, Forest Development Corporations, NGOs and Farmers raising nurseries for plantation purpose will be benefited by the package of practices to manage pest problems in nurseries.

146. *Prosopis cineraria* (Khejri) Based Traditional Agroforestry in Rajasthan, India : A Successful Tree Outside Forests (TOFs)

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Key words : *Prosopis cineraria (Linn.), arid tracts, agroforestry, soil quality, ecological balance*

Prosopis cineraria (Linn.) is one of the successful tree outside forests which meets the multifarious requirement of the people besides improving soil quality and maintaining the ecological balance in the arid tracts. To evaluate the performance of the six annual crops (*Brassica campertris* L., *Brassica nigra* Koch, *Cuminum cyminum* L., *Cicer arietinum* L., *Plantago ovata* Forsk. and

Hordium vulgare L.) under khejri trees, an investigation was carried out at farmer's field in Nagaur and Sikar districts of Rajasthan. When compared to open field the per cent light reduction was more (53%) at nearer to the base and less (16%) at 5-6 m distance from tree base. To asses the growth and yield of annual crops, $1m^2$ quadrates were placed in all the four directions at three distances viz., 1-2, 3-4 and 5-6m from tree base besides open field. Four trees having average girth were selected for each crop combination. No definite trend was found among the directions for the various crop yields. While a increasing trend was occurred as the distances increases from the tree base. Compared to the open field increased grain production was obtained in *C. arietinum* (7.3 %) and *B. nigra* (4.9 %) where as grain yield was decreased in *Brassica campertris* (9.0 %), *C. cyminum* (11.4 %), *P. ovata* (14.6 %) and *H. vulgare*(5.9 %). The proper tree management like cent per cent lopping of the branches during winter season (before sowing of the crop), optimum tree density and its arrangement facilitates the crops for maximum production. Interaction with farmers perceived that there is little or no effect of the khejri on under-storey crop's yield and the tree density was decreasing owing to mechanization and insect infestation of lately.

147. Inter-specific Grafting in Jatrophas : A Viable Option to Green the Wastelands of Bundelkhand

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Key words : *Prosopis cineraria (Linn.), arid tracts, agroforestry, soil quality, ecological balance*

Observations were carried out at NRCAF, Jhansi during 2007-10 to evaluate the inter-specific grafting compatibility between the bio-diesel plant *Jatropha curcas* L., and the naturally abundant weed *Jatropha gossypifolia* L. The early union (18 to 21 days) of cleft grafting by *J. gossypifolia* as root stock and *J. curcas* as scion resulted in >80% grafting union success both in ex- and in-situ conditions. About six number of 1 year old inter-specific grafts planted in the nursery exhibited good growth due to their initial grafting compatibility

between the species. It is well known that both the species are differing in growth characters. Hence, their further union success dependence over root stock and scion thickess, early fruiting, performance of grafts over mother plants were observed after following the recommended pruning (at 30 cm height) practice until its third year after grafting. The later onservations revealed that the union was successful and expressed the intermediate performance of grafts over parents due to its same dimension of root stock and scion, while the different dimensions evident the incompatibility symptosm such as necrotic layers at the unions, swelling at the point of grafting, peeling and fluted bark, bulginess, abnormality and oozing of chemicals from the union, etc. which finally cause for drying of grafts after the imposing of pruning practice. Hence, this study advised us to carry out grafting with same dimension of root stock and scion. This innovative technique is considered potential to green the wasteland of Bundelkhand region with the dual benefit of *J. curcas* seed production while eradicate the weed *J. gossypifolia*.

98th Indian Science Congress
January 3-7, 2011, Chennai

VI

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