NATIONAL CONFERENCE FOR
POST GRADUATE STUDENTS (NCPGS-2018)

TECHNO-STRATEGIC INTERVENTIONS
for
PROFITABLE AGRICULTURE

26-27 MARCH, 2018

Organized by
Advanced Post Graduate Centre (APGC), Lam, Guntur &
Agricultural College, Bapatla

Venue: Agricultural College, Bapatla

ACHARYA N.G. RANGA AGRICULTURAL UNIVERSITY
LAM, GUNTUR, ANDHRA PRADESH
www.angrau.ac.in
NATIONAL CONFERENCE FOR POST GRADUATE STUDENTS
(NCPGS-2018)
onTECHNO-STRATEGIC INTERVENTIONS FOR PROFITABLE AGRICULTURE
March 26-27, 2018

Jointly organized by
Advanced Post Graduate Centre
Lam, Guntur- 522 034
&Agricultural College
Bapatla- 522 101

Editorial Committee
Dr. V. Padma
Dr. Lal Ahamed M.      Dr. M. Raghavendra
Mr. S. Vinod Babu       Ms. D. Swarajya Lakshmi
Committees for National Conference
on
Techno-Strategic Interventions for Profitable Agriculture

ORGANIZING COMMITTEE

Dr. R. Veeraraghavaiah, Dean of PG Studies, ANGRAU  
Chairperson
Dr. T. Ramesh Babu, Dean of Agriculture, ANGRAU  
Co-Chair Persons
Dr. D. Bhaskara Rao, Dean of Ag. Engg. & Tech., ANGRAU  
Mentors
Dr. T. Neeraja, Dean of Home Science, ANGRAU  
Dr. D. Lokanadha Reddy, Associate Dean, Ag. College, Bapatla  
Organizing Secretary
Dr. K.L. Narasimha Rao, Special Officer, APGC, Guntur  
Dr. T. Srinivas, Professor (Academic & Education), ANGRAU  
Dr. V. Padma, Professor & Head, APGC, Guntur  
Dr. P. Anil Kumar, Professor & Head, Ag. College, Bapatla  
Conveners of all the Committees
Dr. D. Lokanadha Reddy, Associate Dean, Ag. College, Bapatla  
Co-organizing Secretary
Dr. K.L. Narasimha Rao, Special Officer, APGC, Guntur  
Dr. T. Srinivas, Professor (Academic & Education), ANGRAU  
Dr. V. Padma, Professor & Head, APGC, Guntur  
Dr. P. Anil Kumar, Professor & Head, Ag. College, Bapatla  
Conveners of all the Committees

INVITATION COMMITTEE

Dr. P.R.K. Prasad, Professor & Head, Ag. College, Bapatla  
Convener
Dr. A. Vijaya Gopal, Assoc. Professor & Head, APGC, Guntur  
Co-convener
Dr. M. Srinivasa Rao, Assoc. Professor, Ag. College, Bapatla  
Member
Dr. D. Ratna Babu, Asst. Professor, APGC, Guntur  
Member
Dr. Sk. Nafeez Umar, Asst. Professor, Ag. College, Bapatla  
Member
Mrs. M. Tushara, Asst. Professor, Ag. College, Bapatla  
APGC Students
P. Prasanna Lakshmi, B. Siva Bharathi, P. Lakshmi Pravallika  
Ag. College Students
K. Anil Kumar, Venkata Reddy, Sarath Kumar,  
U. Gudarankaiah, N. Kishore Kumar

DAIS AND DECORATION COMMITTEE

Dr. V. Srinivasa Rao, Professor & Univ. Head, Ag. College, Bapatla  
Convener
Dr. K. Radhika, Professor & Head, APGC, Guntur  
Co-convener
Dr. V. Prasanna Kumari, Assoc. Professor, Ag. College, Bapatla  
Member
Dr. S. Prathibha Sree, Assoc. Professor, APGC, Guntur  
Member
Dr. Y. Bindiya, Asst. Professor, Ag. College, Bapatla  
Member
Ms. M. Latha, Asst Professor, Ag. College, Bapatla  
APGC Students
D. Aleena, G. Usha, S. Vinod Babu, D. Nagendra  
Kranthi Priya, V. Sravan Kumar, S. Sravanthi, N. Sai Bhargavi,  
B. Raga Sravanthi, T. Hema Sravanthi, Ch. Nani Babu, G. Venkoteswara Rao  
Ag. College Students

RECEPTION AND ACCOMMODATION COMMITTEE

Dr. Martin Luther, Professor, Ag. College, Bapatla  
Convener
Dr. T. Gopi Krishna, Professor & Head, Ag. College, Bapatla  
Co-convener
Dr. Ch. Sandhya Rani, Assoc. Professor, Ag. College, Bapatla  
Member
Dr. V. Sitarambabu, Asst. Professor, Ag. College, Bapatla  
Dr. M. Swathi, Asst. Professor, Ag. College, Bapatla  
Mr. G. Vinay Kumar, Asst. Professor, Ag. College, Bapatla  
K. Mallikarjuna Reddy, K. Prasanth Raju, J. Amani, N. Ramya  
N. S. Praveen Kumar, P. Harish Babu, A. Appala Raju, Akshata, K. Blessy Susanna, V. Hima Varsha, G. Sandeep Kumar, D. D. Prathyusha  

**Member**

Dr. B. Venkateswarlu, Professor, Ag. College, Bapatla  
Dr. T. Gopi Krishna, Professor & Head, Ag. College, Bapatla  
Dr. Uma Devi, Asst. Professor, Ag. College, Bapatla  
Dr. N. Venkata Lakshmi, Asst. Professor, APGC, Guntur  
Mr. M. Ravi Babu, Asst. Professor, Ag. College, Bapatla  
Dr. CH. Bhargava Rami Reddy, Asst. Prof., Ag. College, Bapatla  
A. Anjani, P.V. Srividya, M. Srikanth  
B. Sarath Babu, S. Kiran Kumar, A. Aliveni, N. Jyothish Raju, R. Sai Kumar, S. Raj Kumar, Ananth Vihari, Jaswanth Naik, K. Srinivasa Reddy, Ch. Divya Sree, L. Usha Rani, M. Uday Bhaskar  

**Convener**

Dr. P. Ravindra Babu, Professor, Ag. College, Bapatla  
Dr. Y. Ashoka Rani, Prof & Head, Ag. College, Bapatla  
Dr. K. Chandra Sekhar, Professor and Head, APGC, Guntur  
Dr. M. Sreerekha, Assoc. Professor, Ag. College, Bapatla  
Dr. Kiran Prakash, Assoc. Professor, APGC, Guntur  
Dr. V. Manoj Kumar, Assoc. Professor, Ag. College, Bapatla  
Dr. Lal Ahamed M., Assoc. Professor, APGC, Guntur  
Dr. Suseela, Asst. Professor, Ag. College, Bapatla  
K. Pavani, K. Vasundhara, K. Manorama  
Swetha Soju, G. Bharathi, J. Deepika, Mandakranta Chakraborty, S. Pavani, Sushitha, Ch. Yamuna  

**APGC Students**

Dr. E. Narayana, Prof & Head, Ag. College, Bapatla  
Dr. Ch. Sujani Rao, Professor, Ag. College, Bapatla  
Dr. R. Lakshmipathy, Asst. Professor, APGC, Guntur  
Dr. V. Roja, Asst. Professor, Ag. College, Bapatla  
Dr. T. Haritha, Asst. Professor, Ag. College, Bapatla  
Dr. Ch. Naga Jyothish, Asst. Professor, Ag. College, Bapatla  
K. Neeraja, T. Dakshayani, Jagruti Mohapatra, V. Ajitha  

**Co-convener**

**Member**

**APGC Students**

**Ag. College Students**
TRANSPORT COMMITTEE
Dr. B. Sreekanth, Asst. Professor, Ag. College, Bapatla
Dr. K. Bayyapu Reddy, Asst. Professor, APGC, Guntur
Mr. Sk. Abdul Salam, Asst. Professor, Ag. College, Bapatla
M. Ashok Mourya, A. Narendra Reddy, M. Satish, B. R. V. Ramaraju
R. Saidhar, S. Mallikharjun, D. Suneel, G. Suneel Kumar,
M. Sumanth Kumar, Shalem Raju, M. Venkatesh

PRESS AND PUBLICITY COMMITTEE
Dr. V. Satyanarayana Rao, Professor & Head, Ag. College, Bapatla
Dr. G. Suneel Kumar Babu, Professor, Ag. College, Bapatla
Dr. T. Prashanth Kumar, Assoc. Professor, Ag. College, Bapatla
B. Prasanna Kumar, S. Manoj Naidu, P. Sai Kumar,
Mr. Raliengoane Tebesi Peter
V. Dinesh Rahul, R. Gunasri, G. S. Naga Raju,
Sk. Sameer, B. Srikanth, P. Kavya

TECHNICAL COMMITTEE
Dr. G. V. Lakshmi, Professor and Head, APGC, Guntur
Dr. V. Radha Krishna Murthy, Professor, Ag. College, Bapatla
Dr. G. V. Lakshmi, Professor and Head, APGC, Guntur
Dr. T. Madhumathi, Professor, Ag. College, Bapatla
Dr. J. V. Ramana, Assoc. Professor, APGC, Guntur
Dr. B. V. S. Prasad, Professor & Head, CAE, Bapatla
Dr. T. Gopi Krishna, Professor & Head, Ag. College, Bapatla
Dr. Y. Radha, Professor, Ag. College, Bapatla

FINANCE COMMITTEE
Dr. G. Ramachandra Rao, Professor, APGC, Guntur.
Dr. J. V. Ramana, Assoc. Professor, APGC, Guntur
Dr. V. Manoj Kumar, Assoc. Professor, Ag. College, Bapatla
Dr. B. Srikanth, Asst. Professor, Ag. College, Bapatla
P. Tejadeep, G. Prashanth Mourya
N. Harisha, K. Anil Kumar, J. Sai Santosh,
G. Ravindranath, B. Gowthami

PUBLICATION COMMITTEE
Dr. V. Padma, Professor & Head, APGC, Guntur.
Dr. P. Anil Kumar, Professor & Head, Ag. College, Bapatla
Dr. G. Ramachandra Rao, Professor, APGC, Guntur
Dr. D.V. Sai Ram Kumar, Professor, Ag. College, Bapatla
Dr. Lal Ahamed M., Assoc. Professor, APGC, Guntur Member
Dr. M. Raghavendra, Asst. Professor, APGC, Guntur Member
Dr. T. Haritha, Asst. Professor, Ag. College, Bapatla Member
Dr. T.V. Sridhar, Technical Officer, Administrative office, ANGRAU Member
B. Swarajya Lakshmi Naidu, R. Himaja, N. Aiswarya, G. Kavitha APGC Students
V. Ravi Kumar, Ch. Vidhya sree Ch, K. Vykhaneswari, Ag. College Students
V. Divya Mani, M. Priyanka, P. Chinna Rao, B. Viswateja

CULTURAL COMMITTEE

Dr. Ch. Chiranjeevi, Professor & Head, Ag. College, Bapatla Convener
Dr. K. Jayalalitha, Professor, Ag. College, Bapatla Co-convener
Dr. B. Krishnaveni, Asst. Professor, Ag. College, Bapatla Member
Dr. C. Uma Devi, Asst. Professor, Ag. College, Bapatla Member
Dr. B. Ratna Kumari, Asst. Professor, Ag. College, Bapatla Member
Dr. D. Ramesh, Asst. Professor, Ag. College, Bapatla Member
Dr. K. Lakshman, Asst. Professor, Ag. College, Bapatla Member
P. Suma Varshini, K. Hamika, S. Nazma APGC Students
N. S. Praveen Kumar, Y. Jhansi, P. Manasa, G. Sarath Kumar, Ag. College Students
Md. Farahat Kausar, R. Asha, N. Bindu Madhavi
Dr. V. Damodara Naidu
Vice-Chancellor

Message

It gives me an immense pleasure to note that Advanced Post Graduate Centre, Lam and Agricultural College, Bapatla are jointly organizing a National Conference on “Techno-Strategic Interventions for Profitable Agriculture” on 26th and 27th March, 2018 for the benefit of the Post Graduate Students.

Agriculture is the most important sector of Indian economy. Majority of Indian farmers still get very low returns on their investment because of the low productivity and lesser quality. One of the primary constraints to increased productivity and profitability stems from the limited use of modern farming technology, equipment and inputs. The use of modern equipment could also make harvests more efficient and help to move produce to market more quickly and in better condition. Finally, important agricultural inputs such as seeds, agro-chemicals, and fertilizers can dramatically reduce losses.

Adoption of modern technology such as “precision farming” boosts crop yields and reduces waste by using satellite maps and computers to match seed, fertilizer, and crop protection applications to local soil conditions. By utilizing proven modern farming techniques and science-based solutions, farmers can increase productivity, efficiency, and profitability as well as reduce malnutrition and enhance food security. The increased productivity, even for small land holders, means that they can afford many of the needed inputs. For more expensive equipment, farmers have the option of pooling their resources to share ownership.

Acharya N.G. Ranga Agricultural University is assisting farmers of Andhra Pradesh to diversify their incomes with different crops and seasonal rotations and taking so many initiatives to increase crop productivity. Our scientists are doing need based research for the farming community to develop new varieties and crop management techniques to improve production and sustainability. All these efforts are helping the agricultural sector to grow into a sustainable business model.

This National Conference is a step towards sharing information and knowledge in addition to discussing and deliberating on trends to double the farmer income. I am certain that the presence of eminent scientists and students from all corners of India will contribute to success of the Conference and this event will set new goals and targets for the students to make the agriculture profitable.

I wish the Conference a grand success.

(V.DAMODARA NAIDU)
Message

I am pleased to state that, the Acharya N.G. Ranga Agricultural University has come up with first of its kind event of organizing a National Conference for the Post Graduate and Doctoral Students only to offer a thought provoking platform to exchange ideas, and create opportunity to broaden scientific thinking and networking of Young Agri-professionals. I congratulate Advanced PG Centre, Guntur and Agricultural College, Bapatla, jointly organizing the National Conference on ‘Techno-Strategic Interventions for Profitable Agriculture’ on the 26th and the 27th of the March, 2018 at Agricultural College, Bapatla.

Themes set up for the Conference are very much relevant and significant in channelizing scientific efforts, innovations and technological advances for achieving the future requirements in the field of Agriculture. I am happy to note that several Lead Speakers, Post Graduate & Doctoral Students, Academicians and Scientists from the Universities across the Country are participating in the Conference. Therefore, the outcome of the Conference would certainly be useful to all those concerned, especially the Young Minds to serve for Food and Nutritional Security of the Country.

I wish all the participants to have a comfortable and pleasant stay with a memorable experience in sharing of information for furtherance of their domain knowledge.

On this occasion, I extend my warm greetings to the Organizers and wish for its success.

(R VEERARAGHA V AIAH)
Message

Scientific interventions are the key drivers for the development of new technologies in the field of Agriculture. I am happy to congratulate the Organizers, who take initiative to organize the National Conference on “Techno-strategic Interventions for Profitable Agriculture”. The conference will equip the Post Graduate and Doctoral students with professionalism, knowledge and skills to face the current challenges and to derive workable solutions for the future of Agriculture.

Various Themes set up under the Conference are very much relevant and significant in channelizing scientific efforts, innovations and technological advances for improving the livelihood of the farmer through profitable agriculture. I am happy to note that, lead paper presentations of the eminent personalities in respective thematic areas will certainly drive the post graduate students to turn as better scientists for future also. Therefore, the outcome of the Conference would certainly be useful to all those concerned, especially scientific community.

I am sure that this Seminar will provide a good platform for the participants to exchange their ideas and views in addition to establish networking.

On this occasion, I extend my heartfelt greetings to organizers of the National Conference and wish for its success.

(T. RAMESH BABU)
Message

Deteriorated natural resources posed serious challenges to Agriculture and reduced the income of farming community and to overcome this, it is essential to develop strategies with novel techno-strategic interventions and to revisit policies to enhance and sustain farm profitability. With this in view, the National Conference on ‘Techno-strategic Interventions for Profitable Agriculture’ is being organized at Agricultural College, Bapatla during 26-27th March 2018.

I am happy to note that this National Conference addresses the strategic coordination and convergence of all the stakeholders concerned duly harnessing the creative and novel ideas/concepts of young agricultural professionals to plan, design and develop situation specific, climate-smart and eco-friendly technological interventions to make agriculture into profitable. Acharya N. G. Ranga Agricultural University designed the conference to suit for Post-graduate and Doctorate students, who are getting equipped with professionalism, knowledge and skills to face the current challenges and workable solutions for the future of Agriculture. The objective of the conference is to offer a thought provoking platform for exchange of ideas and opportunity to broaden scientific thinking and networking of young agri-professionals. It is learnt that a variety of scientific research and novel technological related to Eco-friendly and climate-smart Agriculture, Resource efficient and cost reducing technologies, Crop improvement and management for biotic and abiotic stresses, Farm mechanization and post-harvest technologies to enhance farm profitability, Extension strategies including e-initiatives towards farmers prosperity and interventions for food and nutritional security are to be discussed in the conference.

I wish the national conference to be a grand success and congratulate all the faculty and staff members involved in organizing the National Conference.

(D. BHASKARA RAO)
Message

National conference exclusively for the future promising scientists is an innovative idea to promote quality research. Along with providing a platform, this sort of conferences helps the young minds to taste the pride in sharing their research ideas to a larger group.

This being a students’ competitive conference will greatly help the students in their future professional life. The conference would definitely bring together some of the latest most thought provoking researches from around the country. It will surely push the boundaries of knowledge another significant step forward.

I congratulate the organizers who have invested a great deal of their time in organizing the conference.

I extend my best wishes for great success of the conference.

(T. Neeraja)
Preface

It gives me immense pleasure to organize the National Conference for Post Graduate students for the first time in ANGRAU at Agricultural College, Bapatla on “Techno-Strategic Interventions for Profitable Agriculture” as focal theme. The conference is being jointly organised by the Advanced Post Graduate Centre, Lam, Guntur and Agricultural College, Bapatla, A.P., India on 26-27th March, 2018.

I extend hearty welcome to all the Scientists, Academicians, Resource persons, Delegates and Post Graduate students participating in the Conference. The very objective of this conference is to provide platform where PG students can present their research work and share their ideas and discuss with the eminent scientists. About 250 Post Graduate Students and doctoral students from various Universities are participating as delegates in the conference and I am confident that this conference inspires the aspiring students to reach a milestone and offers a vision of progress that integrates immediate and long term objectives of the core needs of the farming community.

The theme of the conference is highly relevant to face the emerging challenges that the society is facing in the field of Agriculture. I am sure that the national conference will bring laurels to the University and remain as memorable event to the PG students.

I wish that all the participants of this conference will make fruitful and meaningful deliberations for making the agriculture profitable.

(V. Padma)
## CONTENTS

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Title</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Theme-01 Eco-friendly and Climate Smart Agriculture</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01-01</td>
<td>Crop production constraints and strategies for improvement in north coastal zone of Andhra Pradesh</td>
<td>7</td>
</tr>
<tr>
<td>01-02</td>
<td>Zero tillage mustard – A better technology for rice fallows of A.P.</td>
<td>7</td>
</tr>
<tr>
<td>01-03</td>
<td>Yield, consumptive use and water use efficiency of dry sown rice (<em>Oryza sativa</em> L.) influenced by irrigation schedules and weed management options</td>
<td>8</td>
</tr>
<tr>
<td>01-04</td>
<td>Hydroponics green fodder production a boon to small and landless farmers</td>
<td>9</td>
</tr>
<tr>
<td>01-05</td>
<td>Climate smart agriculture – A boon to livestock sector</td>
<td>10</td>
</tr>
<tr>
<td>01-06</td>
<td>Indigenous technical knowledge – A boon to climate smart agriculture</td>
<td>10</td>
</tr>
<tr>
<td>01-07</td>
<td>Impact of agricultural research in achieving food security</td>
<td>11</td>
</tr>
<tr>
<td>01-08</td>
<td>Resource use efficiency of maize producers in Guntur district of Andhra Pradesh – An economic perspective</td>
<td>11</td>
</tr>
<tr>
<td>01-09</td>
<td>Agrometeorological advisories for sustainable agriculture</td>
<td>12</td>
</tr>
<tr>
<td>01-10</td>
<td>Nanotechnology in agriculture: poly (caprolactone) nanocapsules as carrier systems for herbicides</td>
<td>13</td>
</tr>
<tr>
<td>01-11</td>
<td>Laser land leveling – Climate smart agronomic approach</td>
<td>14</td>
</tr>
<tr>
<td>01-12</td>
<td>Nutrient uptake by <em>rabi</em> maize as influenced by different irrigation schedules and nitrogen management</td>
<td>14</td>
</tr>
<tr>
<td>01-13</td>
<td>Soil health management for sustainable agriculture</td>
<td>15</td>
</tr>
<tr>
<td>01-14</td>
<td>Cost effective green fodder production by hydroponic technique</td>
<td>16</td>
</tr>
<tr>
<td>01-15</td>
<td>Organic farming in Indian perspectives</td>
<td>16</td>
</tr>
<tr>
<td>01-16</td>
<td>Nonconventional weed management strategies for modern agriculture</td>
<td>17</td>
</tr>
<tr>
<td>01-17</td>
<td>Water management practices for managing water scarcity and to enhance water productivity in maize</td>
<td>18</td>
</tr>
<tr>
<td>01-18</td>
<td>Utilization of maize stalks for mushroom cultivation and compost making</td>
<td>19</td>
</tr>
</tbody>
</table>
01-19 Millets: Resilient crops in changing climate
Triveni, U., Mounika, D and Martin Luther, M.

01-20 Climate smart agriculture: developing models at a regional scale

01-21 Agronomic interventions for enhancing productivity in castor
Jyothiraju, N.N and Venkateshwaralu, B.

01-22 Importance of organic farming and resource use efficiency in crop improvement
Ravichandra Reddy, P and Debjyoti Chakraborty

01-23 Agronomic options to enhance the productivity and profitability of millets
Prasanth Mourya, G., Pratibha Sree, S., Mallikarjuna Reddy, K and Manoj Naidu, S.

01-24 Effect of different crop establishment methods and weed management practices on alkaline, acid phosphatase activity and dehydrogenase activity in rice
Ravikumar, A., Madhavi, M., Pratibha, G and Ramprakash, T.

01-25 Water productivity and yield of summer pearl millet as influenced by cultivars and integrated nutrient management
Divya, G., Vani, K. P., Surendra Babu, P and Suneetha Devi, K. B.

01-26 Evaluation of natural farming on performance of maize in comparison with inorganic and organic farming on soil properties
Vinay, G., Padmaja, B., Malla Reddy, M and Jayasree, G.

01-27 Methods and technologies to improve water use efficiency in rice
Mounica, D., Kiran Kumar, S., Venkatlakshmi, M and Triveni, U.

01-28 Crop production constraints and strategies for improvement in Godavari zone of Andhra Pradesh
Ganapathi, S., Bharathi, S., Sree Rekha, M and Jayalalitha, K.

01-29 Climate smart agriculture: prospects and adaptation
Madhurya, D., Murthy, V.R.K and Sree Rekha, M.

01-30 Trends of pulses production, consumption and import scenario in India
Pradeep Kumar, P and Dharmendra.

01-31 Crop production constraints and strategies in Krishna zone
Venkatalakshmi, M., Kiran Kumar, S., Mounica, D and Gouthami, N.

01-32 Water productivity and water use efficiency of millet based cropping systems
Nazma, S., Venkata Lakshmi, N., Chandrasekhar, K and Pratibha Sree, S.

01-33 Direct seeded rice - weed management
Aliveni, A., Sravanthi, S and Venkateshawalu, B.

01-34 Conservation agriculture- A potential alternative to sustain soil health and crop productivity.
Salomi Grace, M.

01-35 Influence of climate change on plant diseases
Ranga Rani, A., Rajan, C.P.D and Harathi, P.N.

01-36 Conservation of natural resources for sustainable agriculture-soil moisture management
Arunakumari, H and Vinaya Lakshmi, P.

01-37 Exploration of options for saving of water in low land rice
(Oryza sativa L.) –A review
Jagruti, M., Chandrasekhar, K., Lakshmi, N.V and Prathibha Sree, S.
01-38 Irrigation and nitrogen management strategies for water saving under drip irrigation in maize (Zea mays L.) - A review
Hamika, K., Chandrasekhar, K., Lakshmi, N.V and Prathibhasree, S.

01-39 Performance of rice (Oryza sativa L.) under different crop establishment methods and irrigation schedules.
Manoj Naidu S, Prasanth Mourya, G and Mallikarjuna Reddy, K.

01-40 Effect of global warming on crop production
Vasundhara, K., Neeraja, K and Dakshayani, T.

01-41 Biodiversity and its conservation
Neeraja, K., Vasundhara, K and Dakshayani, T.

01-42 Precision farming
Sai Krishna, M., Venkateswarlu, B., Prasad, P.V.N and Prasad, P.R.K.

01-43 Effects of air pollution on agricultural crops
Srikant M., Amani J and Tejdeep P.

01-44 Biodegradation of oil sludge
Srikant M., Amani J and Tejdeep P.

01-45 Factors influencing the crop growth under climate change
Smitha, P., Tripathi, S.K., Bharath Kumar, Sonu Sharma and Ravi Upadhyay

01-46 Eco friendly disposal of oil sludge through composting
Srikant M., Tejdeep P and Amani J.

01-47 Direct seeded rice as a resource conservative and cost reducing technology
Prasanth Raju, K., Radhika K and Bayyapu Reddy K.

01-48 Breeding crop varieties for organic farming: A need for food, nutritional and environmental security
Suma Varshini, P., Bayyapu Reddy, K and Radhika, K.

01-49 Economics of maize (Zea mays L.) on sequential application of herbicides
Shaik Nazreen, D., Subramanyam, D and Prathap Kumar Reddy, A

01-50 Effect of different crop establishment methods and weed management practices on alkaline, acid phosphatase activity and dehydrogenase activity in rice
Ravi Kumar, A., Madhavi, M., Pratibha, G and Ram Prakash, T.

01-51 Nonconventional weed management strategies for modern agriculture
Sanskruthi Priyadarshini, Prasad, P. V. N., Venkateswarlu, B and Prasad, P. R.K.

01-52 Nutrient and quality of quinoa influenced by dates of sowing and varied crop geometry
Ramesh, K and Suneetha Devi, K. B.

01-53 Strategies to improve the pulse production and its impact on Indian economy
Sai Kumari, G and Venkata Rao, P.

01-54 Impact of crop residue mulching on crop production – review
Rajasekar, M.

01-55 Crop residue management for enhancing opportunity income of farmers in Andhra Pradesh
Paila Harikrishna.

01-56 Spirulina–An alternate source of protein
Prasanna Lakshmi, P and Vijaya Gopal, A.

01-57 Vulnerability of climate change in Andhra Pradesh
Praveen Kumar, N.S., Radha, Y and Subba Rao, D.V.
Theme-02 Resource efficient and cost reducing technologies

02-01 Conservation agriculture through crop residue management: potentialities and constraints.
Padma, S.

02-02 Role of optical sensor based nitrogen management in field crops
Suresh Kumar, B.

02-03 Nanopedology and its applications in agriculture
Nagaraju, K and Prasad, T.N.V.K.V.

02-04 Influence of PSB - Biofertilizers on soil microbial biomass carbon in maize
Vinod Babu, S., Triveni, S., Subhash Reddy, R. and Sathyarayana, J.

02-05 Biochar: Amendment for agricultural soil management
Karthik, A and Uma Maheswari, V

02-06 Enrichment of rice with micro nutrients: biofortification of Fe and Zn
Vinod Kumar Naik, M., Lakshminarayana R Vemireddy and Saravanan, S.

02-07 Utilizing crop residues for improving nutrient availability in soils
Surya Krishna, G.K. and Giridhara Krishna, T.

02-08 Resource conservation technologies
Mandeep Singh Patel, Krishna and Alam, M.A.

02-09 Effect of organic acids on physico - chemical properties of calcareous soils
Jagga Rao, I., Ravindra Babu, P., Prasad, P.R.K and Venkata Lakshmi, N.

02-10 Effect of silver nano particles on defence related enzymes activity in rice seedlings and plant growth parameters in pot culture

02-11 Technologies to boost agriculture production in India
Vishnuvardhan, P., Areef, M., Krishna Teja I and Ramakrishna, M.

02-12 Blue green algae in sustainable agriculture and environmental management
Nagendra, D., Ashok Mourya, M and Siva Bharathi, B.

02-13 Effects of silicon in rice under biotic and abiotic stresses
Adhikari Suryakala, Radhakrishnamurty, V and Sreerekha, M.

02-14 Soil health card a tool to reduce fertilizer overuse
Mandakranta Chakraborty, Martin Luther, M and Mounika, D.

02-15 Carbon sequestration in cropping systems.
Sivaleela, S., Srinivas, M and Pulla Rao, Ch.
02-16 A brief review on performance of millet varieties to varied levels of nitrogen application across diverse rainfed ecosystems. Ramyasri, K.

02-17 Ecofriendly farm trends to conserve soil Vidhyashree Venkatarao, Ch., Goutami, N., Jagga Rao, I and Siva Nagaraju, G

02-18 Municipal solid waste management in India Amani, J., Srikanth, M and Tejadeep, P.

02-19 Effect of humic substances on nutrient uptake and dry matter production of aerobic rice (Oryza sativa L.) Eshwar, M., Srilatha, M., Bhanu Rekha, K and Harish Kumar Sharma, S.

02-20 Remote sensing- applications in agriculture Kiran, B.V.S and Murthy, V.R.K.

02-21 Water pollution: causes, effects and preventive measures Raliengoane Tebesi Peter, Tejadeep, P and Srikanth, M.

02-22 INM for enhancing nutrient use efficiency and farmer’s income Vinayak, T., Narasimha Rao, S.B.S., Murthy V.R.K and Prasad, P.R.K.

02-23 Agronomic biofortification of rice Hemasravanthi Thaninki and Radhakrishna, Y.

02-24 Zero-till maize: Nitrogen management Sravanthi, S., Aliveni, A and SreeRekha, M.

02-25 Crop residues as biochar Rentapalli Balaji

02-26 Integration of Biochar, FYM with inorganic fertilizers and its effect on soil properties and sweet corn yield Sivadevika, O., Ratna Prasad, P., Prasuna Rani, P. and Lakshmipathy, R.

02-27 Performance of sorghum hybrids under different nitrogen levels in rice-fallow conditions of North Coastal A.P. Sri Sai Siddartha Naik, B., Ramana Murthy, K.V., Ramana, A.V and Gurumurthy, P.

02-28 Sweetcorn a better option for high monetary returns Kavya, T., Venkateswarulu, B. and Prasad, P.V.N.

02-29 Performance of blackgram (Vigna mungo L.) to deficit irrigations and foliar nutrition Vijaya Lakshmi, K., Prathibha Sree, S., Venkata Lakshmi, N. and Madhu Vani, P.

02-30 Phytoremediation in saline soils Chandrakanth, A., Pramila Rani, B., Sree Rekha, M and Madhu Vani, M.

02-31 Residual effect of integrated nutrient management to succeeding rabi jowar Mounika, B., Pulla Rao, Ch., Martin Luther, M., Prasad, P.R.K and Ashoka Rani, Y.

02-32 Foliar fertilization for improving water productivity in pulses Mallikarjuna Reddy, K., Prathibha Sree, S., Prashant Mourya G and Manoj Naidu, S.

02-33 Air pollution with special emphasis on stone crushing units Tejadeep, P., Amani J and Srikanth, M.

02-34 Utilization of microorganisms for better crop production Ashok Mourya, M., Lakshmipathy, R., Vijaya Gopal, A and Nagendra, D.
<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>02-35</td>
<td>Arbuscular Mycorrhizal Fungi distribution pattern in different rice farming systems in selected agro climatic zones of Andhra Pradesh</td>
<td>Saikumar, P., Lakshmipathy, R and Vijaya Gopal, A</td>
</tr>
<tr>
<td>02-36</td>
<td>Fertilizer use pattern by the farmers in Guntur district of Andhra Pradesh</td>
<td>Shaik Mohammad Irfan and Rupa, K.V.N.S.L.</td>
</tr>
<tr>
<td>02-37</td>
<td>Phytoremediation of heavy metals in contaminated soils</td>
<td>Dakshayani, T., Vasundhara, K., Amani, J and Neeraja, K.</td>
</tr>
<tr>
<td>02-38</td>
<td>Organic farming in India</td>
<td>Giriraj Char, Priyanka and Shruti Singh</td>
</tr>
<tr>
<td>02-39</td>
<td>Conservation agriculture: A new paradigm for improving resource use efficiency</td>
<td>Vinaya Lakshmi, P and Aruna Kumari, H.</td>
</tr>
<tr>
<td>02-40</td>
<td>Potassium solubilising microorganisms for sustainable soil management</td>
<td>Goutami, N., Vidhyasree, Ch., Venkata Lakshmi, M and Deekshitha, D.K.D.</td>
</tr>
<tr>
<td>02-41</td>
<td>Organic manuring in grape vine cultivation in Maharashtra - An economic analysis</td>
<td>Wälke Shivaji, S., Munikanth, K and Sushmitha Reddy, Ch.</td>
</tr>
<tr>
<td>02-42</td>
<td>Soil acidifiers and chelates – A way to ameliorate lime induced micronutrient deficiency in crop production</td>
<td>Sai Bhargavi, N.V.L., Prasad P.R.K and Rajyalakshmi, B.</td>
</tr>
<tr>
<td>02-43</td>
<td>PGPR characteristics of Pseudomonas fluorescens isolated from Rhizospheric soils of Telangana</td>
<td>Biyyani Suman, Vijaya Gopal, A and Triveni, S.</td>
</tr>
<tr>
<td>02-44</td>
<td>Antagonistic activity of Pseudomonas fluorescens against sheath blight of rice.</td>
<td>Biyyani Suman, Vijaya Gopal, A and Triveni, S.</td>
</tr>
<tr>
<td>02-45</td>
<td>Use of industrial waste water for agricultural purpose</td>
<td>Heenakausar, P and Sandhya Rani, P.</td>
</tr>
<tr>
<td>02-46</td>
<td>Isolation and characterization of PGPR isolated from saline soils of Telangana</td>
<td>Biyyani Suman and Triveni, S.</td>
</tr>
<tr>
<td>02-47</td>
<td>Climate- smart agriculture through soil management practices</td>
<td>Deepika, J and Sudha Rani, Y.</td>
</tr>
<tr>
<td>02-48</td>
<td>Use of crop residue biochar for enhancing soil health and mitigation of climate change</td>
<td>Gowthami, B., Gurumurthy, P and Sujani Rao, Ch.</td>
</tr>
<tr>
<td>02-49</td>
<td>Suppressive composts in promoting plant growth and supressing diseases</td>
<td>Divyamani, V and Prasanna Kumari, V</td>
</tr>
<tr>
<td>02-50</td>
<td>Integrated phosphorus management in blackgram</td>
<td>Charishma, N and Kavya, T.</td>
</tr>
<tr>
<td>02-51</td>
<td>Micronutrient seed priming- an effective way to reduce the cost of fertilizers</td>
<td>Vijaya Durga, P.</td>
</tr>
<tr>
<td>02-52</td>
<td>Eco-friendly and climate smart vermi-compost technology with cotton stalks</td>
<td>Madhuravani, G.S., Lalita Kumari, A., Ramachandra Rao, G and Narasimha Rao, K.L.</td>
</tr>
<tr>
<td>02-53</td>
<td>Soil Informatics – As a tool for land evaluation</td>
<td>Raghu, R. S.</td>
</tr>
</tbody>
</table>

vi
### Theme-03 Crop Improvement and Management for Biotic and Abiotic Stresses

<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-01</td>
<td>Plant hormesis management: A novel tool to enhance plant performance</td>
<td>Sandhya, M and Ramana, J. V.</td>
</tr>
<tr>
<td>03-02</td>
<td>Necessity of introgressing biotic and abiotic stress resistant genes in existing cultivars for future crop improvement programmes</td>
<td>Virender Jeet Singh, T and Gaurishankar, V.</td>
</tr>
<tr>
<td>03-03</td>
<td>Genetic diversity and population structure of a diverse set of rice germplasm for association mapping</td>
<td>Swarajya Lakshmi Bollineni, Jeevul, N.B., Eswar, G and Laksmi Narayana Reddy, V</td>
</tr>
<tr>
<td>03-04</td>
<td>Flow cytometric analysis for identification of induced ploidy level in Bajra Napier hybrid.</td>
<td>Swathi Lekkala and Babu, C.</td>
</tr>
<tr>
<td>03-06</td>
<td>Morphological and reproductive characters of pulse bruchid, Callosobruchus maculatus (Linnaeus) due to nano based botanical seed protectants</td>
<td>Mounica, D and Natarajan, N.</td>
</tr>
<tr>
<td>03-07</td>
<td>Marker assisted selection for phosphorus deficiency in rice</td>
<td>Kavitha, G.</td>
</tr>
<tr>
<td>03-08</td>
<td>New era in gene editing CRISPER- Cas9 &amp; its utilization in crop improvement</td>
<td>Kavya, P., Satyanarayana Rao, V and Shruti, K.</td>
</tr>
<tr>
<td>03-09</td>
<td>Genetic diversity analysis in maize (Zea mays L.) inbreds using Mahalanobis D² Analysis</td>
<td>Mounika, K., Lal Ahamed, M., Vijaya Lakshmi, B and Shaik Nafeez Umar</td>
</tr>
<tr>
<td>03-10</td>
<td>Various approaches for developing resistant varieties for yellow stem borer in rice</td>
<td>Nagamallikadevi, M., Shilpa, M.N and Bhargavaramireddy, Ch.</td>
</tr>
<tr>
<td>03-11</td>
<td>Push pull strategy for stem borers management in maize</td>
<td>Ravi Kumar, V and Madhumati, T.</td>
</tr>
<tr>
<td>03-12</td>
<td>In vitro rearing of tobacco caterpillar, Spodoptera litura (Fabricius)</td>
<td>Pattapu Sreelakshmi and Thomas Biju Mathew</td>
</tr>
<tr>
<td>03-13</td>
<td>Genome editing for crop disease resistance</td>
<td>Sandhya, Y., Padmodaya, B and Ranga Rani, A.</td>
</tr>
<tr>
<td>03-14</td>
<td>Poty virus the severe threat on crop plants</td>
<td>Saratbabu, K., Sayirprathap, R. B., Ganesh, T and Mahendra, K.</td>
</tr>
<tr>
<td>03-15</td>
<td>Screening of rice genotypes – A multivariate approach</td>
<td>Chinni, D., Shaik Nafeez Umar, Srinivasa Rao, V and Venkata Krishna, V.</td>
</tr>
<tr>
<td>03-16</td>
<td>Screening of various groundnut genotypes for their reaction to groundnut leaf miner</td>
<td>Peeru saheb, Y.,Hari Prasad, K.V.,Swarajya Lakshmi,K and Sailaja Rani, J.</td>
</tr>
<tr>
<td>03-17</td>
<td>Efficacy of insecticides in management of brown plant hopper</td>
<td>Ambati Gouri Harishchandra Prasad</td>
</tr>
</tbody>
</table>

*Note: The sessions are numbered from 03-01 to 03-17.*
03-18 Effect of elevated CO$_2$ on feeding preference and performance of beet armyworm, *spodoptera exigua* (Noctuidae: *Lepidoptera*) on chickpea Divya Bharathi, T., Krishnayya, P. V and Srinivasa Rao, M

03-19 Standardization of lethal dose of gamma radiation and its effect on growth and flowering of tuberose variety ‘Hyderabad single’ Sai Ratna Sharavan, Ch., Swarajya Lakshmi Kode, Tanuja Priya, B., Usha Bharathi, T., Ruth, Ch and Reddi Sekhar, M.

03-20 *In vitro* evaluation of confrontation assay of different isolates of *Trichoderma* spp. against *Sorosporium paspalithunbergii* causing head smut disease of kodo. Jahaar Singh, Ashish Kumar, Jain, A. K and Tripathi, S. K.

03-21 Improvement of vegetables for heat tolerance Vara prasad, N and Pratyusha, P.


03-23 Occurrence of fungal foliar diseases of blackgram in Guntur district of A.P. Reddi Gunasri, Manoj Kumar,V., Prasanna Kumari,V., Sreekantha, B and Sairam Kumar, D.V.


03-25 Bioefficacy of new insecticidal molecules against sucking pests of okra Hemadri, T. and Vijaykumar, L.

03-26 Importance of refuge plants for natural pest control in maize crop Ravi Kumar, V.


03-28 Development of *in vitro* technique to screen for drought stress tolerance in (*Musa acuminate* AAA, grand nain) by peg induced osmotic stress Viswanath, M.

03-29 Host plant responses to insect oviposition Neethu Natarajan, Pranyusha, B and Chenmarao, P.

03-30 Effect of micro nutrients on urdbean leaf crinkles disease Usha Rani, L., Manoj Kumar,V., Anil Kumar,P., Prasanna Kumari,V., Bhavani G and Sandhya Rani, C.

03-31 Current scenario in global climate changes and its effect on efficacy of insecticides Deekshita, K., Krishnayya, P.V., Srinivasa Rao, M., Anil Kumar, P and Shaik Nafeez umar

03-32 Seasonal incidence and insecticidal management of major insect pests of grain legumes - Indian perspective Swathi Kolli

03-33 Seasonal incidence and insecticidal management of diamondback moth (*Plutella xylostella* L.) on cabbage and cauliflower Gudivada Harika,

03-34 Impact of climate change on insect pests Lochala Sangeetha
<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-35</td>
<td>Citrus tristeza virus and haunglongbing (citrus greening) two major biotic threats to citriculture.</td>
<td>Ganesh, T., Saratbabu, K., Mahendra, K and Lakshmi Narayana, U.</td>
</tr>
<tr>
<td>03-36</td>
<td>Genetically modified crops and its economic, nutritional, environmental importance in Indian perspective</td>
<td>Nayak, B. B., Bharathi, S., Sree Rekha, M and Jayalalitha, K.</td>
</tr>
<tr>
<td>03-39</td>
<td>Physiological genetical and molecular basis for salt tolerance in rice (Oryza sativa L.)</td>
<td>Somla Naik, R., Umamahesh, V., Lora Anusha, P and Mrudula, G.</td>
</tr>
<tr>
<td>03-40</td>
<td>Compatibility of pesticide mixtures - An effective way of management of crop pests</td>
<td>Anil Kumar, K., Madhumathi, T., Sarma, A. S. R., Sai Ram Kumar, D.V., Chiranjeevi, Ch and Prasanna Kumari, V.</td>
</tr>
<tr>
<td>03-41</td>
<td>Genetic improvement of bio-control agents and their use in integrated pest management</td>
<td>Anil Kumar, K and Prashanthi, P.</td>
</tr>
<tr>
<td>03-42</td>
<td>Heterosis and combining ability studies for yield and yield components in rice</td>
<td>Sudeepthi, K., Jyothula.,D.P.B and Suneetha, Y.</td>
</tr>
<tr>
<td>03-43</td>
<td>Effect of climatic extremes on polyphagous caterpillars in cotton</td>
<td>Sravan Kumar, D. V and Krishnayya, P. V.</td>
</tr>
<tr>
<td>03-44</td>
<td>Improved human nutrition by biofortified crops</td>
<td>Govada Venkateswara Rao and Deepak Sharma</td>
</tr>
<tr>
<td>03-45</td>
<td>Biotin binding proteins – An eco-friendly method of crop improvement by management of biotic stress</td>
<td>Pranyusha, B., Madhumathi, T., Krishnayya, P.V and Manoj Kumar, V.</td>
</tr>
<tr>
<td>03-46</td>
<td>Diversity for yield and biochemical traits in Italian millet (Setaria italica (L.) P. Beauv) elite germplasm</td>
<td>Kavya, P., Sujatha, M., Pandravada, S.R and Hymavathi, T.V.</td>
</tr>
<tr>
<td>03-47</td>
<td>RNA interference technology for crop improvement</td>
<td>Swarajya Lakshmi, B., Padma, V., Ramana, J.V., Satish, Y and Lal Ahamed Mohammed</td>
</tr>
<tr>
<td>03-48</td>
<td>Evaluation of phenylpyrazole group insecticides against Scirpophaga incertulas (Walker) in rice</td>
<td>Paidi Satyanarayana, Raghuroman, M and Santeshwari</td>
</tr>
<tr>
<td>03-49</td>
<td>Strategies for development of biotic and abiotic stress resistant/tolerant genotypes for profitable agriculture</td>
<td>Manorama, K., Pavani, K, Ramana, J.V and Ramana, M.V.</td>
</tr>
<tr>
<td>03-50</td>
<td>Molecular markers: a tool for diversity studies in sesame</td>
<td>Pavani, K., Manorama, K., Lal Ahamed M., Ramana, J.V and Sirisha, A.B.M.</td>
</tr>
<tr>
<td>03-51</td>
<td>Detection of seedborne mycoflora of groundnut (Arachis hypogaeae L.)</td>
<td>Srinivas, A., Pushpvathi, B.K.M., Lakshmi, B and Shashibhushan, V.</td>
</tr>
<tr>
<td>03-52</td>
<td>Bacteriophages in plant disease control</td>
<td>Siva Bharathi, B and Lakshmipathy, R.</td>
</tr>
</tbody>
</table>
03-53 Morphological characterization of cotton genotypes for DUS characters
Anjani, A., Padma, V., Ramana, J.V and Satish, Y.

03-54 Comparative evaluation of different indigenous and exogenous barley
(Hordeum vulgare L.) genotypes for terminal heat tolerance.
Bantho Vinesh and Prasad, L. C.

03-55 Physiological and molecular analyses of drought tolerance responses in amaranthus
(Amaranthus tricolor L.) under elevated carbon dioxide environments.
Dheeraj Chatti and Manju R.V

03-56 Seed protection with natural pesticides against storage pests
Kavitha, G., Sesha Mahalakshmi, M., Radhika, K and Bayyapu Reddy, K.

03-57 Management of seed borne diseases using bio-control agents
Lakshmi Pravalli, P., Bhattiprolu, S.L and Radhika, K.

03-58 Isolation of cellulase-producing bacteria and characterization of the cellulase
from the isolated bacterium
Prasanna Kumar, B., Triveni, S., Subhash Reddy, R and Vijaya Gopal, A.

03-59 Genotyping platforms and high throughput SNP chips for crop improvement
Sri Vidy, G. K., Amaravathi, Y., Eswara Reddy, N.P and Vasanthi, R. P.

03-60 Strategies for the development of biotic and abiotic stress resistant crops in
changing climatic conditions
Ajitha, V., Mamatha, P and Usha, G.

03-61 Biochemical changes in okra due to infection with Cercospora abelmoschii
Amulya, G., Prasanna Kumari, V., Anil Kumar, P and Manoj Kumar, V.

03-62 Seed drying using silica gel and aluminium silicate (zeolite) beads
Aiswarya, N., Bhattiprolu, S.L and Bayyapu Reddy, K.

03-63 Bioefficacy of new molecules against aphids on okra
Srinivas Kumar, D. V and Meena, R. S.

03-64 Study of parental polymorphism in oil palm (Elaeis guineensis Jacq.)
using SSR markers.
Ramaraju, B.R.V., Ramana, J.V and Kalyana Babu, B.

03-65 A review on biological control of postharvest diseases
Eden Georgia, K., Anil Kumar, P and Manoj Kumar, V.

03-66 Characterization of Sclerotium rolfsii isolates causing collar rot in Chickpea
Srividya, P.V., Lal Ahamed, M., Ramana, J.V and Khayyum Ahammed, S

03-67 An essential biotechnological procedure- Transgenic breeding
Archana, R.S and Sudha Rani, M.

03-68 Transmission and control of plant virus through interfering with vector transmission
Sayiprathap, B.R., Korla Sarathbabu, Ambarish, K.V., Girish, B.R. and Ramachandra, V.

03-69 Modernization in plant breeding approaches for improving biotic stress
resistance in crop plants
Deepika Sahu

03-70 Genome editing for crop improvement
Amarnath, K and Durga Prasad, A.V.S.

03-71 Physiological interventions to enhance drought tolerance in black gram
Mikhina, M.S and Sandhya Rani, P.
Isolation and screening of bacterial antagonists against *Sclerotium* sp. inciting collar rot in brinjal
Bhanothu Shiva, Deepa Khulbe and Srinivas, P.

Genetically modified crops and its economic, nutritional, environmental importance in Indian perspective
Nayak, B. B., Bharathi, S., Sree Rekha, M and Jayalalitha, K.

Eco-friendly management of banded leaf and sheath blight of little millet (*Panicum sumatrense*) caused by *Rhizoctonia solani* Kuhn
Bahrat Kumar, Jain, A. K., Tripathi, S.K., Sonu Sharma and Smita Prajapati

Screening of PGPR microorganisms from the soil
Hari Priya, V and Jayanthi Abraham

Indices for screening of drought tolerance in maize (*Zea mays* L.)
Dinesh Rahul, V., Rama Rao, G., Jayalalitha, K., Ashoka Rani, Y and Hareesh Babu, P.

Comparative efficacy of newer insecticide molecules against brown planthopper, *Nilaparvata lugens* Stal.
Deekshita, K., Rama Rao, C.V., Sandhya Rani, C and Prasanna Kumar, V.

Detection of seed borne mycoflora of groundnut (*Arachis hypogaeae* L.)
Srinivas, A., Pushpavathi, B., Lakshmi, B.K.M and Shashibushan, V.

Correlation and path analysis studies of grain yield, yield attributes and quality traits of ratooning in rice (*Oryza sativa* L.).
Hari Ram Kumar Bandi, Satyanarayana, P.V., Ratna Babu, D., Srinivasa Rao, V., Chamundeswari, N and Krishnam Raju, S.

Effect of milk and milk products on blackgram powdery mildew
Manasa, P. and Anil Kumar, P.

Screening of germplasam against alternaria leaf spot of blackgam
Ambarish, K.V., Adhinarayana, M and Anil Kumar, P.

Nanotechnology and its applications in agriculture
Deekshitha, D.K.D., Raj Rushi, V.S.L and Gouthami, N.

Effect of gamma radiation on seed mycoflora and seed quality parameters of groundnut at different storage periods
Srinivas, A., Pushpavathi, B., Lakshmi, B.K.M and Shashibushan, V.

Nano technology – A boon for plant disease management
Sumanth Kumar, M., Prasanna Kumari, V and Anil Kumar, P.

Next generation techniques in plant breeding principles and prospects
Ayesha, Md., Ratna Babu, D., Satyanarayana Rao, V and Dayal Prasad Babu, J.

SPLAT- an effective method of pheromone dispersion for the management of pests
Prashanthi, P., Anil Kumar, K and Debjyoti Chakraborty.

Efficacy of fungicide on sheath blight severity (lesion length) of rice
Ashok Kumar Koshariya, Indra Kumar, Anil S. Kotasthane and Toshy Agrawal

**Theme-04  Farm Mechanization and Post Harvest Technologies to Enhance Farm Profitability**

Advances in farm mechanization and post harvest management for improving productivity of Indian agriculture
Venkata S. P. Bitra
<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>04-01</td>
<td>Perceptual mapping of tractors - A correspondence analysis approach</td>
<td>Bindu Madhavi, N., Nafeez Umar, Sk., Srinivasa Rao, V and Ramesh, D.</td>
</tr>
<tr>
<td>04-02</td>
<td>Utilization and evaluation of drumstick leaves (<em>Moringa oleifera</em>) as</td>
<td>Navaneetha, Y. Lakshmi, J and Lakshmi, K.</td>
</tr>
<tr>
<td></td>
<td>a functional food ingredient in biscuit preparation</td>
<td></td>
</tr>
<tr>
<td>04-03</td>
<td>Application of drones in agriculture</td>
<td>Sameer, Sk., Srinivasulu, K., Prasad, P.V.N. and Prasuna Rani, P.</td>
</tr>
<tr>
<td>04-04</td>
<td>Robotics - New trend for agriculture: A real fleet of robots</td>
<td>Sreenivasreddy, K., Pullarao, Ch., Martin Luther, M and Ramakrishna Prasad, P.</td>
</tr>
<tr>
<td>04-05</td>
<td>Mechanical harvesting in chickpea (<em>Cicer arietinum</em> L.) for higher productivity</td>
<td>Sabeeha Sultana, Sd. and Venkata Rao, P.</td>
</tr>
<tr>
<td>04-06</td>
<td>Farm mechanization and enhancing resource use efficiency by adoption new</td>
<td>Reddamma, K., Ashok Naik, M., Srinivasa Reddy, M. Bhaskar Reddy, U.V and Ramesh Babu, P.V.</td>
</tr>
<tr>
<td></td>
<td>technologies to reduce the post-harvest losses</td>
<td></td>
</tr>
<tr>
<td>04-07</td>
<td>Prospects of mechanization in rice cultivation</td>
<td>Sanjana, G</td>
</tr>
<tr>
<td>04-08</td>
<td>Impact of mechanization on high density planting system in cotton</td>
<td>Uma Maheswari, M and Karthik, A.</td>
</tr>
<tr>
<td>04-09</td>
<td>Enhancement of productivity through mechanization and post harvest technologies</td>
<td>Divya, K., Naipunya, J and Areef, M.</td>
</tr>
<tr>
<td>04-10</td>
<td>Post harvest technologies</td>
<td>Krishna,M.A. Alam, Dharmendra and Umashankar Kaushik</td>
</tr>
<tr>
<td>04-11</td>
<td>Post harvest technologies to enhance farm profitability in fruit crops</td>
<td>Antony Prajwala, K.</td>
</tr>
<tr>
<td>04-12</td>
<td>Food-based nutrition interventions and food-based strategies</td>
<td>Mahesh, M.</td>
</tr>
<tr>
<td>04-13</td>
<td>Farm mechanization through custom hiring centres for small and marginal farmers</td>
<td>Jhansi,Y and Sunanda, N.</td>
</tr>
<tr>
<td>04-14</td>
<td>Farm mechanization and post harvest technologies to enhance farm profitability</td>
<td>Amrutha, S.</td>
</tr>
<tr>
<td>04-15</td>
<td>Use of mechanization and its impact on agriculture</td>
<td>Sowjanya, A and Pulla Rao, Ch.</td>
</tr>
<tr>
<td>04-16</td>
<td>Post harvest technology in vegetables</td>
<td>Pratyusha, P and Vara Prasad, N.</td>
</tr>
<tr>
<td>04-17</td>
<td>Enhancement of farm efficiency through value addition of agricultural produce;</td>
<td>Sridevi, P and Vijaya Bhaskar, V.</td>
</tr>
<tr>
<td></td>
<td>An evergreen technology for profit making</td>
<td></td>
</tr>
<tr>
<td>04-18</td>
<td>Improving the crock fastness of the annato natural dye with eco-friendly dye leveling agents on cotton</td>
<td>Prabhavathi, R.</td>
</tr>
<tr>
<td>04-19</td>
<td>Value addition: An approach to enhance farm profitability</td>
<td>Dhruva Shukla and Santosh Shivran</td>
</tr>
</tbody>
</table>
## Theme-05 Extension Strategies Including E-initiatives Towards Farmers Prosperity

<table>
<thead>
<tr>
<th>Title</th>
<th>Authors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Powering disruption in the extension advisory services</td>
<td>Shaik N. Meera</td>
<td>202</td>
</tr>
<tr>
<td>ICT initiatives related to agricultural marketing in India- A content analysis.</td>
<td>Bhavani, G and Bhuvana, N.</td>
<td>211</td>
</tr>
<tr>
<td>Extension approaches and policy issues for rural development in India</td>
<td>Naipunya, J. and Divya, K.</td>
<td>211</td>
</tr>
<tr>
<td>Farmer producer organisations – A tool for the welfare of farmers</td>
<td>Vedasri, R and Uma Devi, K.</td>
<td>214</td>
</tr>
<tr>
<td>Perception on online cocoon trading system among sericulture farmers in Kolar district of Karnataka</td>
<td>Harisha, N and Chinmayi, V.</td>
<td>214</td>
</tr>
<tr>
<td>Farmers’ problems with reference to fertilizers use in Chittoor district of A.P</td>
<td>Sudheer Varma, A and Sreemanth, M.V.</td>
<td>216</td>
</tr>
<tr>
<td>Strategies to enhance marketing of agricultural produce through electronic national agriculture market (E-NAM)</td>
<td>Pruthvi Kumar, K., Rohindra Kumar, M and Rafi, D.</td>
<td>216</td>
</tr>
<tr>
<td>Digital green –participatory videos and mediated instruction for agricultural development</td>
<td>Kishore Kumar, N., Jaswanth Naik, B and Srinivasrao, M.</td>
<td>217</td>
</tr>
<tr>
<td>Digital innovations for transfer of technology among small and marginal farmers –An extension prospective</td>
<td>Venkata Reddy, L., Gopi Krishna, T., Harisha, N and Archana, K.</td>
<td>218</td>
</tr>
<tr>
<td>Climate change: Impact on ecology and economy</td>
<td>Mahalakshmi, S. M and Vinoda Shankara Naiyk</td>
<td>219</td>
</tr>
<tr>
<td>Utilisation of social media by professional graduate students</td>
<td>Swathi ,A.</td>
<td>220</td>
</tr>
<tr>
<td>Digital agriculture: Pathway to prosperity</td>
<td>Saikumar, R., Prasad, P.V.N and Lakshman, K.</td>
<td>220</td>
</tr>
<tr>
<td>Information and communication technology - A boon for farmers</td>
<td>Vysali, K., Ram Babu, P., Mukunda Rao, B and Gopi Krishna, T.</td>
<td>221</td>
</tr>
<tr>
<td>Extension strategies for promotion of millets for sustainable development and future food security in Karnataka</td>
<td>Harisha, N., Chinmayi, V., Venkata Reddy and Archana, K.</td>
<td>222</td>
</tr>
<tr>
<td>Perception of the farmers about eco-friendly farming in Rewa district (M.P)</td>
<td>Rakhi Kori</td>
<td>223</td>
</tr>
<tr>
<td>Empowerment of farmers through the use of ICT</td>
<td>Uday Bhaskar, M., Srinivasa Rao, M and Gopi Krishna, T.</td>
<td>223</td>
</tr>
<tr>
<td>Farmer perception towards Pradhan Mantri Fasal Beema Yojana</td>
<td>Soni Verma</td>
<td>224</td>
</tr>
</tbody>
</table>
Awareness about kisan call centres among the farming community
Meena, D., Archana, K and Srinivasa Rao, H.

A statistical study on arrivals and prices of paddy in Chhattisgarh state
Chowa Ram Sahu, Mohan Naidu, G. and Lakhera, M.L.

**Theme-06 Agri-preneurial Interventions for Food and Nutritional Security**

Transforming value chains for food and nutrition security
N. Chandrasekhara Rao

Efficiency of national agricultural insurance scheme–A DEA analysis
Ajith, S., Srinivasa Rao, V., Nafeez Umar, Sk and Krishna, V. V.

Forecasting of arrivals and prices of chickpea in Chhattisgarh

A study of forecasting onion prices in India
Venkata Viswa Teja, B., Srinivasa Rao, V., Ramesh, D and Venkata Krishna, V.

Agri-entrepreneurship for development of sustainable agriculture development
Venkata Reddy, I., Bhavani,G., Archana, K., Harisha, Nand Gopi Krishna, T.

A study on mega food parks in India
Sushmitha Reddy, Ch., Rupa, K.V.N.S.L and Suneesha, G.

Price discovery in basmati rice
Anil Kumar Reddy and Phani Vardhan, J.

Value addition: An ever green technology in agriculture for profit making
Rafi, A., Kandeebun, M and Pruthvi Kumar, K.

Agribusiness incubation: An effective intervention for promoting agripreneurship among rural areas in India
Rohindra Kumar, M., Bhavani Devi, I and Chalam, G.V.

Comparative economics of direct sown paddy vis a vis transplanted paddy
Archana, K., Saidhar, R and Srinivasa Rao, H.

Youth as social entrepreneurs in achieving food to nutritional security
Uday Bhaskar, M., Srinivasa Rao, M and Gopi Krishna, T.

Resource use levels of farmers in Wanaparthy, Gadwal, Mahboobnagar districts of Telangana
Rafi, D., Pruthvi Kumar, K., Kandeeban, M and Rohendra Kumar, M.

Impact of climate on productivity of agricultural crops and resource allocation for cost minimisation
Areef, M., Vishnuvardhan, P and Divya, K.

Development of value-added fruit cake with germinated sorghum flour and whole wheat flour
Soumya, P., Lakshmi, J and Lakshmi, K.

Development of value added ready-to-cook breakfast millets
Anusha, T., Lakshmi, J and Lakshmi, K.

Thought of open equitable global food system in agribusiness for food security
Bhavani, G.

Agri-preneurial interventions for food and nutritional security.
Shwetha Soju and Radha, Y.

Foreign direct investment
Sanskala Patel
Theme – 1
Eco-friendly and Climate Smart Agriculture
ECO-FRIENDLY AND CLIMATE SMART AGRICULTURE: WATER MANAGEMENT PERSPECTIVE

P. S. Brahmanand, Principal Scientist (Agronomy)
ICAR-Indian Institute of Water Management, Bhubaneswar, India

One of the major challenges faced by Indian agriculture is in the form of climate induced natural disasters which pose severe threat to national food security. The diminishing water resources in agriculture coupled with ever increasing human population further intensifies the challenge to achieve food security in India. Though the food grain production of India was pegged at 275.1 M ha during 2016-17, the fulfillment of projected target during 2025 and 2050 would be a challenging task in the context of declining water resources. Extreme climatic events have been witnessed at higher frequency now. This necessitates us to minimize the damage to agricultural sector in the backdrop of changed climate and to develop or enhance climatic resilience. We need to promote adaptive capacities and the mitigation of climate change and work towards disaster risk reduction. Eco-friendly and climate smart agriculture (CSA) is the solution for this scenario.

Climate-smart agriculture may be defined as an approach for making necessary transformation and reorientation in agricultural development keeping in consideration of the new realities of climate change (Lipper et al. 2014). As per the Food and Agricultural Organization of the United Nations (FAO), CSA may be defined as “agriculture which aims at sustainably increasing productivity, enhancing resilience (adaptation) and reducing / removing green house gas emissions (mitigation) which in turn would facilitate achievement of national food security and development goals” (FAO 2013). The resilience capacity of the community reduces the proportion of vulnerability of the community (UNESCO-IHE, 2009). The positive role of both mitigation and adaptation of climate change impacts in reducing the yield losses is significant (Adger, N., & Kelly, M. (1999). Resilient agricultural system may be defined as a combination of different agricultural practices that provide better resistance and adaptability to different crops when exposed to various natural disasters such as floods and drought. It is a known fact that the natural disasters cannot be stopped, but at the same time, we can improve the level of preparedness to face such disasters.

Water is one of the key inputs for agricultural productivity and its timely and adequate supply is directly proportionate with the economic produce. However, its supply / availability is negatively influenced due to climate change. Owing to extreme events, the crops are subjected to either excess water stress or deficit water stress (Brahmanand et al., 2013). In terms of magnitude, drought events are on increasing trend and we have to plan for integrated water resource management plan for combating the negative effects of climate change. As water is becoming a limiting factor for crop production, soil and water management should be the key to the development of eco-friendly and climate smart agriculture for both irrigated as well as rainfed areas. The rainfed ecosystems contribute about 58% of world cereal production and hence water management in these areas is essential for sustaining the food production. This holds more relevance in view of shrinking per capita land and water resources under the backdrop of climate change. This necessitates us to critically analyze the existing water resources of India, sector wise water demand and prioritization and wide scale adoption of innovative water management techniques and integrating them in to water management policy interventions or schemes such as Pradhan Mantri Krishi Sinchayee Yojana (PMKSY).

Water resources scenario in India

Owing to increasing demand of water for sectors like domestic, industrial and energy, there is a severe constraint in the availability of water for irrigation sector / farming. It has been assessed that the utilisable water is 1123 BCM (690 BCM from surface 433 BCM ground water) only, which accounts to about 28% of the water derived from precipitation. Annual groundwater recharge is about 433 BCM, of which 212.5 BCM is used for irrigation. Out of net sown area of about 141.4 million ha, the net irrigated area in India as on 2013-14 is 68.1 million ha (48.2% of net sown area). The remaining 73.3
million ha area is under rainfed condition (51.8% of net sown area). The net irrigated area through canals, tanks and wells is 16.28 million ha, 1.84 million ha, 42.44 million ha respectively as on 2013-14. The area irrigated through other sources is 7.54 million ha. Similarly, the gross irrigated area of the country is 95.8 million ha is 47.7% of the total cropped area.

The 2030 Water Resources Group assesses that about half of the demand for water will be unmet by 2030 if the current pattern of demand continues. The per capita per year availability of water resources of India has been declining from 5176 m³ in 1951 to 1703.6 m³ in 2007 and it is expected to decline to 1140 m³ by 2050. The availability of water for agriculture in India is expected to decline from 84% in 2010 to 74% by 2050. Even within agriculture, the water demand for different subsectors or farming systems will change significantly in the coming years. The enhanced water demand in domestic, industrial and energy sectors will need additional 222 BCM water by 2050 (Table 1).

Table 1: Sector wise projected water demand in India

<table>
<thead>
<tr>
<th>Sector/Year</th>
<th>2000</th>
<th>2010</th>
<th>2025</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation</td>
<td>541</td>
<td>688</td>
<td>910</td>
<td>1072</td>
</tr>
<tr>
<td>Domestic</td>
<td>42</td>
<td>56</td>
<td>73</td>
<td>102</td>
</tr>
<tr>
<td>Industry</td>
<td>8</td>
<td>12</td>
<td>23</td>
<td>63</td>
</tr>
<tr>
<td>Energy</td>
<td>2</td>
<td>5</td>
<td>15</td>
<td>130</td>
</tr>
<tr>
<td>Others</td>
<td>41</td>
<td>52</td>
<td>72</td>
<td>80</td>
</tr>
<tr>
<td>Total</td>
<td>634</td>
<td>813</td>
<td>1093</td>
<td>1447</td>
</tr>
</tbody>
</table>

(Source: Central Water Commission, 2010)

Low water use efficiency and poor maintenance of irrigation systems are some of the major problems while managing the water resources in the country. Under the scenario of producing 350 million tonnes food grain from shrinking water resources, this will put tremendous pressure on the existing water sources. This challenge can be met by enhancing irrigation efficiency and water productivity under eco-friendly and climate smart agriculture. Keeping these points in view, there is a strong need to focus on climate resilient improved/advanced/innovative water management techniques and supporting policies.

Climate resilient innovative water management interventions

ICAR-flexi rubber dams for watersheds

The installation of rubber dams in watersheds act as better drought resilience structure and it will significantly help in additional water storage, crop productivity and net economic returns to the farmers (Jena and Brahmanand, 2014). This technology has potential to create an additional water storage capacity of about 52,000 to 80,000 m³ for irrigating about 30-40 ha of paddy in kharif and 6 ha of pulses, oilseeds and vegetable crops in rabi season. In rubber dam command the productivity of rice in kharif season enhanced up to 62% and in rabi season productivity of vegetables increased up to 47% due to installation of rubber dams in watersheds. It has potential to enhance the net returns of the farmers up to Rs.48,000/ha (2013 prices).

Design of tank cum well system in watersheds in rainfed areas

The tank cum well system technology along the drainage line in a watershed is recommended for plateau areas having slope of 2 to 5% (Roy Chowdhury et al., 2016). The site for the technology should be selected in such a way that the area should have a well defined valley where the runoff flows either as overland flow or channel flow. The well is constructed about 100 to 300 m downstream of the tank to tap the water that is lost by seepage from the tank. A set of 15 tanks and wells is required for a catchment area of 500 ha to irrigate 60 ha area. The technology has a potential
Micro tube wells in coastal areas having saline groundwater below 10 M

The existing technology of exploiting groundwater through shallow/deep tube wells will lead to draw water from saline aquifers in coastal areas especially those very near to sea within 2-5 km away from coastline. Therefore to provide irrigation to small farm holdings mainly during rabi season or at critical stage during long dry spell even in kharif season, strategically designed tube well is necessary. The technology has potential to generate Rs. 8,000/- extra gross income/year with additional employment generation of 50 man days/ha. It can provide assured irrigation for growing paddy in 1 ha of land and increase in yield from 1.5 to 2 t/ha.

Rainwater conservation through increased dyke height

The bund height of 6 cm can store up to 57% of the rainwater whereas bund height of 30 cm could store as much as 99% of the rainwater. The technology is applicable in rice growing areas vulnerable to moisture stress during critical growth stage of the crop.

Adjustment in planting/sowing time and crop diversification

Advancement of planting time of some crops will help in efficient utilization of soil moisture and it will also avoid drought during reproductive or flowering phase resulting in minimization of yield loss. At the same time, spraying Potassium chloride @ 2% and boron @ 0.1% would provide better drought resistance in crops like blackgram. Crop diversification from rice to maize, groundnut-pigeon pea, sole groundnut and sole pigeon pea in drought prone area would be beneficial for farmers in the changing climate scenario.

Conservation agricultural practices for better drought resilience

In-situ moisture conservation measures such as zero tillage, mulching and residue incorporation play vital role in drought management. Zero tillage was found to enhance the economic yield of crops such as okra, sunflower and bittergourd up to 15% compared to conventional tillage in addition to significant moisture saving.

Secondary (auxiliary) reservoir in irrigation commands

The creation of secondary (auxiliary reservoir) also has a vital role in enhancing the cropping intensity, crop productivity and net returns of the farmers in drought prone minor irrigation commands (Mishra et al., 2013).

Drought resistant crops and varieties

The practice of cultivation of drought resistant varieties of rice, pulses and oilseeds would provide drought resilience thereby enhancing water use efficiency. Drought resistant short duration rice varieties such as Heera and Sneha, groundnut variety ‘smruti’ and greengram varieties ‘PDM-54’ and ‘Sujatha’ are found suitable for East coast Plains and Hills region (Agro-climatic region XI).

Flood resistant/tolerant rice varieties

Flash floods are frequently witnessed due to heavy rains with in short period resulting in huge crop loss. The flash flood tolerant rice varieties such as Swarna Sub-1 should be used by the farmers to reduce the yield loss under such conditions.

Over-aged rice seedlings

ICAR-Indian Institute of Water Management, Bhubaneswar developed a flood resilient mechanism in the form of over aged seedlings of 60 days old which has provided an yield advantage of about 32% over the normal seedlings (30 days old) and most importantly this practice has helped successful establishment of seedlings in flood prone areas (Roy Chowdhury et al., 2011).

Flood resistant aquatic crops with economic importance

In areas of perennial waterlogging where even rice cultivation is difficult, ICAR-Indian Institute of Water Management, Bhubaneswar has standardized a technique for cultivation of aquatic crops with economic importance such as water
chestnut (Roy Chowdhury et al., 2016). It was revealed that water chestnut either as sole crop or with fish which has potential to provide net income of farmers by Rs.33,000/ha.

Contingency crop planning and post flood management

Contingency crop planning helps in providing better resilience in post flood period resulting in lesser extent of crop damage.

Bio-drainage options for better flood resilience

In flood prone and waterlogged areas, the practice of bio-drainage using *Casuarina and Eucalyptus* plantations would act as a viable flood resilient system as they improve soil drainage and operates better microclimate. This allows intercrop cultivation and helps in advanced planting of rabi crop resulting in higher water and land productivity.

Contribution of Food and Agricultural Organization in climate smart agriculture

Food and Agricultural Organization (FAO) has been playing vital role in assisting different nations including India in climate smart agriculture by developing climate resilience through enhancement of adaptive capacities and better preparedness to climate induced natural disasters. It promotes the programmes such as Globally Important Agricultural Heritage Systems (GIAHS) and Adapting Irrigation to Climate Change (AICCA) which represent the models of sustainable agricultural production. AICCA targets to generate and share up-to-date information regarding vulnerability and adaptability to climate change of small scale irrigation schemes in different agro-ecological regions of central and Western Africa.

Conclusion

Owing to the higher frequency and magnitude of extreme climatic risks or events in the recent years, the vulnerability of different agro-ecosystems has been found to be on increasing trend. This challenges the national food security objectives by affecting the crop production resulted by excess water stress or deficit water stress. Hence, the efforts must be concentrated on evolving eco-friendly and climate smart agriculture through best utilization of created water resources and adoption of innovative water management practices leading to higher water use efficiency and water productivity. Upscaling of the proven innovative water management techniques suitable for climate induced excess and deficit water stress scenarios would certainly make agriculture more viable economically thereby providing better cushion to the farming community.

References

- Lipper, L., Thornton, P., Campbell, B.M., Baedeker, T., Braimoh, A., Bwalya, M., Caron, P., Cattaneo, A., Garrity, D., Henry, K., Hottele,


01-01

CROP PRODUCTION CONSTRAINTS AND STRATEGIES FOR IMPROVEMENT IN NORTH COASTAL ZONE OF ANDHRA PRADESH

Kiran Kumar, S., Mounica, D and Venkatalakshmi, M.
Department of Agronomy, Agricultural College, Bapatla
Corresponding author: kirankumarsingupurapu@gmail.com

Out of 63.0 lakh ha of net sown area of Andhra Pradesh, 37.0 lakh ha area is in Coastal region. Out of which 10.0 lakh ha is in North coastal zone (Srikakulam, Vizianagaram and Visakhapatnam). Major soils of Srikakulam are red soils. Prevailing weather conditions are 1062 mm rainfall; Maximum temperature and minimum temperature are 32.2 and 23.2°C and sunshine hours 6.7. Total geographical area is about 0.58 m. ha. Net area sown is 0.32m. ha. Area sown more than once is 0.13 m. ha, gross cropped area and cropping intensity 0.45 m. ha and 140 % respectively. Majority of the area is under kharif rice which is followed by legume sequence in rabi. Major soils of Vizianagaram are red soils. Prevailing weather conditions are 1017 mm rainfall; Maximum temperature and minimum temperature are 33.3 and 23.6°C and sunshine hours 6.2. Total geographical area is about 0.65 m. ha. Net area sown is 0.31m. ha. Area sown more than once is 0.10m. ha, gross cropped area and cropping intensity are 0.41 m. ha and 132.4 % respectively. Majority of the area in kharif is under rice, groundnut, mesta and sugarcane, followed by legume sequence in rabi. Major soils of Visakhapatnam are red soils. Prevailing weather conditions are 1055 mm rainfall; Maximum temperature and minimum temperature are 32.1 and 23.4°C and sunshine hours 5.9. Total geographical area is about 1.12 m. ha. Net area sown is 0.30 m. ha. Area sown more than once is 0.073 m. ha, gross cropped area and cropping intensity are 0.37 m. ha and 123.9 % respectively. Majority of the area in kharif is under rice, sugarcane, ragi and pulses which were followed by legume, oilseed crop sequence in rabi.

Common Crop production constraints in North Coastal Zone of Andhra Pradesh are poor soils with low to medium organic carbon content, delayed rice plantings with over aged seedlings, severe incidence of neck blast in rice, Yellow Vein Mosaic Virus (YVMV) in pulses in rabi and non-adoption of proper agronomic practices. Common strategies to improve North Coastal Zone are (a) Popularization of packages for rice cultivation with over aged seedlings and pest and diseases; (b) Revision of fertilizer recommendation for different crops and newly released varieties based on soil health cards; (c) Popularization of YVMV resistant pulse varieties; (d) Improving water use efficiency by promoting micro irrigation systems; (e) Establishment of small scale industries to create employment for rural youth; (f) Use of low cost energy by installing solar panels to pump sets for lifting water and (g) Strengthening of agro-advisory services through mobiles, etc.

Key Words: North coastal zone, constraints, strategies

01-02

ZERO TILLAGE MUSTARD - A BETTER TECHNOLOGY FOR RICE FALLOWS OF ANDHRA PRADESH

Rajyalaskhmi, B and Venkateswarlu, B.
Department of Agronomy, Agricultural College, Bapatla
Corresponding author: rajyalakshmibommmidi@gmail.com

Rice is the principle crop during kharif (rainy) season in India. The crop occupies an area of over 44.11 million ha. At present the area is not fully utilized for crop production in the subsequent rabi (postrainy) season. In rice fallow areas mustard crop can better fit and has a good potential for increasing cropping intensity and farm returns and meet oilseed demand. Mustard is cultivated mostly under temperate climate. It is also grown in certain tropical and subtropical regions as a cold weather crop. Indian mustard is reported to
tolerate annual precipitation of 500 to 4200 mm, annual temperature of 6 to 27°C, and pH of 4.3 -8.3. Mustard being rabi season and low water requiring crop, fit well in the rainfed cropping system.

The residual soil moisture left at the time of rice harvest is often sufficient to cultivate short-duration oilseed crops and rice fallows can be converted into productive lands. Excess moisture content in low lands and low moisture in uplands after kharif rice are the main problems in zero tillage. Excess moisture in lowland and soil moisture reduction in uplands, might not be suitable to grow these crops under traditional tillage practices. In case of waterlogged condition, one of the best options is adoption of no-till along with the provision of field drainage. Similarly, in uplands, adoption of no-till and residue retention can conserve moisture for cultivation of these crops. Crop residues covering on soil surface along with suitable planting methods can conserve soil moisture and alleviate drought stress.

Optimum plant population of mustard must be maintained in rice fallows for better yields. It requires about 5-6 kg seed for one hectare area to sow in spacing of 25 cm apart and 3-5 cm plant to plant. The optimum date of sowing for mustard is in between 2nd fortnight of October to last week of November. The sowing should be done before 30th November because plant establishment is a problem. Sowing of mustard during last week of September to middle of October helps in utilizing the residual moisture effectively. Early maturing varieties may escape the terminal moisture stress and suitable for late planting in rice fallow areas. NRCBH-101, PM-28 and NPG-112 are more suitable varieties for rice fallow areas due to tolerant to moisture stress and give reasonable yield even under late planting conditions.

Fertilizer dose of 40:20:20 kg NPK/ha (88 kg Urea + 130 kg SSP+ 33 kg MOP) is recommended. Total quantity of SSP (130 kg) + half of MOP (16 kg) should be applied at or before sowing when there is moisture in the field. Urea should be applied in two splits, first half (44 kg) at early seedling stage and the remaining half (44 kg) mixed with the remaining quantity of MOP (17 kg) be applied at 25-30 days after first application/pre-flowering stage and one irrigation should be given. Mustard have higher requirement for sulphur, therefore, application of S @ 15-20 kg/ha is viable option to fulfill requirement of the crops.

Flower bud initiation and silique development stages are the critical growth stages in mustard. Hence, in case of moisture stress, two life-saving irrigations may be provided at these stages to harness its high yield potential. Mulching or retaining standing stubbles helps in conserving soil moisture and reduce irrigation requirement. Oilseeds fit in such a scheme without much disruption of the kharif cereal production system.

Key words: Zero tillage, edible oil, residual soil moisture, optimum seed rate

01-03

YIELD, CONSUMPTIVE USE AND WATER USE EFFICIENCY OF DRY SOWN RICE (Oryza sativa L.) INFLUENCED BY IRRIGATION SCHEDULES AND WEED MANAGEMENT OPTIONS

Haindavi, P., Chandrasekhar, K., Venkata Lakshmi, N and Ratna Prasad, P.
Department of Agronomy (Water Management), APGC, Lam, Guntur
Corresponding author: haindavi017@gmail.com

In the present scenario, looming scarcity of water and labour due to population explosion and urbanization, poses a serious threat to sustainability of traditional methods of rice production. Direct-seeded rice (DSR) can address these problems, as it is economically feasible and technically viable alternative to transplanted rice, as cost of cultivation was 15% less in DSR. Weeds are the major hurdle for cultivation of direct-seeded rice. Weed communities in dry sown rice are floristically diverse and higher in abundance than in transplanted rice, causing dry sown rice to face much higher weed pressure than conventional puddled transplanted rice.
A field experiment was carried out during the year 2016-17 at Agricultural Research Station, Jangamaheshwarapuram, Gurazala, Andhra Pradesh to study the growth and yield of dry sown rice (*Oryza sativa* L.) as influenced by irrigation schedules and weed management options. The treatments consisted of four irrigation schedules (I₁-1.5 IW/CPE ratio, I₂-2.0 IW/CPE ratio, I₃-3.0 IW/CPE ratio and I₄-continuous submergence) assigned to main plots and four weed management treatments (W₁-control, W₂-hand weeding at 20 DAS and 35 DAS, W₃-pendimethalin @ 1 kg a.i. ha⁻¹ (PE) fb. hand weeding at 25 DAS, W₄-pendimethalin @ 1 kg a.i. ha⁻¹ (PE) fb. bispyribac sodium 25 g a.i. ha⁻¹ at 15-20 DAS, W₅-pendimethalin @ 1 kg a.i. ha⁻¹ (PE) fb. bispyribac sodium 25 g a.i. ha⁻¹ at 15-20 DAS fb. metsulfuron methyl + chlorimuron ethyl 8 g a.i. ha⁻¹ at 35 – 40 DAS to sub plots.

The effect of irrigation schedules found to be significant on increasing consumptive of water, whereas the effect of weed management options and their interaction was not significant. Consumptive use of water increased with increasing irrigation frequency. It was significantly the lowest of 374.8 mm with irrigation at 1.5 IW/CPE and increased to 488.9 mm with 2.0 IW/CPE and 631.7 mm at irrigation with 3.0 IW/CPE. This was because of increased soil moisture supply due to increase in number of irrigations facilitated more moisture availability for evapotranspiration. The highest WUE of 14.5 was obtained from five irrigations given under 1.5 IW/CPE ratio which was significantly higher than 2.0 and 3.0 IW/CPE ratios.

Continuous flooding (CF) provides a favorable water and nutrient supply under anaerobic conditions. However, irrigation at 3.0 IW/CPE found equally effective as that of continuous submergence in increasing grain yield and higher harvest index was observed under in irrigation schedules based on IW/CPE over continuous submergence. Among the weed control treatments, the highest grain yield (6555 kg ha⁻¹) and straw yield (9470 kg ha⁻¹) recorded with two hand weedings(W₂) were found to be significantly higher over all other treatments. It was followed by the treatment W₃ (pendimethalin + hand weeding) which recorded significantly higher grain yield over W₄ and W₅.

**Key words:** Consumptive use, water use efficiency, direct sown rice

**01-04**

**HYDROPONICS GREEN FODDER PRODUCTION A BOON TO SMALL AND LANDLESS FARMERS**

*Ashok Babu, V., Prabhakaran, N.K and Natarajan, S.K.*

Department of Agronomy, TNAU, Coimbatore, India.

Corresponding author: reachtoshokv@gmail.com

India is the leading milk producing country in the world where livestock plays an important role for nutritional and economic security particularly for small and marginal farmers. The gap between supply and demand for fodder is increasing day by day due to shrinking of agriculture land and poor labour availability. Hydroponics green fodder production is a technology of producing forage by growing plants without soil, but in water or nutrient rich solutions for a short duration in an environmentally controlled house. It will be a viable alternative technology to bridge the gap between demand and supply of green fodder to livestock. It requires 98% less water than conventional method. The green fodder produced through this technology will be ready for harvest within 8 to 10 days, having high palatability, and enhanced nutritional values as the fodder contains seed along with root, with higher crude protein content than conventional fodder.

**Key words:** Hydroponics, green fodder, livestock
Climate change is a major challenge for agriculture, food security and rural livelihoods of billions of people. Climate change disrupts food markets, posing population-wide risks to food supply. Climate risks to cropping, livestock and fisheries are expected to increase in coming decades, particularly in low-income countries where adaptive capacity is weaker. Livestock makes a key contribution to global food security. Its contribution is especially important in marginal lands where livestock represents a unique source of energy, protein and micronutrients. Climate change has substantial impacts on ecosystems and the natural resources upon which the livestock sector depends. Climate change poses serious threats to livestock production. But, the impacts are difficult to quantify due to the sector’s uncertain and complex interactions among agriculture, climate, the surrounding environment and the economy. Increased temperatures, shifts in rainfall distribution and increased frequency of extreme weather events are expected to adversely affect livestock production and productivity around the world. These adverse impacts can be the direct result of increased heat stress and reduced water availability. Indirect impacts can result from the reduced quality and availability of feed and fodder, the emergence of livestock diseases and greater competition for resources with other sectors. Scarcity of resources, impacts of climate change, and the increase in demand for livestock products have made some traditional coping mechanisms less effective. Therefore, in order to meet the challenges, the Climate-Smart Agriculture (CSA) concept is gaining considerable action at international and national levels. It is an approach for transforming and reorienting agricultural systems to support food security under the new realities of climate change. It also makes agriculture and allied sectors a part of solution to the negative impacts of climate change. There is an urgent need to develop and implement ‘climate-smart’ livestock management options viz. grazing management, improved breeds, improved livestock feeding strategies, infrastructure adaption etc., that can achieve the triple win scenario of increasing productivity, adapting and building resilience to climate change, and mitigating climate change through reduction of GHG emissions which targets to increase income and improve food security.

Key words: Climate change, food security, climate smart agriculture, livestock, GHGs.
farmers to retrace the indigenous technical knowledge. These effects lead to the era of climate smart agriculture. The identification and documentation of ITKs, have greater role in adopting climate smart agriculture. A research effort was made to document the ITKs viz., spraying curd for sucking pest in cotton, trap crop of marigold in tomato, land preparation with wooden plough, organic manure application etc., at Shamshabad mandal of Telangana state. These ITKs were documented using matrix pair ranking methodology and scientific reasons for their practice and their relevance in climate smart agriculture was recorded. It was found that, there is every need to conserve the natural resources for present and for future generations. The integration of ITKs with scientific knowledge were also documented in the study. These integrated technologies resulted the farmers to conserve their resources and get better yields at present and in future, as well.

**Key words:** Indigenous technical knowledge, cost effective, conservation resources and climate smart agriculture

**01-07**

**IMPACT OF AGRICULTURAL RESEARCH IN ACHIEVING FOOD SECURITY**

*Ravindranadh, G., Sree Rekha, M., Prasad, P.V.N and JayaLalitha, K.*

Agricultural College, Bapatla

Coresponding author e-mail: gottipatiravi007@gmail.com

India’s base streamline profession of farming is a lineage from Indus valley civilization. Even though it’s an age-old profession, its main fruits were enjoyed only after the green revolution. The shift from ‘food shortage’ to ‘food surplus’ achieved because of education and research, from adopting the improved technologies, modern techniques of farming and extension activities taken by a large number of researchers, agri-graduates, and extension workers. It was the greatest achievement of mankind since the advent of agriculture. Soil degradation and climate change are haunting the positive effects of green revolution, with every technological use there is an ill corner neglected to prove it as best has driven our society into the worse. Even though the food for the entire world without hunger was achieved, it was at the cost of malnutrition and health degradation. The emphasis of research should be shifted from the quantitative to qualitative side.

Keywords: Food shortage, food surplus, soil degradation and climate change.

**01-08**

**RESOURCE USE EFFICIENCY OF MAIZE PRODUCERS IN GUNTUR DISTRICT OF ANDHRA PRADESH – AN ECONOMIC PERSPECTIVE**

*Jhansi Lakshmi, B and Paul, K. S. R.*

Cost of Cultivation Scheme, Department of Agricultural Economics, Agricultural College, Bapatla

Maize is globally a top ranking cereal not only in productivity but also as human food, animal feed and as a source of large number of industrial products next to rice and wheat. Maize is considered as Queen of cereal crops in the world. In India 55 per cent of grain produce of maize is used for food purposes, about 14 per cent for livestock feed, 18 per cent for poultry feed, 12 per cent for starch and 1 per cent for seed. Despite enormous importance of maize crop, maize farmers have to be helped to increase productivity. Therefore, the focus should not only be on whether or not they have adopted productivity enhancing technologies, but it is necessary to carefully examine whether they are even making maximum use of the technologies on inputs available to them. In a study, the productivity and resource use efficiency of maize producers in Guntur district of Andhra Pradesh, were analysed.
The data used were obtained through cross sectional survey of 60 maize growing farmers and they were interviewed using structured questionnaire to obtain data pertaining to farm production, input usage and other variables including socio economic and institutional factors during the agricultural year 2016-17 in Guntur district of Andhra Pradesh. Data Envelopment Analysis (DEA) technique was employed to assess resource use efficiency in maize cultivation.

The results depicted that the technical efficiency in maize production were found to be 71 per cent indicating, thereby changes in production are possible by 29 per cent with the available technology. Allocative efficiency was 65 per cent, indicating that farmers could reduce costs by 35 per cent by using optimum proportions of inputs considering its prices while selecting its quantities. The value of Cost Efficiency(CE) emphasizes the reduction of cost by 30 per cent to produce existing level of output at least cost a given level of output (rational use of resources) with available technology so as to optimize the net income of maize producing farmers in the study area.

The study concluded that there is a scope to increase productivity (29%) with the available technology. There is also an ample scope to minimize the cost of production at a given level of input (rational use of resources) to produce a given level of output with available technology. There is every possibility to optimize the net income of maize cultivating community in Guntur District of A.P.

**Key words:** *Maize, resource use efficiency, cost efficiency*

**01-09 AGROMETEOROLOGICAL ADVISORIES FOR SUSTAINABLE AGRICULTURE**

*Basava Swathi, V, RadhaKrishnamurthy, Sreerekha, M and Jayalalitha, K.*

Agricultural College, Bapatla

Coresponding author: swathisatya699@gmail.com

Weather plays a crucial role in sustainable agricultural production. All the activities of agriculture starting from field preparation to post harvest are affected by weather. The adverse impact of weather on the farmers livelihood can be reduced if the weather information is used effectively. The weather related farming operations, therefore, need cooperation of Agricultural Scientists, Meteorologists and Computer Scientists for development of Expert systems to produce location specific advisories.

Both climate change and climate variability are causing concern on the biodiversity and ultimately eco-system in different parts of the country. In order to address this issue and others, India Meteorological Department/Ministry of Earth Sciences is operating an initiative under Agromet Advisory Services (AAS). They provide a very special kind of inputs to the farmers as advisories that can make a tremendous difference to the agriculture production by taking the advantage of benevolent weather and minimize the adverse impact of weather.

The government of India established the National Centre for Medium Range Weather Forecasting (NCMRWF) In 1988 to develop operational medium range (3-10 days in advance) weather forecasting and to develop and disseminate AAS for all the 127 Agro-climatic zones. This initiative was taken to benefit the farming community in India.

At present the NCMRWF generates location specific medium range weather forecasts for rainfall, cloud cover, Average wind speed, Predominant wind direction and Maximum and Minimum temperature trends. These forecasts are communicated to the AAS units in real-time using fast Information and Communication Technologies. On receipt of the forecast at an AAS unit, the nodal officer prepares the medium range weather forecasts based on the agrometeorological advisories. These advisories are prepared
in consultation with a panel of subject matter specialists in agriculture and then disseminated to the farmers through different mass media like newspaper, radio, tv, personal contact and modern ICTs.

IMD began regular weather services for farmers in 1945 in the form of a Farmers Weather Bulletin and broadcasts through All India Radio in regional languages. The proforma consists of Weather information, Crop information and Advisory. The Agrometeorological services rendered by India Meteorological Department (IMD), Ministry of Earth Sciences is a step to contribute to weather information based crop/livestock management strategies and operations dedicated to enhancing crop production and food security. IMD is operating a project “GraminKrishiMausamSewa” (GKMS) with an objective to serve the farming community at different parts of the country. The following are the major activities being carried out under this project minimising the threat on the biodiversity in the agricultural system in India.

**Keywords:** Agrometeorological; biodiversity; meteorological; earth sciences; agromet advisory services.

01-10

**NANOTECHNOLOGY IN AGRICULTURE: POLY (CAPROLACTONE) NANOCAPSULES AS CARRIER SYSTEMS FOR HERBICIDES**

*Divyamani, B and Reddi Ramu, Y.*

Department of Agronomy, S.V. Agricultural College, Tirupati

Corresponding author: divyamani126@gmail.com

Agriculture is the backbone of most developing countries, around 60 per cent of population rely on it for their livelihood. Weeds are menace in agriculture. Herbicides are used to control the weeds. Improvements in the efficacy of herbicides through the use of nanotechnology could result in greater production of crops. Nanotechnology deals with the matter at nanoscale (1-100 nm) dimensions. The toxicity of herbicides used in agriculture is influenced by their chemical stability, solubility, bio-availability, photo-decomposition, and soil sorption. Possible solutions designed to minimize toxicity include the development of carrier systems able to modify the properties of the compounds and allow their controlled release. Polymeric poly(-caprolactone) (PCL) nanocapsules containing three triazine herbicides (ametryn, atrazine, and simazine) were prepared and characterized in order to assess their suitability as controlled release systems that could reduce environmental impacts. The efficiency of these herbicides are more than 80%. Assessment of stability (considering particle diameter, zeta potential, polydispersity, and pH) was conducted over a period of 270 days, and the particles were found to be stable in solution. In vitro release kinetic experiments revealed controlled release of the herbicides from the nanocapsules, governed mainly by relaxation of the polymer chains. Microscopy analyses showed that the nanocapsules were spherical, dense, and without aggregates. It was revealed that the Poly (I-
caprolactone) nanocapsules are fit to act as carrier systems for improving efficacy of herbicides.

**Key words:** Nanotechnology, carrier systems, herbicides
LASER LAND LEVELING – CLIMATE SMART AGRONOMIC APPROACH

Hari Krishna P.
Teaching Associate, Polytechnic College, Narasaraopet, Guntur
Corresponding author: pharikrishna025@gmail.com

The crop productivity in India is very low as majority of the farmers are still practicing traditional farming techniques. The existing crop production technologies do not offer effective and efficient utilization of natural resources, particularly that of water. Moreover, a significant amount of irrigation water is wasted due to uneven fields and ditches. Unevenness of the soil surface also has a major impact on the seed germination, plant stand and yield of crops through nutrient-water interaction and salt and soil moisture distribution pattern. Therefore, the water use efficiency along with yield per acre could be increased by adopting resource conservation technologies like laser levelling. The use of laser technology in the precision land levelling is of recent origin in India. It not only minimizes the cost of levelling but also ensures the desired degree of precision. Precision land levelling (PLL) facilitate application efficiency through even distribution of water and increased water-use efficiency that result in uniform seed germination, better crop growth and higher crop yield. The Manual for Laser Land Levelling seeks to explain the benefits of land levelling in fields, particularly rice fields. Therefore, laser land levelling is a climate smart agronomic approach to enhance the crop productivity to achieve climate resilience and to ensure food security.

Key words: Laser land levelling, agronomic approach, precision land levelling.

NUTRIENT UPTAKE BY RABI MAIZE AS INFLUENCED BY DIFFERENT IRRIGATION SCHEDULES AND NITROGEN MANAGEMENT

Hari Krishna, P., Venkata Lakshmi, N., Chandrasekhar, K and Prasuna Rani, P.
Department of Agronomy (Water Management), APGC, Lam, Guntur
Corresponding author: pharikrishna025@gmail.com

Maize is cultivated in India, throughout the year in all the states of the country in an area of 9.5 million hectares, with annual production of 23.3 million tonnes with 2452 kg ha⁻¹ of productivity (DACNET, 2014). Maize responds relatively better to management factors especially irrigation and nitrogen. Irrigation is one of the important factors in agricultural practices. Optimal crop production is dependent on the time and amount of irrigation. Therefore, performance of a plant in terms of its growth and yield is mainly dependent on plant water status which can be maintained at optimum level by following an optimum irrigation schedule. Availability of optimum moisture in the soil enhances the efficiency of applied nutrients. So proper irrigation scheduling is essential for efficient use of water and crop production. Concept of IW/CPE ratio incorporates the climatic factors into consideration while scheduling the irrigation and has been found to be a reliable, economical and practical basis for scheduling irrigation. Maize has maximum nitrogen use efficiency of about 50 per cent, but under poor management, its efficiency varies from 30-40 per cent. Water and nitrogen are two important resources for crop production.

A field experiment was conducted at yard block of Agricultural Research Station, Jangamaheswarapuram, Guntur district, Andhra Pradesh, during rabi, 2016, to study the effect of different irrigation schedules on nitrogen levels on performance of rabi maize. The experiment was laid out in split-plot design with three irrigation schedules as main plots and three nitrogen doses as sub plots and replicated thrice. It was found that the maximum number of yield attributes was recorded with 1.0 IW/CPE ratio and minimum were recorded with 0.6 IW/CPE ratio.
The interaction effect of irrigation and nitrogen management on kernel rows per cob was found to be significant. The highest mean maximum kernel rows per cob was recorded with I1N3 (Irrigation at 1.0 IW/CPE with 100% RDN through urea + 50% N through FYM) and the lowest was recorded with I3N1 (Irrigation at 0.6 IW/CPE along with 100% RDN only) treatment. Irrigation scheduled at IW/CPE ratio of 1.0 (I1) recorded the maximum grain yield (7827 kg ha⁻¹), and stover yield (9558 kg ha⁻¹) over scheduling of irrigation at IW/CPE of 0.8 (I2) and 0.6 (I3). Among the nitrogen levels tested, application of 100% RDN (Recommended dose of nitrogen) through urea + 50% RDN through FYM (N3) recorded significantly higher yield attributing characters and yield compared to application of 100% RDN (N1 - 200 kg N ha⁻¹), and 100% RDN through urea + 25% RDN through FYM (N2) other nitrogen levels practices in rabi maize.

The maximum N (137.9 kg ha⁻¹), P (38.6 kg ha⁻¹) and K (150.3 kg ha⁻¹) uptake was also observed with the plot that received irrigation at 1.0 IW/CPE and 100% RDN through urea + 50% RDN through FYM, and found statistically on a par with IW/CPE ratio of 0.8. The lowest NPK uptake was recorded with irrigation applied at IW/CPE ratio of 0.6 compared to other treatments. Among the nitrogen levels, the highest nutrient (N, P and K) uptake was recorded with application of 100% RDN through urea + 50% RDN through FYM, which was significantly higher over 100% RDN through urea + 25% RDN through FYM and 100% RDN.

01-13
SOIL HEALTH MANAGEMENT FOR SUSTAINABLE AGRICULTURE

Bhargavi, B and Sree Rekha, M.
Department of Agronomy, Agricultural College, Bapatla.
Corresponding author: bhargavibeela123@gmail.com

Since the advent of agriculture, human being in societies has been inextricably dependent on “the soil” for their livelihoods. As soon as soil health was compromised, so was agriculture, and in turn, the lives of people. In the last few decades, the adoption of intensive agricultural practices, new patterns of food consumption and increasing demographic pressure, all threaten soil health everywhere in the world. Around the world, soil is under pressure. FAO studies have found that one quarter of the earth’s land areas are highly degraded due to a variety of human activities-including farming. A healthy agricultural soil is one that is capable of supporting the production of food and fibre, to a level and with a quality sufficient to meet human requirement, together with continued delivery of other ecosystem services that are essential for maintenance of the quality of life for humans and the conservation of biodiversity. For enhancing soil health the general principles are (1) improving soil organic carbon (2) adoption of conservation agriculture (3) increase soil biodiversity (4) maintenance of live vegetative cover (5) use of organic amendments such as mulch, compost and (6) adoption of integrated nutrient management. Thus, maintaining of soil health is essential to human health, ecosystem function and nature conservancy.

Key words: Soil quality, ecosystem, conservation, soil health management
COST EFFECTIVE GREEN FODDER PRODUCTION BY HYDROPONIC TECHNIQUE

Bhargavi, B and Sree Rekha, M.
Department of Agronomy, Agricultural College, Bapatla.
Corresponding author: bhargavibeela123@gmail.com

Livestock production is the backbone of Indian agriculture and also plays a key role in providing employment especially in rural areas and is making significant contribution to the country’s GDP. The livestock sector in India contributes to nearly 32% of total agricultural output. This sector has been the primary source of energy for agriculture operation and major source of animal protein for masses. Having only 4% of total cropping area under fodder cultivation has resulted in a severe deficit of green fodder (36%), dry fodder (40%) and concentrates (57%). India has 15% of world cattle population and due to ever increasing population pressure of human, arable land is mainly used for food and cash crops, thus there is little chance of having good quality arable land available for fodder production. In India, there is no practice of fodder production in rural areas and animals generally consume naturally grown grasses and shrubs which are of low quality in terms of protein and available energy. They are thus heavily dependent on seasonal variations and this results in fluctuation in fodder supply affecting supply of milk round the year. Traditional fodder production has a number of limitations regarding soil and climatic conditions. In such conditions, the technique of green fodder production by hydroponic method is a very useful technique. With this technique, it is possible to produce green fodder like maize, wheat, bajra etc. The benefits of hydroponic fodder production are land preservation, water conservation, faster growth and maturity, contamination free, minimal use of fungicide and pesticide, less labour and maintenance costs, time saving, continual produce, weed free and highly palatable nutritious fodder. Importance of forage production in maintaining food security as well as nutritional security has been felt since long. The overall scene of forage production is very alarming and corrective measures have to be taken to improve this problem. With increased pressure on farm lands to produce increasing needs of food grains, providing green fodder by hydroponics fodder growing is a technological necessity for the Indian dairy industry.

Key Words: Livestock, fodder, hydroponics

ORGANIC FARMING IN INDIAN PERSPECTIVE

Deepak Katkani, M., Dharmendra and Yogesh Patidar
College of Agriculture, Rewa (M.P.); Krishi Vigyan Kendra, Rewa (M.P.)

Organic Agriculture is one among the broad spectrum of production methods that are supportive of the environment. Organic production systems are based on specific standards precisely formulated for food production. They aim at achieving agro ecosystems, which are socially and ecologically sustainable. Increasing consciousness about conservation of environment as well as health hazards associated with agrochemicals and consumers preference to safe and hazard-free food are the major factors that lead to the growing interest in organic farming of agriculture in the world. Organic farming systems have attracted increasing attention over the last decade because they are perceived to offer solutions to the problems currently being faced by the agricultural sector. Organic farming has the potential to provide benefits in terms of environmental protection, conservation of non-renewable resources and improved food quality. India is bestowed with lot of potential to reduce all varieties of organic products due to its diverse agro-climatic conditions. In several parts of the country, the inherited tradition of organic farming is an added advantage. This holds promise for the organic producers to tap the market which is growing steadily in the domestic market related to the export market.
India, the land under certification is around 2.8 million ha. But, there is considerable latent interest among farmers in conversion to organic farming.

**Keywords:** Organic farming, agro-ecosystem, export

**01-16**

**NONCONVENTIONAL WEED MANAGEMENT STRATEGIES FOR MODERN AGRICULTURE**

Priyadarsini, S., Prasad, P.V.N., Venkateswarlu B and Prasad, P.R.K.
Department of Agronomy, Agricultural College, Bapatla, ANGRAU

Weeds are the major factor causing reduction in crop yields through competition and allelopathic interactions. In modern-day agriculture, weed infestations and weed behaviors frequently change because of intensive management practices, climate change, and ecological shift. In addition, the natural disasters affect weed dynamics. This situation demands a change in weed management protocols. The existing manual control options are no longer viable because of labour shortages; chemical control options are limited by eco-degradation, health hazards, and development of herbicide resistance in weeds. Therefore, there is a need to find some potential nonconventional weed management strategies for modern agriculture that are viable, feasible, and efficient improvement in tillage regimes has long been identified as an impressive weed-control measure.

Harvest weed seed control and seed predation are found as potential tools for reducing weed emergence and seed bank reserves. Developments in the field of allelopathy for weed management has led to new techniques for weed control. The remarkable role of biotechnological advancements in developing herbicide-resistant crops, bio-herbicides, and harnessing the allelopathic potential of crops is also worth mentioning in a modern weed management program. Thermal weed management has also been observed as a useful technique, especially under conservation agriculture systems. In addition, precision weed management has been elaborated with sufficient details. The role of remote sensing, modeling, and robotics as an integral part of precision weed management has been highlighted in a realistic manner. All these strategies are viable for today’s agriculture. However, site-specific selection and the use of right combinations will be the key to success. No single strategy is perfect, and therefore an integrated approach may provide better results. The right choice of one or more of these strategies according to geographic, agricultural, and socioeconomic conditions may offer an impressive weed control. None of them has the potential to comprehensively replace chemical weed management. It was found that integrated approach may lead to success. The diversified nature of these strategies may be very useful against invasive and resistant weeds. In the long run, a single weed-control measure may not remain effective and, thus, integrated weed management on the basis of advanced nonconventional strategies will be a pragmatic option in modern intensive agriculture.

Further research is needed to optimize these tools for improvement in efficiency and practical suitability. In the long run, a single weed-control measure may not remain effective and, thus, integrated weed management on the basis of advanced nonconventional strategies will be a pragmatic option in modern intensive agriculture.

**Key words:** Allelopathy, non-conventional weed management, herbicide resistance, precision agriculture, weed management.
WATER MANAGEMENT PRACTICES FOR MANAGING WATER SCARCITY AND TO ENHANCE WATER PRODUCTIVITY IN MAIZE

Ramya, N., Venkata Lakshmi, N., Chandrasekhar K and Prathibasree, S.
Department of Agronomy (Water Management)
Advanced Post Graduate Centre, Lam, Guntur
Corresponding author: ramyaba104@gmail.com

Water is the prime natural resource which very often becomes costly and limiting input particularly in semi-arid tropics and needs to be judiciously used to reap the maximum benefit of other inputs. On a global scale, water deficiency is the major factor limiting agricultural production. The increasing demand for food and water calls for a more efficient use in agriculture. Steps should be needed for efficient and judicious utilization of this resource or else it will be difficult to sustain agricultural productivity as well as the demand of water for the survival of society. With good management and adoption of appropriate practices improves agricultural water conservation and subsequent use of that water for more efficient crop production are possible under both dry land and irrigated area. Inappropriate irrigation system design and management and the use of traditional irrigation methods have been reported to cause large water losses in agricultural fields (Wang et al., 1996; Howell, 2001). Irrigation system upgrade and replacement can mitigate water shortages or lead to increased irrigated area to cope with rapid population growth (Rijsberman, 2006).

Maize is the third most important food crop of the world and India after rice and wheat. It is cultivated in all the states of the country in an area of 9.18 m.ha. with a production of 24.17 m.t. and productivity of 2632 kg ha⁻¹, whereas in Andhra Pradesh it is grown in an area of 0.303 m.ha. with a production of 1.938 m.t. and productivity of 6396 kg ha⁻¹. As a C₄ plant it is considerably more water efficient crop than C₃ plant. Even though maize makes productive utilization of water, it is considered more susceptible to water stress than other crops. So, irrigation might be designed in such a way that part of the root system is exposed to drying soil while the rest is in wet soil (Alternate furrow irrigation, partial root zone drying), which could lead to reduced stomatal opening without leaf water deficit which finally enhances water productivity in maize. Alternate furrow irrigation is an irrigation management strategy in which one out of two adjacent furrows is irrigated and enhances water productivity.

In an effort to make irrigation more efficient to obtain more crops per drop of water, farmers have to adopt alternative improved irrigation methods over conventional flooding method of irrigation. Development of new methods for reducing water loss in agriculture sector can mitigate the water shortage. Depending on soil type these methods are quite effective but can be improved.

Highest grain yield was recorded with full irrigated treatment which is not significantly different from partial root zone drying at 80% field capacity where 18% less water was used with only 13.5% reduction in yield. Maximum water productivity was recorded under 50% water requirement where 250 mm of water is used when compared with 75% water requirement where 375 mm of water is used. Water productivity of maize was highest in alternate furrow irrigation when compared with flooding and conventional method of irrigation with 41.77% and 20.16% saving of water over flooding. Irrigation scheduled at 60% crop evapotranspiration produced highest water productivity with only 11.4% reduction in yield when compared with irrigation at 100% crop evapo-transpiration. Highest Water use efficiency of maize was recorded when the irrigation was scheduled at 0.6 IW: CPE ratio than 0.8 and 1.0 IW: CPE ratios, while lowest water use efficiency of maize was recorded under the conventional method of irrigation. High yields and water use efficiency of summer maize can be gained by reducing row spacing under the same planting densities. The reduced irrigation water level on maize crop showed increased water productivity at all growth stages.
Deficit irrigation helps to stabilize crop yields and obtain maximum WP rather than maximum yields. Regulated deficit irrigation can play a useful role in developing practical recommendations for optimizing crop water productivity under conditions of scarce water supply. Water deficit up to 40% can be acceptable for maize with less reduction in yields. Under water limited environment growing maize at 75% or 50% water requirement achieve higher yields and enhances water productivity. Water productivity can also be enhanced by supplying 2 irrigations at knee-high stage and silking stage. Highest water use efficiency was recorded in case of Furrow irrigated raised bed with 100% Field capacity. Alternate furrow irrigation is the better method among the surface irrigation with 41% of water saving over flooding with 20 per cent reduction in crop yield. Under water scarcity, scheduling of irrigation at 75% days to available soil moisture depletion and reduction in yield was only marginal.

01-18

UTILIZATION OF MAIZE STALKS FOR MUSHROOM CULTIVATION AND COMPOST MAKING

Harikrishna, P and Lakshmipathy, R.
Department of Microbiology, Advanced Post Graduate Centre, Lam, Guntur

The experiment entitled “Utilization of maize stalks for mushroom cultivation and compost making” was conducted at, Post Harvest Technology Centre, Bapatla, A.P. Aim of this research work was to evaluate feasibility of maize stalks for oyster mushroom cultivation as that of paddy straw and sorghum stalks and also, to evaluate maize stalks and maize stalks after mushroom cultivation for composting and vermicomposting.

In an experiment to evaluate maize stalks for mushroom cultivation, there were 6 treatments viz., T1 – 100% maize straw, T2 – 100% sorghum straw, T3 – 100% paddy straw, T4 – 50% maize straw + 50% paddy straw, T5 – 50% sorghum straw + 50% paddy straw, T6 – 50% maize straw + 50% sorghum straw. Oyster mushroom yield and bioefficiency was more in 100% paddy straw. But difference in mushroom yield and bioefficiency between the treatments is not statistically significant. Difference in mushroom pin head initiation was recorded between the different substrates and their combinations used, but it was not statistically significant. However, mushroom pin heads were formed soon in case of 50% sorghum stalk + 50% paddy straw. Moisture content of the fresh mushroom varied between different substrates. It was highest in case of mushrooms harvested from 50% maize stalk + 50% paddy straw.

Protein content and total amino acids of oyster mushrooms were statistically differed among the treatments. However, highest protein content was recorded in the mushrooms harvested from 100% maize stalk. The difference in total amino acid content of the mushrooms harvested from different substrates and their combinations used was statistically significant. Amino acid content was more in the mushrooms harvested from 50% sorghum stalk + 50% paddy straw. Similarly total sugars and phenolic content of the oyster mushrooms were statistically differed among different treatments. Highest total sugars recorded in the mushrooms harvested from 100% maize stalk. Highest phenolic content was recorded in the mushrooms harvested from 100% sorghum stalk. Crude fibre, ash content and calorific value of the oyster mushrooms were statistically differed among different treatments. Highest crude fibre content was recorded in mushrooms harvested from 100% paddy straw. Highest ash content was recorded in the mushrooms harvested from 100% maize stalk. Highest calorific value was recorded in mushrooms harvested from 100% maize stalk. pH of oyster mushrooms varied significantly with the various substrates and these combinations used for cultivation of mushrooms. pH was highest in oyster mushrooms grown on 50% sorghum stalk + 50% paddy straw.

In another experiment maize stalks and maize stalks after mushroom cultivation (Spent mushroom substrates) were utilized for composting with different treatments viz., T1 – Maize stalk untreated, T2 – Maize stalk + P. chrysosporium (PC) + T. spiralis (TS), T3 – Maize stalk + Earth worms, T4 –
Maize stalk after mushroom production untreated, $T_5$ – Maize stalk after mushroom production + *Phanerochete chrysosporium* (PC) + *Trichurus spiralis* (TS), $T_6$ – Maize stalk after mushroom production+ Earth worms.

During composting there was a variation in the population of microorganisms, nutrient content, pH and temperature at different stages of composting. Bacterial population was increased in all the treatments up to 20th day of composting and then decreased. However, bacterial population varied significantly between different treatments during different substrates of composting process. Fungal and actinomycetes population also varied significantly between the treatments during composting. In both the cases the population increases during 20th day of composting and then started decreasing in subsequent stages.

Nitrogen, Phosphorous and Potassium contents in the mushroom spent substrate (maize stalk after mushroom production) (0.98 %, 0.19 %, 0.78 %) were more compared to fresh maize stalks (0.7 %, 0.17 %, 0.72% respectively). These nutrients slightly increased during composting process. But the rate of increase in nutrients content was more in case of vermicomposts compared to other treatments. Among the two different substrates used viz., fresh maize stalks and mushroom spent substrate, N, P, K contents were more in the treatments with spent substrate compared to treatments with fresh maize substrates in all the stages. But it is quite opposite in case of organic carbon and C : N ratio. Organic carbon contents of the spent substrate (maize stalk after mushroom production) (26.6 %) was less than the fresh maize substrate (36.5 %). The organic carbon content slightly decreased during composting process in all the treatments in all the stages of composting. And also in case of C : N ratio, decrease in C : N ratio was noticed during composting treatments in all the stages of composting. However, C : N ratio was least in the composts prepared with earthworms that too with spent substrate (15.20 %) and highest in case of composts with fresh maize stalk (22.77 %). During in all the stages of composting fresh maize stalk composting from maize stalk + earth worms had less pH compared to other treatments.

Regarding compost recovery, maize stalk untreated recorded highest compost recovery (487.3g/500g.) and least in case of maize stalk after mushroom production+ earth worms (278.3g/500g.). Among the two substrates used for vermicomposting, the multiplication rate of earthworms is more in case of mushroom spent substrate (572%) compared to fresh maize stalk (400%). Regarding pile temperature during composting, it gradually increase up to 3rd week and then decreased. Maximum pile temperatures were recorded in the treatment with maize stalk after mushroom production + *Phanerochete chrysosporium* + *Trichurus spiralis* (44.2°C).

Treatments: Mushroom production:

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>100% maize stalk</td>
</tr>
<tr>
<td>T2</td>
<td>100% Sorghum straw</td>
</tr>
<tr>
<td>T3</td>
<td>100% paddy straw</td>
</tr>
<tr>
<td>T4</td>
<td>50% maize straw + 50% paddy straw</td>
</tr>
<tr>
<td>T5</td>
<td>50% sorghum straw + 50% paddy straw</td>
</tr>
<tr>
<td>T6</td>
<td>50% maize straw + 50% sorghum straw</td>
</tr>
</tbody>
</table>
Treatments: Compost making:

- **T1**: Maize stalk untreated
- **T2**: Maize stalk + *Phanerochete chrysosporium* (PC) + *Trichurus spiralis* (TS)
- **T3**: Maize stalk + Earth worms
- **T4**: Maize stalk after mushroom production untreated
- **T5**: Maize stalk after mushroom production + PC+TS
- **T6**: Maize stalk after mushroom production + Earth worms

Experiment 1 (mushroom production) Results:

Table: Growth of mushroom on different treatments

<table>
<thead>
<tr>
<th>Sl.</th>
<th>Treatments</th>
<th>Initial dry wt. (g.)</th>
<th>Final compost (g.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>T₁</td>
<td>500</td>
<td>487.3</td>
</tr>
<tr>
<td>2</td>
<td>T₂</td>
<td>500</td>
<td>469.6</td>
</tr>
<tr>
<td>3</td>
<td>T₃</td>
<td>500</td>
<td>355.3</td>
</tr>
<tr>
<td>4</td>
<td>T₄</td>
<td>500</td>
<td>483.3</td>
</tr>
<tr>
<td>5</td>
<td>T₅</td>
<td>500</td>
<td>467.0</td>
</tr>
<tr>
<td>6</td>
<td>T₆</td>
<td>500</td>
<td>278.3</td>
</tr>
</tbody>
</table>

| SEM± |                 | N.S | 23.87 |
|          |                  |     | 3.17  |

Effect of different substrates and treatments on compost recovery.
### Experiment 2 (compost making) Results:

#### N P K content at different stages of composting

<table>
<thead>
<tr>
<th>Sl.no</th>
<th>Treatment</th>
<th>Initial (0days) (%)</th>
<th>Initial (0days) (%)</th>
<th>Initial (0days) (%)</th>
<th>30 DDC (%)</th>
<th>30 DDC (%)</th>
<th>30 DDC (%)</th>
<th>Final (90 days) (%)</th>
<th>Final (90 days) (%)</th>
<th>Final (90 days) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>P</td>
<td>K</td>
<td>N</td>
<td>P</td>
<td>K</td>
<td>N</td>
<td>P</td>
<td>K</td>
</tr>
<tr>
<td>1</td>
<td>T₁</td>
<td>0.7(4.79)</td>
<td>0.17(2.36)</td>
<td>0.72(4.88)</td>
<td>0.74(4.92)</td>
<td>0.24(2.81)</td>
<td>0.79(5.09)</td>
<td>1.08(5.96)</td>
<td>0.28(3.03)</td>
<td>0.85(5.29)</td>
</tr>
<tr>
<td>2</td>
<td>T₂</td>
<td>0.7(4.79)</td>
<td>0.17(2.36)</td>
<td>0.72(4.88)</td>
<td>0.91(5.48)</td>
<td>0.34(3.34)</td>
<td>0.96(5.62)</td>
<td>1.15(6.15)</td>
<td>0.40(3.63)</td>
<td>1.21(6.31)</td>
</tr>
<tr>
<td>3</td>
<td>T₃</td>
<td>0.7(4.79)</td>
<td>0.17(2.36)</td>
<td>0.72(4.88)</td>
<td>0.85(5.28)</td>
<td>0.38(3.53)</td>
<td>1.18(6.24)</td>
<td>1.53(7.10)</td>
<td>0.40(3.63)</td>
<td>1.21(6.31)</td>
</tr>
<tr>
<td>4</td>
<td>T₄</td>
<td>0.98(4.79)</td>
<td>0.19(2.49)</td>
<td>0.78(5.07)</td>
<td>1.11(6.05)</td>
<td>0.26(2.92)</td>
<td>0.82(5.19)</td>
<td>1.25(6.42)</td>
<td>0.31(3.19)</td>
<td>0.98(5.68)</td>
</tr>
<tr>
<td>5</td>
<td>T₅</td>
<td>0.98(4.79)</td>
<td>0.19(2.49)</td>
<td>0.78(5.07)</td>
<td>1.16(6.19)</td>
<td>0.38(3.53)</td>
<td>0.98(5.68)</td>
<td>1.25(6.42)</td>
<td>0.41(3.67)</td>
<td>1.18(6.24)</td>
</tr>
<tr>
<td>6</td>
<td>T₆</td>
<td>0.98(4.79)</td>
<td>0.19(2.49)</td>
<td>0.78(5.07)</td>
<td>1.220(6.34)</td>
<td>0.40(3.63)</td>
<td>1.12(6.07)</td>
<td>1.58(7.22)</td>
<td>0.42(3.71)</td>
<td>1.25(6.42)</td>
</tr>
</tbody>
</table>

Sem

CD(P=0.05) N.S

CV (%) 3.87 4.743 4.166 3.19 3.31 3.93
From the above results and discussion it can be concluded *Pleurotus florida* can be grown on pure maize and sorghum stalks and combinations with paddy straw with good yield, proteins, sugars and amino acid on par with paddy straw.

Among the two different substrates used viz., fresh maize stalks and mushroom spent substrate, nutrient contents were more in the treatments with spent substrate compared to treatments with fresh maize substrates in all the stages. So in this way double benefits can be reaped for growing mushroom from maize and sorghum stalks which in turn gives compost of high nutritive value after mushroom production.

Spent mushroom substrate may also have some organo chloride pesticide residues used against fungus and also chemicals may also have been used to treat the straw. It may be contamination of ground water and rivers, due to high phosphorus content of spent mushroom substrate in that way composting of spent mushroom substrates are ecologically sound.

01-19

**MILLETS: RESILIENT CROPS IN CHANGING CLIMATE**

*Triveni, U., Mounika, D and Martin Luther, M.*
Department of Agronomy, Agricultural College, Bapatla
Corresponding author: triveniungata@gmail.com

Millets are also known as ‘coarse cereals’. These are widely grown around the world for fodder and human food. Millets are broadly classified in to two, 1) Major millets and 2) Minor millets. Major millets include Sorghum /Jowar (*Sorghum bicolour*) and Pearl millet /Bajra (*Pennisetum glaucum*); and minor millets include Fingermillet or Ragı (*Eleusine coracana*), Foxtail millet (*Setaria italic*), Little millet /Samai (*Panicum miliare*), Common millet (*Panicum miliaceum*), Barnyard millet (*Echinchloa colona var frumentaceae*), Kodomillet /Varagu (*Paspalum scrobiculatum*). Millets are nutritionally superior to other major cereals as they are rich in dietary fibres, resistant starches, vitamins, essential amino acids, storage proteins and other bioactive compounds. Fingermillet, is full of calcium and phosphorus, jowar have potassium and phosphorus and foxtail millet is fibrous kodomillet, pearlmillet and barnyardmillet are rich in iron, prosomillet and foxtailmillet are rich in protein. Millets are non-gluten foods and are having low glycemic index value.

Almost all the millets are the best fit for contingent planning during aberrant weather conditions because of their photo insensitivity, drought resistant and earliness. Millets have a wider scope to be introduced as an intercrop, relay crop and sequence crop with cereals, grain legumes, vegetables and oil seed crops. It was reported that the highest B:C ratio with Finger millet+Pigeon pea(8:2) followed by Finger millet+Bhendi (8:2) intercropping system. Introduction of *rabi* jowar as relay crop in foxtailmillet. Introduction of fingermillet as relay crop in *kharif* paddy, growing of pearl millet/sorghum in zero till conditions after harvest of *kharif* paddy are some of the newly emerging successful millet based cropping systems in Andhra Pradesh.

In recent times, pulses production in rice fallow lands in Andhra Pradesh has declined drastically due to the risk of pests and disease problems like yellow vein mosaic virus disease, powdery mildew, cercospora leaf spot and leaf curl. Millets can successfully be grown as an effective alternative to pulses in the areas where these problems are severe. As they are short duration and drought tolerant, they can sustain on residual soil moisture. Millets are C4 grasses and are known for their climate-resilient features including adaptation to a wide range of ecological conditions, less irrigational requirements, better growth and productivity in low nutrient input conditions, less reliance on synthetic fertilizers, and minimum vulnerability to environmental stresses. Millets hold great promise for food security and nutrition to the burgeoning population worldwide. These features accentuate millets as crops of choice amid growing concerns about climate change.

**Key words:** Millets, climate change, resilient crops, nutrition, food security.
CLIMATE SMART AGRICULTURE: DEVELOPING MODELS AT A REGIONAL SCALE

Department of Agronomy, Agricultural College, Mahanandi

Agriculture faces some stiff challenges in future. It has to address the fact that almost one billion people go to bed hungry every day, while more than two billion people will be added to the global population by 2050. There is increased competition for land, water, energy, and other inputs into food production. Climate change poses additional challenges to agriculture, particularly in developing countries. At the same time, many current farming practices damage the environment and are a major source (19-29%) of anthropogenic greenhouse gas emissions. ‘Climate smart agriculture’ is an approach that has recently achieved much prominence, given the adaptation and mitigation challenges facing humanity. CSA is defined by three objectives: 1) increasing agricultural productivity to support increased incomes, food security and development, 2) increasing adaptive capacity at multiple levels and 3) decreasing greenhouse gas emissions and increasing carbon sinks. Since the relative priority of each objective varies across locations, with for example greater emphasis on productivity and adaptive capacity in low input smallholder farming systems in least developed countries, an essential element of CSA is identifying potential synergies and trade-offs between objectives. The promotion of climate smart agriculture in different parts of the world requires a clear understanding of its relative suitability, costs and benefits and the environmental implications of various technological interventions in a local context under current and future climates. Such data are generally difficult to obtain from the literature, field surveys and focused group discussions, or from biophysical experiments. This describes a spreadsheet based methodology that generates this information based on a region specific production function and ‘target yield’ approach in current and future climate scenarios. Target yields are identified for homogeneous agroecological spatial units using published crop yield datasets, crop models, expert judgement, biophysical and characterisations, assessment of yield gaps and future development strategies. Transfer functions are used to establish relationships between inputs and outputs. The process is repeated for all spatial units of the region, identified through detailed mapping of critical biophysical factors and for all suitable current and potential agronomic production technologies and practices. The application of this approach is illustrated for prioritizing agronomic interventions that can enhance productivity and incomes, help farmers adapt to current risk and decrease greenhouse gas emissions in current and future climates for the flood and drought prone states. In general, climate smartness increases with advanced technologies. Yield is the least limiting while emission is the most limiting factor across the entire crop technology portfolio for climate smartness. Finally, it presents a robust climate smart land use plan at district level under current and future climate scenarios in any state, country etc.

Keywords: Climate smart agriculture, Agricultural productivity and Green house gases.

AGRONOMIC INTERVENTIONS FOR ENHANCING PRODUCTIVITY IN CASTOR

Jyothi Raju, N. N and Venkateswarlu, B.
Department of Agronomy, Agricultural College, Bapatla.
Corresponding author: jyothiraju.ag@gmail.com

Castor (Ricinus communis L.) is the most primitive non-edible oilseed crop, playing a vital role in oilseed economy of our country. India is the largest producer of castor seed and oil in the world. In Andhra Pradesh, total area, production and productivity of castor crop during 2014-15 were 48,000 hectares, 27,000
tonnes and 600 kg ha\(^{-1}\). Enhanced production is possible mainly through appropriate agro techniques which include sowing, crop geometry, nutrient, irrigation, cropping systems, nipping managements.

Sowing around onset of south–west monsoon i.e. June to July found to be optimum. Sowing beyond July reduced yield significantly. Early sowing of castor (May 30\(^{th}\)) recorded significantly higher seed yield (2400 kg ha\(^{-1}\)) as compared to June 30\(^{th}\) (1771 kg ha\(^{-1}\)) and July 30\(^{th}\) sowings (870 kg ha\(^{-1}\)). During *rabi*, planting castor at 90cm x 45cm spacing recorded significantly higher plant population and plant height (153.5 cm). While number of branches plant\(^{-1}\)(8.8), no. of spikes plant\(^{-1}\)(8.3), length of main spike (60.4 cm) and no. of capsules per spike (64.4) as well as seed (82.2 g plant\(^{-1}\)) were significantly higher under wider spacing of 120cm x 60cm.

Among three nitrogen levels, seed yield was higher with application of 120 kg N ha\(^{-1}\) it was on par with 90 kg N ha\(^{-1}\). Spike length was more with application of 120 kg N ha\(^{-1}\) (50.3cm) which was on par with 90 kg N (50 cm). Application of 20 kg sulphur per hectare through single superphosphate recorded significantly higher seed yield (2685 kg ha\(^{-1}\)) compared to no sulphur application (2093 kg ha\(^{-1}\)).

For realizing the full productivity potentials, the first irrigation should be applied at around 55 days or around full flowering of primary spike. Scheduling of irrigation through trickle method @ 0.9 pan evaporation resulted in significantly higher seed yield of 2978 kg ha\(^{-1}\) as compared to that of 0.6 pan evaporation and 0.3 pan evaporation. Pre-emergence application of pendimethalin@ 1 kg/ha one inter-cultivation at 40 DAS resulted in better weed control efficiency to realize higher seed yield and net returns under rainfed conditions.

Short duration pulses and coriander can be grown as intercrops without affecting the yield of castor. Intercropping castor with fingermillet in 1:2 row proportion recorded significantly higher castor equivalent yield compared to rest of intercropping systems and sole castor. Staggered nipping recorded significantly highest yield (2144 kg ha\(^{-1}\)) as against non-nipping (1217 kg ha\(^{-1}\)). Nipping in castor significantly increased the seed yield. Periodical staggered nipping leaving one spike in each branch recorded significantly higher seed yield as compared to non-nipping treatments.

**Keywords:** Castor oil, crop geometry, sulphur, irrigation and nipping

---

**01-22**

**IMPORTANCE OF ORGANIC FARMING AND RESOURCE USE EFFICIENCY IN CROP IMPROVEMENT**

*Ravichandra Reddy, P and Chakraborty, D.*

Department of Entomology, Agricultural College, Bapatla.

Corresponding author: ravichandrareddy1994@gmail.com

As natural resources become increasingly scarce, the transition to a more resource-efficient economy must be a top priority over the coming years. The challenge for agriculture lies in securing sufficient food supply for future generations while reducing resource use and increasing resource recycling. Healthy soil builds the foundation of food production, but is being threatened by degradation and erosion. Organic farming practices increase soil stability, organic matter content and thereby resilience to changing climate conditions. Organic farmland is rich in biodiversity; it bears on average 30% more species than conventional farm land, contributing to the maintenance of ecosystem services from pollination and nutrient recycling, to clean water and air. Organic farming practices also make an important contribution to sustainable phosphorus (P) and potassium (K) use by reducing nutrient inputs and outputs, replenishing P and K stocks through effective crop rotation, and recycling manure to close nutrient cycles. Soil is now increasingly threatened by a number of anthropogenic activities such as erosion (loss of topsoil and humus), humus and nutrient depletion, surface sealing, salinisation (excessive amounts of sodium, magnesium and calcium), contamination and compaction.
Healthy soil is at the heart of organic agriculture. By respecting nature and natural processes and resources, and incorporating farming practices such as crop rotations, cover cropping, alley farming, agro-forestry, animal manure, integration of crop and livestock farming, and abstention from synthetic fertilisers and pesticides, organic farming etc., contributes to a healthy ecosystem, good soil conditions and water environments. Organic farms generally have improved soils teeming with biodiversity, storing carbon and building humus. Organic farming is also best placed to respond to the challenges of effective nitrogen management, with many beneficial practices already an integral part of organic farming systems. Farming practices such as multi-annual crop rotation are particularly important for increasing availability of P in the soil. 21-year comparative study of biodynamic, organic and conventional systems, based on ley rotations in Switzerland, for instance, found that while inputs of N, P & K were 34-51% lower in organic systems, soil activity on organic farms observed faster phosphorus flux through the microbial biomass, which contributed to P supply among plants. Other practices such as intercropping allow farmers to recover currently insoluble forms of P through the cultivation of legumes. While organic farming is on the right path, it must perform better in the future if it is to address the growing problems associated with diminishing supplies of P and K. Currently, over-pumping of groundwater exceeds the ability of the earth to replenish levels by at least 160 billion cubic metres each year. Intensification of agriculture as a means to increase production would lead to more water pollution. Organic farming systems have much to offer in terms of water quality and the management of water holding capacity, as they contribute to the preservation and restoration of water quality, protecting downstream users and water habitats that are rich in biodiversity.

**Key words:** Organic farming, water quality resource use efficiency and crop improvement

01-23

**AGRONOMIC OPTIONS TO ENHANCE THE PRODUCTIVITY AND PROFITABILITY OF MILLETS**

*Prasanth Mourya, G., Prahitbha Sree, S., Mallikarjuna Reddy, K and Manoj Naidu, S.*

Department of Agronomy (Water Management), Advanced Post Graduate Centre, Lam, Guntur

Corresponding author: mouryaprashanth@gmail.com

Millets such as sorghum, pearl millet, foxtail millet, little millet, kodo millet and proso millet need very little water for their production as compared to other cereal crops due to an efficient root system and short life cycle. Millets are important crops in the semi-arid tropics of Asia and Africa with 97% of millet production in developing countries. Millets are all season crops cultivated round the year and are efficient in producing higher yield per unit quantity of water. They are drought resistant crops and require few external inputs. All these qualities of millets make them as the climate resilient crops. In spite of all the extraordinary qualities the area under millets production has shrinking.

Millets possess several morpho-physiological, molecular and biochemical characteristics which confer better tolerance to environmental stresses than major cereals. Hence extensive phenotypic screening to observe the natural genetic variations in stress tolerance across diverse millet germplasm is greatly needed to fully harness the underlying genetic potential through conventional / molecular breeding approach and transgenic technologies. Cropping system based approach of research in holistic manner to sustain the productivity levels of millets is essential. Pearl millet-groundnut, finger millet-cluster bean, finger millet-sorghum, pearl millet-mustard, pearl millet- greengram are some of the millet based cropping system under the low rainfall semi-arid regions to enhance water productivity. Intercropping of millets with legumes like pigeonpea/ greengram/ soybean/ black gram has been found profitable. Most of the HYV and hybrids of sorghum and pearl millet fit well in different cropping systems. Ridge and furrow method of sowing recorded higher grain yield of pearl millet and
chickpea which were 38.2% and 23.8% higher than flat bed method of sowing in Pearlmillet – Chickpea cropping sequence in a watershed at Rahuri, Maharashtra. Modification in surface configuration as ridge and furrow, plastic mulch and presowing seed hardening with KNO₃ enhanced the grain yield to the tune of 22.14, 48 and 10 per cent over flat sowing, straw and dust mulch and with out seed hardening on sandy loam soils of Bikaner, Rajasthan.

Millets provide better nutrition compared to many other food grains and they are now termed as nutritional grains. Favourable pricing, secured market, Inclusion of millets in Public Distribution System (PDS) and Research and extension support as in the case of any other commercial and major cereal crops are the major areas on which action is needed for increasing the productivity and profitability of millets.

01-24

WATER PRODUCTIVITY AND YIELD OF SUMMER PEARLMILLET AS INFLUENCED BY CULTIVARS AND INTEGRATED NUTRIENT MANAGEMENT

Divya, G., Vani, K.P., Surendra Babu, P and Suneetha Devi, K.B.
Department of Agronomy, College of Agriculture, Hyderabad

An experiment was conducted to evaluate the water productivity and yield of summer pearl millet influenced by cultivars and integrated nutrient management at College of Agriculture, Professor Jayashankar Telangana State Agricultural University, Rajendranagar during Summer season 2017-2018. The experiment comprised of nine treatment combination, three levels of cultivars i.e. ICMV-221 (C₁), Dhanashakti (C₂) and PHB-3 (C₃) as first factor and three integrated nutrient management practices i.e. 100% RDF (F₁), 75% RDF + 25% N through vermicompost (F₂) and 75% RDF + Biofertilizers @ 5 kg ha⁻¹ incubated with vermicompost @ 500 kg ha⁻¹ (F₃) as second factor comprising nine treatment combinations, laid out in randomized block design with factorial concept, replicated thrice. The findings revealed that PHB-3 had higher water productivity among the cultivars and 75% RDF + Biofertilizers @ 5 kg ha⁻¹ incubated with vermicompost @ 500 kg ha⁻¹ in integrated nutrient management. Highest grain yield was observed with PHB-3 and 75% RDF + Biofertilizers @ 5 kg ha⁻¹ incubated with vermicompost @ 500 kg ha⁻¹ among the cultivars and INM respectively. Therefore, in addition to increase in crop yield, application of organic manures decreases the amount of water used in the production process and increases crop water productivity substantially.

Key words: Water productivity, summer pearlmillet, integrated nutrient management

01-25

EVALUATION OF NATURAL FARMING ON PERFORMANCE OF MAIZE IN COMPARISON WITH INORGANIC AND ORGANIC FARMING ON SOIL PROPERTIES.

Vinay, G., Padmaja, B., Malla Reddy, M and Jayasree, G.
Department of Agronomy, College of Agriculture, Polasa, Jagtial, Hyderabad

A field experiment was carried out during kharif 2016 on sandy clay loam at College Farm of Agricultural College, Jagtial with an objective to evaluate the “natural farming on performance of maize in comparison with inorganic and organic farming”. The soil was slightly alkaline with a pH of 7.65, EC, 0.074 d Sm⁻¹, low in organic carbon (0.47%) and low in available N (164 kg ha⁻¹) high in available P (43 kg ha⁻¹) and medium in available K (277 kg ha⁻¹). The experiment was laid out in randomized block design with factorial concept and replicated thrice. Eight treatment combinations were taken viz., factor I: Variety vs Hybrid: 2, V₁: DHM 117, V₂: Aswini, factor II: Farming method:4, F1: Absolute control, F2: Natural farming,
F3: Organic farming and F4: Inorganic farming. The results from present study revealed that significantly higher organic carbon content was left in the soil after maize crop in organic method over the other methods, while pH and EC did not change due to farming methods or variety/hybrid. Higher, available N and K₂O were recorded in inorganic farming while available P₂O₅ and Zn were higher in organic farming.

**Key words:** Natural farming, organic farming, inorganic farming.

01-26

**METHODS AND TECHNOLOGIES TO IMPROVE WATER USE EFFICIENCY IN RICE**

*Mounika, D., Kiran Kumar, S., Venkatalakshmi, M and Triveni, U.*

Department of Agronomy, Agricultural College, Bapatla
Corresponding author: dmounika358@gmail.com

Rice (*Oryza sativa* L.) is one of the most important staple food crops in the world. The declining availability and increasing costs of water threaten the traditional way of producing irrigated rice. Moreover, lack of rainfall is a major production constraint in rainfed areas where many poor rice farmers live. Water-saving irrigation techniques often run the risk of yield reduction because of possible drought stress effects on the crop. Therefore, relationship between water input and rice yield needs to be established to find out how far water can be reduced without compromising the economic yield for optimizing use of water in rice production.

In Alternate wetting and drying irrigation (AWDI) water applied to the field in certain number of days, after the disappearance of previously ponded water and field kept in alternately flooded and non-flooded condition. Success of AWDI largely depends on irrigating the field at right time, when plant needs water. Micro irrigation is the slow rate of water application at discrete locations at low pressures, and includes trickle or surface drip, subsurface drip, microsprinklers and bubblers. These systems have small diameter tubing laid in the field, either on the surface or underground, with small water application devices that apply water (usually a drip or very small stream of water) directly to a plant at low pressures.

Aerobic rice production is a revolutionary way of growing rice in well-drained, non puddled, and non-saturated soils without ponded water. There was a saving of 31-36% of water in aerobic rice as compared to puddle and flooded conditions. Significant improvement in water use efficiency (WUE) to the tune of 39 per cent was recorded under intermittently irrigated System of Rice Intensification (SRI) over continuously non traditional flooded conditions.

Remote sensing of plant and soil status using integrated satellite, aerial, and field level plant and soil based sensor systems can provide information on plant and soil nutrient and water status. Nevertheless, this technology needs further development to improve spatial-temporal modeling for on-farm management as well as irrigation operations.

Irrigation scheduling could be very effective in improving water management when based on distributed networks of farm-level microclimate and soil water sensor stations that feed into a microprocessor control system to manage irrigations.

**Key words:** Aerobic Rice, Rice water saving technologies, Alternate wetting and drying.
01-27

CROP PRODUCTION CONSTRAINTS AND STRATEGIES FOR IMPROVEMENT IN GODAVARI ZONE OF ANDHRA PRADESH

Ganapathi, S., Bharathi, S., SreeRekha, M and Jayalalitha, K.
Department of Agronomy, Agricultural College, Bapatla.
Correspondent author: poddu13@gmail.com

In Andhra Pradesh, 160 l.hao of total geographical area, out of 63.0 l.ha of net sown area, 37 l.ha is in coastal region. Out of which 8.5 l. ha is in central coastal zone (East Godavari and West Godavari). Major soils of East Godavari is black soils very fertile and productive. Usual weather conditions are South-West monsoon is active over the district than North-East monsoon. June–November months receive good rainfall which facilitate satisfactory crop season. Temperatures are congenial for cultivation of crops both during kharif and rabi seasons. Floods are common in low lying areas during heavy rainfall periods due to poor drainage. Cropping intensity is 183.3%. Majority of the area is under kharif rice which was followed by rice in rabi. Major soils of West Godavari is alluvial soils supported by canal irrigation are fertile and productive. Prevailing weather conditions are South-West monsoon is active over the district. Copious rainfall is received from June to November. is facilitating a good crop season. Temperatures are congenial for cultivation of crops both during kharif and rabi seasons. Floods are common in low lying areas during heavy rainfall periods due to poor drainage. Cropping intensity is 161.9%. Majority of the area is under kharif rice which is followed by rice sequence in rabi of late kharif rice is followed by rabi Maize.

Main crop production constraints in Godavari zone is delayed planting due to late release of canal water, cloudy weather with low sunshine hours during kharif season, incidence of BPH and stem rot in rice cultivation, delayed rice plantings with over aged seedlings, problem of bacterial leaf blight and sheath blight in rice low lying areas with poor drainage causing water logging. Rat menace in rice cultivation, sucking pest complex in cotton, non adoption of suitable package of practices for maize grown in rice fallows under zero tillage, non availability of proper machinery used in rice, cotton and sugarcane, heavy incidence of YMV in green gram and black gram grown in rice fallows during summer season, low yields in Sugarcane due to poor drainage, red rot and smut diseases in sugarcane, problem of wilt disease in red gram. Therefore strategies to improve Godavari zone are standardization of management practice for over aged seedlings, popularisation of MTU 1064, MTU 1075 and MTU 1061 to have varietal diversification in rice, popularisation of YMV resistant varieties of greengram and blackgram, popularisation of water saving rice production technologies, identification of resistant gene for biotic stress, particularly for plant hoppers viz. BPH and WBPH and also for diseases like Bacterial leaf blight in paddy by using bio-technology tools. Development of high yielding varieties (HYVs) of sugarcane resistant to diseases and water logging, are essential to enhance the production. 

Key words: Cropping Intensity, BPH, zero tillage, YMV and HYVs

01-28

CLIMATE SMART AGRICULTURE: PROSPECTS AND ADAPTATION

Madhurya, D., Murthy, V.R.K and Sree Rekha, M.
Department of Agronomy, Agricultural College, Bapatla

Fluctuations in climate is always a natural phenomenon, but in recent years mushrooming industries and expanded population has imposed pollution threat which ultimately resulted in damaged atmosphere and brought irreparable changes. Urbanization has imposed land stress leaving a little area for agriculture. Reduced land availability has lead to intensive agriculture with change in climatic conditions.
To balance these challenges a paradigm is essential. Climate smart agriculture (CSA) is one such approach that aims to address the challenges of food security. CSA is defined as “agriculture that sustainably increases productivity of climate resilience and enhances achievement of national food security and development goals. CSA concept by definition envisions a transformation of agriculture systems to achieve short and long term agricultural development goals that integrate the three dimensions of sustainable development by simultaneously addressing food security and climate changes.

Though technical side of CSA receives most attention, institutional and policy support will be required for major transformation of agriculture sector with better aligned policy approaches across agricultural, environmental and financial boundaries. Institutions play a major role in CSA implementation when it comes to promoting social inclusiveness, developing a reliable knowledge base, infusing knowledge on climate and responses.

There are different views about CSA and the way to move forward. Technology has played a key role in the advancement of agriculture and food production during the past decades at the same time technology alone cannot solve all the problems. Imparting the knowledge of CSA at field level to farmers is most essential for achieving the aim. The CSA is criticised for increasing smallholder participation in carbon markets and carbon mitigation. Keeping apart all the views, CSA if implemented in true sense it has a significant role in promoting food security and contributing to a range of development goals. Barriers should be met with enabling farmer made decisions along with evidence and context specific approach. There are several approaches by which CSA can be adapted.

A study conducted in Andhra Pradesh and Telangana demonstrated that alternate wetting and drying irrigation, fields have on an average 26% lower irrigation water requirements compared with conventional rice cultivation method and proved that AWD irrigation is a climate smart agriculture practice with multiple benefits. Another study on rice cultivation by SRI method has out yielded conventional method with respect to reducing GHG emissions particularly methane and increasing yield.

**Key words:** Climate Smart Agriculture, agriculture development and landscape approach.

---

**01-29**

**TRENDS OF PULSES PRODUCTION, CONSUMPTION AND IMPORT SCENARIO IN INDIA**

*Pradeep Kumar, P and Dharmendra*

Department of Agriculture Economics & Farm Management
College of Agriculture, Rewa, (M.P.)

Historically, India is the largest producer, consumer and importer of pulses. India accounts for 25 percent of world’s pulses production, consumes 27 percent and imports around 14 percent of its pulses requirement. As per the fourth advance estimates for 2016-17, the production of pulses is projected to be 17.83 million tonnes. Among various pulse crops, chickpea dominates with over 40 percent share of total pulse production followed by Pigeonpea (14%), Moong bean (10%) Urdbean (30%) and other legumes (19%). According to 2016 figures, Madhya Pradesh is India’s largest pulse producing State with 26% share in overall production. For majority of vegetarian population in India, pulses are the major source of protein. Although it is the world’s largest pulses producer, there is still a huge shortage of pulses and also the prices were not affordable to a large section of consumers. An immediate need is the development and dissemination of low-cost technologies in pulses production, so that pulses can be affordable to the common man. Analyses status of pulse crop in India as whole and Madhya Pradesh in particular is that the policy decision, technology generation and dissemination gap are the issues to be addressed.

**Key words:** Pulse production, shortage of pulse production and technology generation.
CROP PRODUCTION CONSTRAINTS AND STRATEGIES IN KRISHNA ZONE

Venkatalakshmi, M., Kirankumar, S., Mounika, D and Goutami, N.
Department of Agronomy, Agricultural College, Bapatla
Corresponding author: mamidi.venkatalakshmi@gmail.com

Krishna district stands first in area, production and productivity of black gram, whereas third in area and production of rice in the State and this district recorded the highest literacy rate with 74.4% and stands first in the State. Most of the rainfall is received under the influence of SW monsoon even through October and November months receive copious rainfall from NE monsoon. Most of the years, the rainfall facilitates crop cultivation. The temperatures are congenial both for kharif and rabi crops. Black soils though highly productive are prone to water logging and floods during heavy downpour periods as these are situated in low land areas. Rice is the most dominant crops grown in these soils. Red soil tracts in the district are medium in depth and mostly utilized for orchards under rainfed or minor irrigation sources. Main crops grown during kharif season are rice, cotton, sugarcane, chilli and maize of which rice and cotton cover more than 80% of the cropped area and during rabi season blackgram, greengram, rice, maize, groundnut, tobacco and bengal gram are the main crops usually grown, of which blackgram and rice cover more than 80% of the area. Predominant cropping systems are Rice-pulse, Rice-maize, Rice- sugarcane and Cotton-fallow. Crop production constraints are delayed plantings due to late release of canal water, water logging and soil salinity resulting in poor yields in sugarcane, problem of BPH and lodging in rice, weed problem in direct sown rice, severe incidence of red rot and smut disease in sugarcane and non availability of suitable machinery in cotton and sugarcane.

Strategies for enhancing crop productivity includes: a) Reclamation of saline and alkaline soils b) Development of high yielding rice varieties as alternatives to BPT 5204 with resistance to BPH c) Weed management in direct seeded rice d) Identification of resistant gene for biotic stress particularly for Bacterial Leaf Blight and also for BPH and WBPH in paddy by using bio-technology tools. e) Development of high yielding sugarcane varieties for biotic and abiotic stresses. f) Complete mechanization in rice, pulses, cotton and sugarcane

Key words: Crop production, reclamation of saline soils, weed management and mechanization.

WATER PRODUCTIVITY AND WATER USE EFFICIENCY OF MILLET BASED CROPPING SYSTEMS

Nazma, S., Venkata Lakshmi, N., Chandrasekhar, K and PrathibhaSree, S.
Department of Agronomy (Water Management)
Advanced Post Graduate Centre, Lam, ANGRAU
Corresponding author: nazmashaik095@gmail.com

Water is the prime natural resource which very often becomes costly and limiting input particularly in semi-arid tropics and needs to be judiciously used to reap the maximum benefit of other inputs. Millet is one of the efficient field crops in producing higher yield per unit quantity of water with the aim of conserving resources, improving input-use efficiency and to sustain productivity. Millets are drought resistant crops and require few external inputs. They can be grown under arid and semi-arid environments requiring less water than many other cereals. Water requirement is very less as compared to other crops due to an efficient root system. They require one to two irrigations for entire growing season.
The rainfall needed for sorghum, pearl millet and finger millet is less than 25% of sugarcane and banana and 30% that of rice. Millets are all-season crops cultivated round the year. Millets require 2-3 irrigations coinciding with tillering, flowering and grain filling stages. They can survive and reliably produce small quantities of grain in areas where mean annual precipitation is as low as 300 mm. This compares with a minimum water requirement of 400 mm for sorghum and 500-600 mm for maize.

Pearlmillet-cabbage-cowpea-pearlmillet-wheat millet based cropping system recorded highest grain yield (28146 kg/ha) and water use efficiency (219.89 kg/ha cm) in Jaipur. Sorghum + green manure inter cropping system recorded the highest water productivity (1.18 kg/m³) and grain yield (823 kg/ha) in Rajasthan. Grain yield, water use and water use efficiency influenced by maize + sorghum inter cropping system and reported that 1:1 row arrangement recorded highest grain yield (3517.11 kg/ha) in Nigeria. Water use efficiency was highest under sorghum + pigeonpea inter cropping system (40 kg/ha cm) in Rajasthan. Highest grain yield (21.36 q/ha) and WUE(9.56 kg/ha mm) was recorded under pearlmillet + cowpea inter cropping system in New Delhi. Highest yield and water use efficiency was recorded under corn followed by millet but corn required more water but millets required less water because short growing season in China.

Water use efficiency was highest under millet – cowpea cropping system (10.08 kg/ha mm) in Nigeria. Inter cropping system of 4– row peanut with 2- row millet recorded the highest grain yield and water use efficiency compared to 2– row peanut with 2- row millet cropping system. Sorghum + cowpea inter cropping system recorded the highest water use efficiency (76.85 kg/ha mm) and grain yield (1.39 t/ha) in South Africa.

**Key words:** Natural resource, water requirement, water use efficiency, cropping system.

01-32

**DIRECT SEEDED RICE - WEED MANAGEMENT**

*Aliveni, A., Sravanthi, S and Venkateswarlu, B.*

Department of Agronomy, Agricultural College, Bapatla

Corresponding author: aliveni165@gmail.com

Rice is cultivated in India in a very wide range of ecosystems from irrigated to shallow lowlands, mid-deep lowlands, deep water to uplands. Transplanting is the major method of rice cultivation in India. However, transplanting is becoming increasingly difficult due to shortage and high cost of labour as transplanting itself takes 25 per cent of the total labour requirement of the rice crop and scarcity of water as it consumes about 30 per cent of the total water requirement of rice for puddling and transplanting. Direct-seeding is gaining popularity among farmers of India and other Asian countries and a good alternative to transplanting as it is more economical and labour saving. DSR matures 7 to 10 days earlier than transplanted rice due to absence of transplanting shock and the yield was almost at par with transplanted crop.

Tough DSR has several disadvantages poor germination, uneven crop stand and high weed infestation are the major constrains. In the rice agro-ecosystems ideal environment conditions are provided for optimal rice productivity are being exploited by the associated weeds. The weed-rice ecological relationship is very complex and dynamic. Weed spectrum and degree of infestation in rice field are often determined by rice ecosystems and establishment methods. However the risk of yield loss from weeds in direct seeded rice is greater than transplanted rice. Yield reduction up to 48, 53 and 74% in transplanted, direct seeded flooded and direct seeded aerobic rice, respectively.

Crop-weed competition is more severe in DSR than in transplanted rice. Because weeds and rice seedlings emerge simultaneously, competitive advantage of the crop is reduced and also the alternate events of wetting and drying enhance growth of weeds. In DSR, the critical period of weed competition has been reported to be 14-41 days after sowing and weed control during the critical weed-free period is essential to
reduce the weed competition and for effective utilization of available resources for enhanced productivity. Weed management is a fundamental practice, failure of which may result in severe losses in terms of yield and economic return. Weeds are mainly controlled using herbicides or manually. However, manual weeding is becoming less effective because of labor crisis at critical times and increased labor costs. Herbicides are replacing manual weeding as they are easy to use. Herbicide is the smartest and most economic tool to fight against weeds.

Pre-emergence application of pendimethalin 0.75 kg ha\(^{-1}\) followed by post-emergence application of bispyribac 25 g ha\(^{-1}\) (30 DAS) resulted in significant reduction in weed dry weight (2.95 q ha\(^{-1}\)) compared to all other treatments on loamy sand soils of Ludhiana, Punjab. On clay loam soils of Pusa, Bihar. (2010) reported that significantly higher grain and straw yield was observed in weed free treatment being at par with azimsulfuron at 25\(^{\circ}\) applied alone or in combination with almix (2685 & 4352 kg ha\(^{-1}\))

**Key words:** Direct seeded rice, weed management and herbicides

01-33

**CONSERVATION AGRICULTURE- A POTENTIAL ALTERNATIVE TO SUSTAIN SOIL HEALTH AND CROP PRODUCTIVITY**

*Salomi Grace, M.*

Department of Agronomy, Agricultural College, Naira.

Agricultural intensification from intensive tillage based production systems generally had a negative effect on soil, water, biodiversity and the associated ecosystem services provided by nature. This degradation of land resource base has caused crop yields and other factor productivities to decline and has forced farmers and scientists to search for an alternative technology that is ecologically sustainable as well as profitable. A set of soil-crop-nutrient-water-landscape system management practices known as conservation agriculture has the potential to deliver all of these goals. Conservation agriculture (CA) has steadily increased worldwide to cover about ~8% (124.8 M ha) (FAO, 2012) of the world arable land. In India over the past few years, adoption of zero tillage and CA has expanded to cover about 1.5 million hectares (Jat *et al.*, 2012). The Indo-Gangetic Plains (IGP) of India is an important region for agricultural production and food security contributing to 50% of the total food grain production and supporting food security of more than 40% population.

**A. Outside India**

*Jane *et al.*, (2014) investigated changes over time, associated with the practice of conservation agriculture in selected soil chemical, physical and biological properties, including an assessment of the effects on soil respiration, nodulation and biological nitrogen fixation in soybean in School of Agricultural Sciences, University of Zambia, Zambia. Six paired soil samples were collected from conservation agriculture and conventional tillage fields. Fields under conservation agriculture were 4, 7 and 16 years old while those under conventional tillage had been cultivated for over 18 years. Effect of CA Practice on Soil Physical, chemical and biological properties is studied.

Bulk density reduced with the age of the CA plot with the 16 years site having the lowest. Soil organic carbon plays an important role in maintaining a good soil physical structure through increased soil particle aggregation which ultimately results in lower bulk density.

The soils from CA plots had a higher pH average 6.18 than the CT (5.62). The results also suggested an increase in pH over the years. This shows that over time CA practices can reduce soil acidification.
SOC under CA was higher than in CT ranging from 1.54 to 1.87%. There was a general increase in SOC under CA over time, while the reverse was true for CT (1.57 to 1.38).

For total N, significant differences were observed at 4 and 16 years. Soils under CA had more total nitrogen, but there was a reduction in N under CT with age.

In general, both soil microbial biomass-C and respiration-CO$_2$ increased with number of years under CA. Reduced tillage and residue retention promote organic matter accumulation.

The number of nodules increased with age of the CA site. It was also observed that the nodules per plant were bigger in CA than in CT soils. The biologically fixed N was higher by 190 and 127% in CA compared to CT.

B. IN INDIA

Conservation agriculture (CA) is considered as a suitable technique for soil erosion control, productivity enhancement, and improved economic benefits. To investigate these issues, an experiment was conducted under rainfed conditions using grass vegetation strip (VS) with minimum tillage, organic amendments and weed mulch during June 2007–October 2011 at Dehradun, Uttarakhand in Himalayan region by Ghosh et al., 2015. The experiment was laid out on a 2% slope, with vegetation grass strips of Palmarosa in maize–wheat crop rotations. Mean runoffs during the growing seasons were 39.8% from plots under conventional agriculture, whereas plots with CA recorded only 21.9% runoff. Weed cut and mulch with MT, along with Palmarosa as a vegetation strip, maintained surface soil even during high intensity rainfall events. Mean maize yield was 1570 kg/ha with conventional agriculture compared to 2000 kg/ha in CA plots, an increase of about 27%.

SUMMARY AND CONCLUSIONS

Conservation agriculture demonstrated its potential by promoting soil microbial population and activity as evidenced through microbial biomass, soil respiration, nodulation, BNF, pH, SOC, total nitrogen, porosity, reduced BD, reduction in runoff losses, soil water retention and increased productivity. However, the soil improvement benefits and crop productivity of conservation agriculture practices become evident after at least seven years of practice and for some, it can take as long as 16 years.

01-34

INFLUENCE OF CLIMATE CHANGE ON PLANT DISEASES

*Ranga Rani, A., Rajan, C.P.D and Harathi, P.N.*
Department of Plant Pathology, S.V. Agricultural College, Tirupathi
Corresponding author: atlarangarani@gmail.com

Climate change is the biggest threat to mankind, and is the cause of nearly 0.4 million deaths a year worldwide and costing the world more than US$ 1.2 trillion. Such changes will have a drastic effect on the growth and cultivation of the different crops on the Earth. The classic disease triangle recognizes the role of physical environment in plant disease as no virulent pathogen can induce disease on a highly susceptible host if weather conditions are not favorable. Climate change may have positive, negative or neutral impact on diseases. CO$_2$ may increase in a greater biomass of high nutritional quality, combined with a much higher microclimate relative humidity. This would be likely to promote plant diseases such as rusts, powdery mildews, leaf spots and blights. Rice plants grown in an elevated CO$_2$ were more susceptible to leaf blast than those in ambient CO$_2$ as indicated by the more number of leaf blast lesions. Acute ozone could inhibit appressoria formation and vegetative growth of pathogen resulting in decreasing of rice blast development during summer. Bud necrosis viral disease infection is strongly influenced by Humidity, Temperature, prolonged leaf wetness...
and Thrips. Changes in Climate influence disease epidemiology. Best management is early detection and elimination wherever it is possible.

**Key words:** Climate change, disease triangle, epidemiology

---

**01-35**

**CONSERVATION OF NATURAL RESOURCES FOR SUSTAINABLE AGRICULTURE-SOIL MOISTURE MANAGEMENT**

*Arunakumari, H and Vinaya Lakshmi, P.*

Department of Agronomy, Agricultural College, Bapatla

Corresponding author: hanumanthu.aruna@gmail.com

In India out of 143.8 m ha of cultivated land, dryland and rainfed area constitutes 69.5%. These areas contribute about 42% of the food grains. Almost of all coarse grains about, 75% of the pulses and oilseeds, two thirds of mustard, most of soybean and groundnut are grown under rainfed condition. Little can be done to increase rainfall or the number of rainfall events. Therefore efforts should be concentrated on increasing the infiltration capacity of the soil, minimizing the moisture loss through runoff and evaporation and improving soil water availability and water use efficiency through improved soil management in rainfed agricultural lands. Soil moisture conservation is possible through appropriate moisture conservation practice like soil mulching (with plastic or straw) reduces evaporation, modifies soil temperature and thereby positively effects on crop yields. Mulching significantly increases yields, WUE (yield per unit water) and NUE (yield per unit N) by upto 60%, compared with no-mulching. Plastic mulching performed better at relatively low temperature while straw mulching showed the opposite trend. Effects of mulching also tended to decrease with increasing water input. In conclusion, soil mulching can significantly increase maize and wheat yields, WUE and NUE, and thereby may contribute to closing the yield gap between attainable and actual yields, especially in dryland and low nutrient input agriculture.

**Key words:** Moisture conservation, dryland, mulch

---

**01-36**

**CONSERVATION AGRICULTURE –A TRANSFORMATIVE APPROACH TO FOOD SECURITY**

*Rajyalakshmi, B and Venkateswarlu, B.*

Department of Agronomy, Agricultural College, Bapatla.

Corresponding author: rajyalakshmibommidi@gmail.com

Global agriculture is facing numerous challenges and adversely affecting food and nutritional security. Among others, intensive agriculture and excessive use of external inputs are leading to degradation of soil, water and genetic resources are negatively affecting agricultural production. Degradation of natural resources is posing a serious threat to meet the future demand for food, feed, fodder and fiber. Wide spread soil erosion, nutrient mining, depleting water table, and eroding biodiversity are the global concerns which are threatening the food security and livelihood opportunities of small farmers. Soil degradation due to erosion and compaction processes is the most serious environmental problem caused by conventional agriculture. The production system is facing serious challenge of soil and water degradation, rising production cost and increasing uncertainty in the form of: (i) declining organic matter and organic carbon in the soil; (ii) practicing intensive agriculture by adopting extensive tillage, imbalance of nutrients, and residue burning; (iii) depletion of ground water table; (iv) high wages and labor scarcity.
These factors are deteriorating the quality of natural resources, adversely affecting crop yields and witnessing unprecedented raising cost of production. These are causing farmers’ unrest and posing key constraints to agricultural commodities. It is therefore, important to provide solutions to efficiently increase agricultural production and prevent degradation of natural resources, especially soil and water. To conserve soil and water resources and overcome the agrarian challenges, the role of conservation agriculture is well recognized by most of the developed countries and many developing countries.

Conservation agriculture has been identified as one of the technological options to meet the global challenges of increasing food production and conserving environment, thereby improves food and nutritional security and alleviates poverty. Conservation agriculture cropping systems improve productivity and provide resiliency to communities. Conservation agriculture provides resilience to changing patterns of rainfall, builds and maintains the soil structure, and adds organic matter for better plant growth and moisture retention. By increasing yields and introducing additional crops, conservation agriculture can increase food security for smallholder farmers. The farmers may consume the added production or sell the increased yield in the market providing income to purchase food. Promotion of and policies to encourage conservation agriculture cropping systems is justifiable and recommended.

**Key words:** Conservation agriculture, soil degradation, food security, nutritional security

**01-37**

**EXPLORATION OF OPTIONS FOR SAVING OF WATER IN LOW LAND RICE* (Oryza sativa L.*) – A REVIEW**

*Mahapatra, J., Chandrasekhar, K., Lakshmi, N.V and Prathibha Sree, S.*
Department of Agronomy (Water Management), Advanced Post Graduate Centre, Lam, Guntur
Corresponding author: mahapatra.jagruti@gmail.com

Out of the total rice area, 58.3 per cent area is under irrigation. While rice is essential for ensuring global food security, traditional rice cultivation practiced in flooded paddy soils, demands higher water inputs than other cereal crops. Low land rice is normally flooded for most of the crop season, it receives about 40% of the water diverted for irrigation. With the increasing threat of water scarcity currently affecting 4 billion people around the globe (Mekonnen and Hoekstra 2016), it is crucial to develop agronomic practices with the potential to reduce water use while maintaining or increasing yields to support a growing population.

AWD (Alternate wetting and drying), SRI (System of rice intensification), Semi dry method of cultivation, Saturated soil cultivation and drum seeder method are the alternative options for water saving in low land rice which will increase the water productivity with minimal or no reduction in yield as compared to traditional flooding conditions. Alternate Wetting and Drying is a water-saving technology that lowland rice farmers can adopt to reduce their water use in irrigated fields.

Alternate Wetting and Drying (AWD) using field water tubes to monitor the depth of ponded water is a practical way to implement AWD. Irrigation to rice at 10 cm depth of water drop using field water tube below ground level recorded higher WUE (6.11 kg/ha-mm) with water saving of 20.6 per cent as compared to conventional method of irrigation in Tamil Nadu (Santheepan & Ramanathan 2016). Similar results were found in Hyderabad where irrigation of 5cm when water level falls below 10 cm from soil surface in field water tube registered higher WUE with 734 mm less water than conventional flooding irrigation of 2-5 cm (Sathish *et al.* 2017). Field experiment in Philippines indicated that irrigation when the perched water
table drops to 15 cm below the soil surface helped in saving more than 15 % irrigation water while maintaining yield comparable with that of continuous flooding irrigation (Lampayan et al. 2015).

**Measuring Soil moisture potential using Tensiometer** based AWD irrigation in lowland rice is another option. Irrigation water requirement of rice is affected by atmospheric evaporativity, soil structure, cultural practices and water management. Thus soil water status is important under such circumstances. It can be described by soil matric suction with the help of tensiometer. Irrigation of 5 cm at soil matric suction of 160±20 cm recorded higher WUE (32.6 kg/ha cm) with 18 number of irrigation without any significant yield reduction in sandy loam soil of Ludhiana, Punjab (Hira et al. 2002). In China, alternate wetting and moderate drying (AWMD) i.e. irrigation when soil moisture potential reached -15 kPa at 15-20 cm depth recorded significantly higher WUE and grain yield than AWSD (alternate wetting and moderate drying) and CF(Continuous flooding) in sandy loam soil (Zhiqin Wang et al. 2016).

**AWD irrigation interval** of 8 days was found to be statistically on a par with that of irrigation at 5 days interval with higher water use efficiency and higher grain yield over to that of continuous submergence in Iran (Majid Ashour et al. 2014). Similar results were found in Iran where irrigation at 8 days interval resulted in significantly higher water productivity (1.47 kg/m³) without any significant yield loss (Mojtaba Rezaei et al. 2009).

**Days after disappearance of ponded water (DADPW)** basis for AWD irrigation is a familiar water saving option in lowland rice. Irrigation at 3 day after disappearance of water registered higher water productivity (0.30 kg/m³) with least amount of total water used (218.2 cm) in Ludhiana, Punjab (Sandhu and Mahal 2014). In sandy loam soils of Bihar, WUE was favourably influenced by irrigation 3 DAD (days after disappearance of ponded water) over 0 DAD and on a par with that of 6 DAD and grain yield obtained was on a par with the higher yield (Chowdhury et al. 2014). Trials at Gazipur revealed that AWD i.e. Irrigation at 3 DAPWD saved about 300 mm irrigation water (29%) over the conventional irrigation practice. However, there was no adverse effect of AWD irrigation on grain yields of rice (Hussain et al. 2009).

**Saturated soil culture (SSC)** where soil is kept as close to saturation as possible is emerging as a new water saving technology in rice. Soil saturation of a 3 cm water depth at weekly interval matching crop needed-water period with the onset of rainfall, saved 40% water with a very low yield sacrifice (%) with efficient utilization of rain water and recorded higher rain water productivity of 0.88 kg/m³ as compared to 2 cm, 4 cm and 5 cm soil saturation in China (Aime Severin Kima et al. 2014). Experiment conducted in clay loam soils at Hyderabad showed that among the three irrigation methods maximum irrigation water saving and higher WUE was observed under saturation method followed by AWD. Again yield obtained under saturation was on a par with the yield obtained in AWD (Shantappa Duttarganvi et al. 2016).

**System of Rice Intensification (SRI)** is a new concept of rice cultivation where fields are kept unflooded and soil is well aerated throughout the entire vegetative growth, while only a little water is kept on the field during the reproductive growth phase. Increased grain yield of 6.7 % and water saving of 14.8 % with highest water productivity (0.47 kg/m³) in SRI as compared to transplanted rice was observed in rice cultivation in Tamil Nadu (Geethalakshmi et al. 2011). SRI practice produced 49 % higher grain yield with 14 % less water than conventional transplanting (CTS); hence recorded increased water productivity by 73 % in sandy clay loam soil in Odisha. SRI method recorded significantly higher yield and WUE as compared to normal transplanting and mechanized transplanting in Tamil Nadu (Shantappa Duttarganvi et al. 2016).

**Semidry method of rice cultivation** where rice crop is raised under semi dry condition up to 45 days, anticipating the release of water in command areas is gaining popularity among farmers. This method offers a scope for advanced crop establishment and increase the effective use of rainfall. Irrigation scheduled from 60 DAE (Days after emergence) recorded higher water productivity of 0.31 kg/m³ by increasing the amount of effective rainfall. The yield obtained was comparable ) with 150 mm less irrigation water to that of irrigation scheduled from 45 DAE with in semidry rice cultivation in sandy clay loam soil in Hyderabad (Sreenivas et al. 2015).
IRRIGATION AND NITROGEN MANAGEMENT STRATEGIES FOR WATER SAVING UNDER DRIP IRRIGATION IN MAIZE (Zea mays L.) - A REVIEW

Hamika, K., Chandrasekhar, K., Lakshmi, N.V and Prathibha Sree, S.
Department of Agronomy (Water Management)
Advanced Post Graduate Centre, Lam, Guntur.
Corresponding author: hamika032@gmail.com

Maize (Zea mays L.) is the third most important cereal crop next to rice and wheat in the world. In India maize is grown in an area of 9.18 million hectares with a production of 24.17 million tonnes and productivity of 2632 kg ha⁻¹. In Andhra Pradesh it is grown in an area of 0.303 million hectares with production of 1.93 million tonnes and productivity of 6396 kg ha⁻¹ (Indiastat.com, 2015). At present, there exists a gap of about 10 lakh tonnes of maize grain between production and demand. One of the possible ways to bridge the gap between demand and supply is to increase the productivity per unit area by adopting the appropriate production and management technologies. Micro irrigation is an effective tool for conserving water resources and studies have revealed significant water saving ranging between 40 and 70 per cent by drip irrigation compared with surface irrigation. Fertigation provides optimum nutrient required for the crop to get optimum yield as well as significantly better quality produce can be achieved only with uniform distribution of nutrients throughout the field. By introducing drip with fertigation, it is possible to increase the yield of crops by 3 times from the same quantity of water. When fertilizer is applied through drip, it is observed that beside the yield increase about 30 per cent of the fertilizer could be saved.

Among deficit irrigation practices, mild deficit with alternate drip irrigation at 100% ETc once in three days registered higher values of grain yield in maize (7420 kg ha⁻¹) and water use efficiency of 18 kg ha⁻¹ mm⁻¹ in sandy clay soils of Coimbatore (Sampathkumar et al. 2012). Highest fresh ear yield was obtained from 2 day irrigation frequency with 100% ET, which is optimal for growing sweet corn in semi arid regions of Turkey (Abdullah oktem et al. 2003). Similarly Irrigation frequency of once in every 2 and 3 days is recommended to enhance growth and yield of drip irrigated maize in sandy soils of Egypt (Hokam et al. 2011). Drip irrigation at 0.8 Epan with normal planting recorded significantly higher green cob yield and fodder yield in red sandy soils of Bangalore (Viswanatha et al. 2002). Similarly significantly higher grain yields recorded at 1.0 PE over 0.6 PE and comparable with 0.8 PE in clay soils of Parbhani (Bibe et al. 2017). Highest grain yield was recorded when irrigation is given at 1.2 ET, however irrigation given at 0.8 ET, with fertilizer application of 80% of irrigation time gave the highest water productivity and saved 27% of the irrigation water compared to surface irrigation in sandy soils of Egypt (Ibrahim et al. 2016). Similarly drip irrigation at 1.2 Epan recorded highest growth and yield in maize in sandy clay loam soils of Hyderabad (Raja et al. 2017). Higher yields are recorded in drip irrigation scheduled at 120% Epan however it was on a par with drip irrigation scheduled at 100 % Epan in clay loam soils of Hyderabad (Basava et al. 2012). Similarly higher yields recorded at 150% Epan however it was on a par with 125% Epan in sandy loam soils of Maharashtra (Prasad Rao et al. 2017).

A significantly increase in yield and yield attributes was observed with the application of nitrogen at 240 kg ha⁻¹ through fertigation and highest water use efficiency was recorded with drip irrigation at 0.9 IW/CPE ratio in tirupati (Deepthi Kiran et al. 2016). Application of 150 per cent of RDF once in 6 days recorded significantly higher grain yield than 100 per cent of RDF in sandy clay loam soils of Coimbatore (Sampathkumar and Pandian 2010). Similarly during kharif higher grain yields of maize was recorded under drip fertigation of 100 per cent RDF with 50 per cent p and k as water soluble fertilizer in sandy clay loam soils of Coimbatore (Fanish et al. 2011). Application of nitrogen in 10 splits once in six days interval through fertigation recorded highest cob yield at 240 kg ha⁻¹. However it was on a par with 200 kg ha⁻¹ in clay loam soils of Hyderabad (Basava et al. 2012). Similarly kernel yield and stover yield recorded highest at 240 kg N ha⁻¹ through
fertigation from 10 days after sowing to 80 days after sowing at weekly intervals in sandy loam soils of Maharashtra (Prasada rao et al. 2017). Maximum green cob yields (17.10 t ha−1) was obtained with fertigation levels of 100 per cent RD and irrigation at 1.0 PE. Therefore the yield was 30.50 and 50.66 per cent higher in fertigation and irrigation levels respectively compared to surface irrigation method in clay loam soils of Maharashtra (Patil et al. 2011). Grain yield with the application of 190 kg N ha−1 was not statistically different from that at 380 kg N ha−1 at once in 5 days interval of drip irrigation in sandy soils of Egypt (Hendawy and Hokam 2007). Higher yields and water productivity are recorded under paired row system (40/80 cm) and fertigation at 1.0 Epan coupled with 100% RDF through water soluble fertilizers (MAP, Urea and KNO₃) over conventional method of ridge and furrow irrigation in sandy clay loam soils of Hyderabad (Ramulu et al. 2010). Similarly paired row planting of maize at 30/90 cm with irrigation at 80 per cent CPE and conventional fertilizer nitrogen, potassium and water soluble phosphorus fertigation recorded significantly higher WUE and grain yield as compared to normal planting and soil application of fertilizers in sandy loam soils of Karnataka (Honnappa et al. 2016). Application of fertilizer @ 100% RDF through drip recorded significantly highest yield and yield attributes over 100% RDF through soil and it was on a par with 75% RDF through drip in clay soils of Parbhani (Bibe et al. 2017).

PERFORMANCE OF RICE (*Oryza sativa* L.) UNDER DIFFERENT CROP ESTABLISHMENT METHODS AND IRRIGATION SCHEDULES.

Manoj Naidu, S., Prasanth Mourya, G and Mallikarjuna Reddy, K.
Department of Agronomy (Water Management)
Advanced Post Graduate Centre, Lam, Guntur.
Corresponding author: sanammanojnaidu@gmail.com

Rice (*Oryza sativa* L.) is the most important and extensively grown food crop in India occupying an area of 40.06 million hectares with a production of 101.8 million tonnes and productivity of 2.5 t/ha. In Andhra Pradesh, it is grown in an area of 25.84 lakh hectares with a production of 9.18 million tonnes and productivity of 3.7 t ha−1 (Agriculture action plan 2015-16, Department of Agriculture, A.P).

Increasing water scarcity is becoming real threat to rice cultivation. Hence water saving technology which maintains soil health and sustainability as well as economically viable, needs to be developed. Rice cultivation requires large quantity of water. To produce 1 kg of rice, about 3000 – 5000 litres of water is required depending on different rice cultivation methods such as transplanted rice, direct-sown rice (wet seeded), alternate wetting and drying (AWD) method, system of rice intensification (SRI) and aerobic rice. Among these methods, SRI recorded significantly higher grain yield over normal transplanting and the increase was 53.8 and 45.7 per cent over normal transplanting in *kharif* and *rabi* seasons respectively, on clay loam soils of Hyderabad, Telangana. By using alternate wetting and drying and the shallow water depth with wetting and drying treatments, irrigation water can be reduced up to 13.1 per cent and 5.4 per cent, respectively. The highest grain yield and water productivity was obtained by alternate wetting and drying begin at 50 days after transplantation, over AWD begin at 20, 30 and 40 DAT at Kyushu University, Japan.

Conventional rice production systems require large quantities of water and labour intensive. The direct sown rice is one of the resource conservation technologies, economically feasible and technically viable alternative to transplanted rice. DSR needs only 34% of total labour requirement saves 29% of total cost and 30-50% of water, compared to transplanted rice. Alternate wetting and drying, whenever hairline cracks appear in soil is the criteria for irrigation in DSR. However, exact time interval for irrigations depends on particular soil type and evaporation demand in the atmosphere at that place. Irrigation scheduled at once in three days interval recorded higher grain yield (3.44 t ha−1) and was significantly superior to those received irrigations at six days and nine days interval and when hairline cracks (12 days after irrigation) develop and the
increase in grain yield was 18.8, 42.8 and 52.9 per cent, respectively, on sandy loam soils of Utukur, Kadapa in Andhra Pradesh.

Aerobic rice culture, an emerging technology and revolutionary way of growing rice where the direct-seeded rice varieties are grown in well-drained, un-puddled and non-saturated soils (aerobic soils). Aerobic rice assumes greater importance in water scarcity areas where, the demand for rice is increasing. Irrigation given at three days interval on sandy loam soils of Sambalpur, Odisha, recorded the maximum plant height, dry matter accumulation and leaf area index and yield attributes over the irrigations given at 5 days, 7 days and 9 days interval. Water Productivity Index was significantly greater (1.7 kg m$^{-3}$) in the AWD irrigation compared to conventional irrigation (1.3 kg m$^{-3}$) on clayey texture soils of Canada. The interaction effects also displayed a greater response of water to grain production in AWD irrigation. The lowest (1.2 kg m$^{-3}$) value was observed under continuous flooding with 21-day old seedlings and close spacing (30×18 cm$^2$).

After comparing different methods of establishment in rice alternate wetting and drying found as an appropriate technology in the context of energy crisis, water scarcity and environmental concern. AWD irrigation can make rice cultivation profitable via reducing irrigation cost and increasing yield to some extent. Any approach that would lessen the amount of water use without compromising the rice yield would certainly be a welcome strategy.

01-40

EFFECT OF GLOBAL WARMING ON CROP PRODUCTION

Vasundhara K., Neeraja, K and Dakshayani, T.
Department of Environmental Sciences, Advanced Post Graduate Center, Lam, Guntur.
Corresponding author: vasundhara.kandi95@gmail.com

Global Warming refers to the increasing temperature of the Earth’s climate system and its related effects. Scientific evidence has conclusively proven that the Earth’s temperature is infact rising and has risen by 0.85°C. It not only has its negative effects on animals and man but it can even leave an adverse effect on the crop production. Rising global temperature is not only causing climate change but also contributing to the irregular rainfall patterns. Uneven rainfall patterns, increased temperature, elevated CO$_2$ content in the atmosphere are important climatic parameters which affects the crop production. Research studies indicate that weathering parameters influence strongly (67%) compared to other factors like soil and nutrient management (33%) during the cropping season. The Intergovernmental Panel on Climate Change (IPCC) projected that the global mean surface temperature will likely rise and may result into uneven climatic changes. This rising temperature may affect crop yield at large scale. It has been reported over 20$^{th}$ century that rising temperature plays an important role towards global warming as compared to precipitation. Researchers have confirmed that crop yield falls by 3% to 5% for every 1°F increase in the temperature. In India, crop production may be divided into two seasons: **Kharif** (influenced by south-west monsoon) and **rabi** (mostly influenced by north-east monsoon). Most studies show that the crop production is dependent on temperature. Temperature vs crop production shows a funnel shape for all the seasons. For the lower temperature both the properties are almost linearly correlated. In rabi, at the beginning production show a negative trend with temperature which slowly converts to the positive trend. In kharif that negative trend is not visible. At higher temperatures production increases for both the seasons but with large scattering. Thus, global warming and change in climate and its impact on agricultural productivity is a serious concern for India, which is mitigating the risks through ‘food security’ for every household.

**Key words:** Global warming, elevated CO$_2$, temperature, productivity.
01-41

BIODIVERSITY AND ITS CONSERVATION

Neeraja, K., Vasundhara, K and Dakshayani, T.
Department of Environmental Sciences
Advanced Post Graduate Center, Lam, Guntur.
Corresponding author: neeraja.kothakota535@gmail.com

Biodiversity Conservation emerges more important due to the globalize process of the world economy and also for survival of the world as a balance habitat. Biodiversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. International Union for Conservation of Nature and Natural Resources (IUCN) has established the following five main conservation categories: Extinct, Endangered, Vulnerable, Rare. Sustainable development stresses on economic development along with the objective of conservation of environment.

India is one of the twelve mega diversity country in the world. India as a whole is divided into 12 biogeography zones, i.e. Trans Himalaya, West Himalaya, Eastern Himalaya, North East India, The Indian Desert, Semi-arid Zone, Gangetic plain, Western ghts, Deccan Peninsula, Indian coasts, Andaman and Nicobar Island and Lakshadweep Island. The country possesses about 8 per cent of global biodiversity occupying the 10th position in terms of plant species, out of the 34 hot spots of biodiversity in the world. North-Eastern region is one of the hottest hot spots ranking 6th position among the 34 biodiversity hot spots. Assam is one of the richest biodiversity zone in North East region. Biodiversity Conservation includes Sacred Lakes, Botanical Gardens, Wildlife Sanctuaries, Sacred Forests, Biosphere reserves, Zoological Gardens, Gene seed banks. Conservation of biodiversity states the planning and management of biological resources in a way so as to secure their wide use and continuous supply, maintaining their quality, value and diversity.

Key words: Biodiversity, natural resources, conservation, species.

01-42

PRECISION FARMING

Sai Krishna, M., Venkateswarlu, B., Prasad P.V.N and Prasad, P. R. K.
Department of Agronomy, Agricultural College, Bapatla
Corresponding author: saimallipeddi114@gmail.com

Precision farming is the process of adjusting husbandry practices within aspects for precision farming using the principles that underly conventional soil management and agronomy. The moisture available for crop growth, organic matter maps may be utilized for precision application of fertilizers and soil acting herbicides, and variation in soil pH can be mapped and used as a basis for variable lime application. However, comprehensive nutrient mapping is less likely to be economic with existing techniques of chemical analysis. The value of yield mapping lies in identifying zones which are sufficiently stable to be of use in determining future practices. Maps of grain quality and nutrient content would significantly augment the value of yield maps in guiding marketing decisions and future agronomy. Interactions between soil differences and seasonal weather are large, so yield maps show considerable differences from season to season. Interpretation of such maps needs to follow a careful, informed, analytical process.

Extensive and thorough field experimentation by crop scientists over many years has shown that yield variation arises as a result of a large and complex range of factors. It is highly improbable that simple explanations will be appropriate for much in-field yield variation. However, the capacity to sense yield variability within
fields as opposed to between fields, where there are many confounding differences, provides an opportunity for the industry to improve its understanding of soil-based effects on crop performance. This should support its decision taking, whether through precision farming or through field-by-field agronomy.

The main obstacle to the adoption of precision farming is the lack of appropriate sensors. Optimal sensor configurations that will measure the specific needs identified by end-users need to be developed.

**Key words:** Nutrient mapping, interpretation, optical sensors

**EFFECTS OF AIR POLLUTION ON AGRICULTURAL CROPS**

Srikanth M., Amani J and Tejdeep P.

Department of Environmental Sciences

Advanced Post Graduate Centre, Lam, Guntur.

Corresponding author: srikanthshadvikm@gmail.com

Air pollution is basically the foreign material in the air can be manmade or occur naturally. Air pollution is probably one of the most serious environmental problems confronting our civilization today. The main air pollutants are represented by gases forms, particles in suspension, different ionizing radiation and noise. Pollutants may cause primary damage, with direct identifiable impact on the environment, or secondary damage in the form of minor perturbations in the delicate balance of the biological food web that are detectable only over long time periods. The mixture of pollutants from all sources, including agriculture, has released a host of contaminants into the air, such as aldehydes, hydrocarbons, organic acids, ozone, peroxyacetyl nitrates, pesticides, and radionuclides.

The effect of these pollutants on food, fibre, forage, and forest crops is variable, depending on concentration, geography, and weather conditions. Damage to crops by air pollution, of course, brings economic loss as well.

The effects of air pollution on crops can be measured by the factors, namely: (1) interference with enzyme systems; (2) change in cellular chemical constituents and physical structure; (3) retardation of growth and reduced production because of metabolic changes; (4) acute, immediate tissue degeneration.

Pollutants that enter the air from sources other than agriculture and that produce plant response are classified as: (1) acid gases; (2) products of combustion; (3) products of reactions in the air; and (4) miscellaneous effluents. Atmospheric pollutants have a negative effect on the crops; they can have direct toxic effects, or indirectly by changing soil pH followed by solubilization of toxic salts of metals like aluminum. They cover the leaf blade reducing light penetration and blocking the opening of stomata. These impediments influence strongly the process of photosynthesis rate which declines sharply. Air pollution injury to plants can be evident in several ways. Injury to the greenery of the leaf may be visible in a short time and appear as dead tissue, or it can develop slowly as yellowing of the leaf. There may be a reduction in growth of various portions of a plant. Plants may be killed outright, but they usually do not succumb until they have suffered recurrent injury.

Little injury takes place at the site of absorption, whereas the margins or the tips of the leaves build up injurious concentrations. Since plants have breathing system called stomata, the breathing hole will end up being clogged leading to the plants to get withered.

Some of the measures to reduce and control air pollution are: Adequate forest cover, Industrial areas should be located at a safe distance, Forest fires should be checked, Air pollution can be checked only through the joint efforts of the government, non government organizations and the general public. Green belts around cropped area, is essential for maintaining the quality of air.
01-44

BIODEGRADATION OF OIL SLUDGE

Srikanth M., Amani J and Tejdeep P.
Department of Environmental Sciences
Advanced Post Graduate Centre, Lam, Guntur.
Corresponding author: srikanthshadvikm@gmail.com

Oil sludge is a thick viscous mixture of sediments (5-10%), water (10-40%), oil (40-80%), and hydrocarbons, encountered during crude oil refining, cleaning of oil storage vessels and waste treatments. Soil contamination with oil sludge is the major global concern today. Contamination especially with hydrocarbons is a major environmental and health concern. Hydrocarbons such as crude oil are highly toxic and can affect plants, animals and human beings and pose serious environmental concerns, as many of them cytotoxic, mutagenic and potentially carcinogenic. Improper management and disposal of oil sludge can cause environmental pollution.

Moreover, oil sludge and its products are by their nature biodegradable. It has been known for many years that certain microorganisms are able to degrade petroleum hydrocarbons and use them as a sole source of carbon and energy for growth. Remediation of the contaminated soil can be done in many ways which include both physico-chemical and biological methods. Biological methods are more economical and efficient than chemical and physical ones. However, the combination of more than one microbial species is usually required for effective biodegradation. This may be due to synergistic interaction among the microbes. Wide variety of bacterial species, which are capable of degradation of hydrocarbons, are aerobic bacteria. Some of these bacteria are Rhodococcus, Pseudomonas, Arthrobacter, Corynobaacterium and Bacillus.

Moreover, the application of a bacterial consortium that is well adapted to environmental conditions of the contaminated site is a main factor for an effective bioremediation process.

01-45

FACTORS INFLUENCING THE CROP GROWTH UNDER CLIMATE CHANGE

Prajapati, S., Tripathi, S. K., Bahrat kumar, Sonu Sharma and Ravi U.
JNKVV, College of Agriculture, Rewa, (MP)
Corresponding author: anantvihar0@gmail.com

The yield and quality of food crops are directly affected by the climate. The climate changes include the increasing concentration of green house gases and thus rising in temperature. There are many studies of climate change focused on effect of increasing concentration of CO₂, rising of global mean temperature and erratic rainfall on crop production. The several scientists were reported that increasing concentration of CO₂ increases the rate of photosynthesis which is responsible for conversion of solar energy into chemical energy, thus its essential for better yield of different crops. In other hand the increasing concentration of CO₂ increasing the atmospheric temperature, which is a major limiting factor for productivity and quality of crops. The relation of crop response with all these factors may be nonlinior because crop responses are subjected to joint effect of different climatic events on growth and yield. In this context, threshold temperatures for crop processes are found not to differ greatly for different crops. Its needed to define for major crops to better predictions about crop critical temperatures and their resolution. The impacts of climate variability on production and quality of many crops were focused in this studied. The climatic variability and extreme events increased the risk in crop production. The issue of food quality has not been given sufficient importance during the study of impact of climate change on crop production. The adaption of different crops are depending in tolerance against drought, frost and other hazardous climatic events and having capacity for better utilization of natural resources.
01-46

ECO FRIENDLY DISPOSAL OF OIL SLUDGE THROUGH COMPOSTING

Srikanth M, Tejdeep P and Amani J.
Department of Environmental sciences
Advanced Post Graduate Centre, Lam, Guntur.
Corresponding author: srikanthshadvikm@gmail.com

Sludge is a complex emulsion of various petroleum hydrocarbons (PHCs), water, heavy metals, and solid particles. Polycyclic aromatic hydrocarbons (PAHs), which are components of crude oil sludge, constitute serious environmental concerns, as many of them are cytotoxic, mutagenic and potentially carcinogenic. It also affects the soil fertility. Treatment of oil sludge includes physical, chemical and biological process but still cost effective method is needed. Composting can serve as remedy to treat the sludge with provided factors such as nutrients, pH, moisture, aeration and temperature within the compost pile. For maintaining the humidity different bulking agent can be used. High microbial diversity and activity during composting, due to the abundance of substrates in feedstocks, promotes degradation of xenobiotic organic compounds, such as pesticides, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). Through composting can also transform pollutants into less toxic substances. The exhaustive investigation of oily sludge treatment methods will provide researchers to have a thorough understanding of recent developments and future research directions.

01-47

DIRECT SEEDED RICE AS A RESOURCE CONSERVATIVE AND COST REDUCING TECHNOLOGY

Prasanth Raju, K., Radhika, K and Bayyapu Reddy, K.
Department of Seed Science and Technology
Advanced Post Graduate Centre, Lam, Guntur.
Corresponding author: iloveindia.g1@gmail.com

Of all the major cereal crops grown in India, rice constitutes 24 per cent of the total food grains production. Around 95 per cent of the cultivated area under rice is irrigated and requires about 1200 mm to 2500 mm of water depending on the soil texture, structure and profile conditions. Rice is a labour-intensive crop. Timely availability of labour and water for various activities of rice cultivation is becoming a problem. The cost of hiring labour also significantly increased during recent years.

Transplanted rice has deleterious effects on the soil environment and nearly 30% of the total water used (1,400-1,800 mm) in rice culture is consumed mainly during puddling and transplanting operations. It also destroys soil structure and adversely affects soil productivity. Therefore, a key concern is how the water requirement of rice culture can be reduced and how farmers can avoid puddling and transplanting operations without yield penalty.

Direct seeded rice which removes puddling and drudgery of transplanting the young rice seedlings provides an option to resolve the adaphic conflict to overcome labour shortage and sustain rice production with less water and enhance the sustainability of rice and subsequent cropping system. The Direct Seeded Rice (DSR) method refers to the sowing of seeds in fields before or immediately after pre-monsoon showers. The nursery stage and transplanting of seedlings can be avoided. The dry seeds are directly sown in the main field manually or with the help of a tractor and attached implements at a depth of 2-3 cm. Based on the availability of water, irrigation has to be given. Hence, the DSR method requires less water and labour with
comparatively equal or slightly higher grain yields than traditional rice cultivation and also the crop matures earlier than the puddled rice.

In direct sowing, water saving is also to the extent of 35–40 per cent. The timely operations and reduced cost of cultivation are other driving forces in direct sowing rice adoption. However, weed management and depth of sowing in direct sown rice are the major constraints. DSR overcomes the problem of seasonality in labour requirement for rice nursery raising and transplanting operations. DSR also facilitates timely establishment of rice and succeeding crops.

01-48

**BREEDING CROP VARIETIES FOR ORGANIC FARMING: A NEED FOR FOOD, NUTRITIONAL AND ENVIRONMENTAL SECURITY**

*Suma Varshini, P, Bayyapu Reddy, K and Radhika, K.*
Department of Seed Science and Technology
Advanced Post Graduate Centre, Lam, Guntur.
Corresponding author: sumavarshinipaturi@gmail.com

Organic farmers currently depend on crop varieties bred for high-input agriculture. It is estimated that more than 95% of organic production is based on crop varieties that were bred for the conventional high-input sector. In modern commercial varieties genetic variation is out ruled result in highly phenotypically and genotypically homogeneous, high-yielding varieties broadly adapted but potentially vulnerable to pests and diseases. As organic farming systems refrain from high input and any chemical inputs they need to stimulate the self-regulatory ability of the farm ecosystem through functional diversity at farm, field, crop and variety levels.

The characteristic of organic agricultural systems is their biodiversity at soil, crop and field level and the greater focus on integration of crop and livestock production systems on the farm compared to conventional farming systems. The high biodiversity of organic farms provides many ecological services that enhance farm resilience to a large extent. Integrating advantages of biodiversity due to agronomic practices with genetic diversity at crop level provides insurance with respect to the impact of biotic and abiotic stress factors on crop yield and quality. The development of genetic diversity focused crop breeding approaches may therefore be essential to improve yields and quality parameters in foods from organic and low-input farming systems especially in the context of the challenges expected due to global climate change.

A range of breeding goals desired for the organic sector, such as yield, resistance to biotic and abiotic stress etc., demanded by consumers do not differ from conventional breeding goals, but it is essential that such traits are expressed under low-input conditions, which cannot be guaranteed if selection is done in high-input agronomic backgrounds. It often takes 10 years or more from the initial inter-varietal crosses to develop a new crop variety. To realize the varietal improvements needed in organic farming in the coming decades, crosses between appropriate parental varieties have to be made now. It is essential therefore to identify the primary limiting factors of existing varieties for organic production and target them in the breeding programmes for organic farming and subsequently communicate results to public and commercial breeders.

The demand for organic products is partially driven by the belief that organically grown products are healthier and more nutritious than conventionally grown products. It is therefore important for a plant breeder developing varieties for the organic sector to also select for nutritional quality parameters. Significant variation in mineral and vitamin contents exists among varieties within crops and nutritional quality is often dependent on specific management practices.
Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. Organic agriculture contributes to food security through a combination of many features, most notably by increasing yields in low-input areas, conserving bio-diversity and natural resources on the farm and in the surrounding area, increasing farmers’ incomes and/or reducing costs, producing safe and varied food and being sustainable in the long term. Organic agriculture should be an integral part of any agricultural policy aiming for food security.

Principle of ecology is one of the major principles of organic agriculture. Inputs should be reduced by reuse, recycling and efficient management of materials and energy in order to maintain and improve environmental quality and conserve resources. Organic agriculture should attain ecological balance through the design of farming systems, establishment of habitats and maintenance of genetic and agricultural diversity. Those who produce, process, trade or consume organic products should protect and benefit the common environment including landscapes, climate, habitats, biodiversity, air and water.

A relevant question is how breeding can contribute to adapting crops and varieties to the organic, lower-input environment by improving the buffering capacity of the farming system and thereby yield stability. The genetic basis for an organic breeding programme should be broadened and newly established, e.g., by creating composite cross populations followed by selection under organic farming conditions.

01-49

**ECONOMICS OF MAIZE (Zea mays L.) ON SEQUENTIAL APPLICATION OF HERBICIDES**

**Shaik Nazreen, D., Subramanyam and Pratap Kumar Reddy, A.**
Department of Agronomy, S.V. Agricultural College, Tirupati
Corresponding author: nazreennaz57@gmail.com

A field experiment was carried out on sandy loam soils of wetland farm of S.V. Agricultural College, Tirupati during *kharif* 2016-17 to study the economics related to maize due to the application of different pre- and post-emergence herbicides. The experiment was laid out in randomized block design and replicated thrice. Ten weed management practices *viz.*, pre-emergence application of alachlor 1000 g ha\(^{-1}\) (W\(_1\)), post-emergence application of halosulfuron-methyl 67.5 g ha\(^{-1}\) (W\(_2\)), post-emergence application of tembotrione 100 g ha\(^{-1}\) (W\(_3\)), post-emergence application of halosulfuron-methyl 67.5 g ha\(^{-1}\) + tembotrione 100 g ha\(^{-1}\) (W\(_4\)), pre-emergence application of alachlor 1000 g ha\(^{-1}\)+ post-emergence application of halosulfuron-methyl 67.5 g ha\(^{-1}\) (W\(_5\)), pre-emergence application of alachlor 1000 g ha\(^{-1}\)+ post-emergence application of tembotrione 100 g ha\(^{-1}\) (W\(_6\)), pre-emergence application of alachlor 1000 g ha\(^{-1}\)+ post-emergence application of halosulfuron-methyl 67.5 g ha\(^{-1}\)+ tembotrione 100 g ha\(^{-1}\) (W\(_7\)), pre-emergence application of atrazine 1000 g ha\(^{-1}\)+ post-emergence application of 2,4-D sodium salt 800 g ha\(^{-1}\) (W\(_8\)), two hand weedings at 20 and 40 DAS (W\(_9\)) and unweeded control (W\(_{10}\)).

The data on gross returns, net returns and benefit-cost ratio of maize were recorded. Among the weed management practices tested higher gross returns were realized with pre-emergence application of alachlor/tembotrione (W\(_7\)). Hand weeding twice (W\(_9\)) was the next best weed management practice in realizing maximum gross returns. While the higher net returns were recorded with pre-emergence application of alachlor/tembotrione (W\(_7\)), which were however comparable with two hand weedings at 20 and 40 DAS (W\(_9\)). Finally higher benefit-cost ratio were recorded with pre-emergence application atrazine + post-emergence application of 2,4-D sodium salt (W\(_8\)), which was significantly higher than with rest of the weed management practices. Hand weeding twice at 20 and 40 DAS (W\(_9\)) was the next best weed management practice.
practice in recording higher benefit-cost ratio, which was comparable with pre-emergence application of alachlor + post-emergence application of tembotrione (Wt).

In conclusion, overall the study revealed that higher gross and net returns were obtained with pre-emergence application of alachlor fb post-emergence application of halosulfuron-methyl + tembotrione (W7) due to increased seed yield as a result of effective control of all the categories of weeds and reduced cost of cultivation in these treatments. However, highest benefit-cost ratio were recorded with pre-emergence application atrazine + post-emergence application of 2,4-D sodium salt (W8) due to low cost of herbicides, among the pre-and post-emergence herbicides.

**Keywords:** Benefit-cost ratio, gross returns, maize, net returns, pre-and post-emergence

---

**01-50**

**EFFECT OF DIFFERENT CROP ESTABLISHMENT METHODS AND WEED MANAGEMENT PRACTICES ON ALKALINE, ACID PHOSPHATASE ACTIVITY AND DEHYDROGENASE ACTIVITY IN RICE**

*Ravi Kumar, M., Madhavi, G., Pratibha and Ram Prakash, T.*
Department of Agronomy, College of Agriculture, Hyderabad

A field experiment was conducted at College of Agriculture, PJTSAU, Hyderabad, during kharif-2016. The soil of the experimental field was sandy clay loam in texture with pH 7.85, low in available nitrogen, high phosphorus and potassium. The experiment was laid out in split plot design with three replications. The treatments consisted of three establishment methods of rice viz., transplanted rice, direct seeded rice and aerobic rice, five levels of weed management practices viz., Farmers method (Hand weeding 20 and 40 DAT/DAS), bispyribac sodium 10% SC 25 g ha⁻¹ as PE fb fenoxaprop-p-ethyl 9.3% EC 62 g ha⁻¹ + 2. 4-D 80% WP 0.5 kg ha⁻¹, penoxsulam+ pendimethalin 25% SE 25 g + 600 g ha⁻¹PE at 4-7 DAS/DAT, pretilachlor 50% EC 0.75 kg ha⁻¹ as PE fb hand weeding at 20 and 40 DAT/DAS and unweeded control. The results from present investigation reported acid, alkaline phosphatase and dehydrogenase activities between the methods of establishment and herbicide treatments. Acid, alkaline phosphatase (µg PNP kg⁻¹ soil day⁻¹) and dehydrogenase activity (µg TPF kg⁻¹ soil day⁻¹) was found to be increased from 0 days after application to flowering stage in all treatments and there was a decrease at the time of harvest in rice crop. In the present study phosphatase and dehydrogenase showed maximum activity at flowering stage. Weed management practices showed the acid, alkaline phosphatase and dehydrogenase activity in the herbicide treated plots was higher than control among all the periods.

---

**01-51**

**NONCONVENTIONAL WEED MANAGEMENT STRATEGIES FOR MODERN AGRICULTURE**

*Priyadarsini, S., Prasad, P.V.N., Venkateswarlu, B and Prasad, P.R.K.*
Department of Agronomy, Agricultural College, Bapatla

Weeds are a major factor causing reduction in crop yields through competition and allelopathic interactions. In modern-day agriculture, weed infestations and weed behaviors frequently change because of intensive management practices, climate change, and ecological shift. Intensive agricultural practices, changing climate, and natural disasters affect weed dynamics and that requires a change in weed management
protocols. The existing manual control options are no longer viable because of labor shortages; chemical control options are limited by ecodegradation, health hazards, and development of herbicide resistance in weeds. Therefore reviewing some potential nonconventional weed management strategies for modern agriculture that are viable, feasible, and efficient. Improvement in tillage regimes has long been identified as an impressive weed-control measure is needed.

Harvest weed seed control and seed predation have been shown as potential tools for reducing weed emergence and seedbank reserves. Development in the field of allelopathy for weed management has led to new techniques for weed control. The remarkable role of biotechnological advancements in developing herbicide-resistant crops, bioherbicides, and harnessing the allelopathic potential of crops is also worth mentioning in a modern weed management program. Thermal weed management has also been observed as a useful technique, especially under conservation agriculture systems. Last, precision weed management has been elaborated with sufficient details. The role of remote sensing, modeling, and robotics as an integral part of precision weed management has been highlighted in a realistic manner. All these strategies are viable for today’s agriculture; however, site-specific selection and the use of right combinations will be the key to success. No single strategy is perfect, and therefore an integrated approach may provide better results. The right choice of one or more of these strategies according to geographic, agricultural, and socioeconomic conditions may offer an impressive weed control. None of them has the potential to comprehensively replace chemical weed management; however, an integrated approach may lead to success. The diversified nature of these strategies may be very useful against invasive and resistant weeds. In the long run, a single weed-control measure may not remain effective and, thus, integrated weed management on the basis of advanced nonconventional strategies will be a pragmatic option in modern intensive agriculture.

Further research is needed to optimize these tools for improvement in efficiency and practical suitability. In the long run, a single weed-control measure may not remain effective and, thus, integrated weed management on the basis of advanced nonconventional strategies will be a pragmatic option in modern intensive agriculture.

**Key words:** Allelopathy, biotechnology, crop nutrition, herbicide resistance, precision agriculture, weed management.

01-52

**NUTRIENT AND QUALITY OF QUINOA INFLUENCED BY DATES OF SOWING AND VARIED CROP GEOMETRY.**

*Ramesh, K and Suneetha Devi, K.B.*

Department of Agronomy, College of Agriculture, Hyderabad.

Corresponding author: rameshkhattravath@gmail.com

A field experiment was conducted at College farm, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad during *rabi* 2015-16 to study the “Evaluation of Quinoa (*Chenopodium quinoa* Willd.) at different dates of sowing and varied crop geometry in semi-arid regions of Telangana.” The experiment was laid out in split plot design with three replications to test three dates of sowing and to standardise the crop geometry of quinoa in semi-arid conditions of Telangana. The higher stalk and seed N content was recorded at 16th November. Whereas higher P and K content in stalk and seed were obtained at 15th October date of sowing. The higher N, P and K uptake was recorded on 15th October date of sowing. The higher N and P content in stalk and seed were recorded under wider spacings 45×10 cm, the higher K content in stalk and seed recorded with narrow (15×10 cm) spacing. The higher N, P and K uptake was recorded with narrow (15×10 cm spacing). The protein and oil content was found non significant with dates of sowing. The
higher protein content was recorded with 30 × 10 cm, where as higher oil content was obtained with 15 × 10 cm compared to other crop geometries.

01-53

STRATEGIES TO IMPROVE THE PULSE PRODUCTION AND ITS IMPACT ON INDIAN ECONOMY

Sai Kumari G and Venkata Rao, P.
Agricultural College, Bapatla.

Corresponding author: saikumari2711996@gmail.com

Pulses on account of their vital role in nutritional security and soil ameliorative properties have been an integral part of sustainable agriculture since ages. Pulse cultivation improves soil health by fixing nitrogen. Their importance as a source of protein for masses in India is well recognized and therefore, their production and availability: assume special significance for the nutritional security of the people. However, pulse production in the country is stagnating due to long standing problems. This disturbs nutritional balance of the population especially of poor and weaker sections who cannot afford expensive animal proteins. Per capita per day net availability of pulses is woefully lower even after liberal imports. The requirement for pulses as per physiological norms set by the Indian Council of Medical Research is 43 gms/day/capita.

The Planning Commission has revised this norm to 40 gms. per day per capita in view of increasing consumption of other dietary proteins. The current net availability however is much below these norms. This is the consequence of rising population and stagnant pulse production over the past three decades. The long drawn stagnation in production of pulses is likely to reduce per capita availability of this protein rich food in future unless huge imports are resorted to or steps are taken to enhance production of pulses in India. The production of pulses in India has remained below the estimated demand during the past decades. Some of the studies have estimated demand and supply gap of pulses based on domestic production.

About 20% of the total pulses demands are met by imports only. Apart from legumes fix atmospheric ‘N’ in readily available form to the upcoming succeeding crop. Associated non legume intercrop also gets benefited by ‘N’ transfer from legume roots up to some extent. It also contributes to sustain production system through physical, chemical and biological improvements of soil properties, as a rotation effect. The seed replacement rate is still (<30%) which lower than cereals especially wheat and rice.

Major constraints in Pulses Production

Participatory rural appraisal (PRA), a widely adopted methodology to prioritize the list of researchable issues, has been conducted by several workers to identify the important cause of such low productivity. Unfavourable weather conditions, Abnormal soil conditions, Agronomic constraints, Input quality and availability related constraints, Varietal constraints, pests and diseases, Technological constraints, Infrastructural Constraints, Credit, Marketing and Policy constraints. Realizing potential productivity in pulses and way forward:

There is need to promote high yielding varieties along with selection of suitable varieties for different agro climatic conditions. Further use of disease and pests resistance varieties is highly advocated under present climate change scenario. Methods and techniques which can be potentially used for improving pulses production are: Promotion of sequential cropping intercropping and utera cultivation of pulses, Adoption of best agronomic practices, Balance nutrient management, Use of Plan Growth Regulators, Efficient Pest Surveillance and management practices, Better extension for adoption of improved pulse production technique, Mechanization in pulses, Post-harvest handling of grains for reducing losses, Expansion of irrigation using resource conservation technologies, Managing blue bull effectively, Efficient utilization of rice fallow lands and replacement of low productivity crops with pulses, Policy intervention.
India needs around 32 million tons of pulses by 2030, to feed the estimated population of about 1.68 billion. Global supply of pulses is limited, as India happens to be the largest producer and consumer of pulses. Hence, India needs to produce the required quantity, but also remain competitive to protect indigenous pulses production. The recent efforts and programs initiated by the government are bearing fruits, and it is hoped that this momentum is sustained and strengthened to make India self-sufficient in pulses.

**Key words**: Pulse, constraints, potentiality, global supply.

### IMPACT OF CROP RESIDUE MULCHING ON CROP PRODUCTION – REVIEW

**Rajasekar, M.**  
Department of Agronomy, TNAU, Coimbatore, Tamil Nadu  
Corresponding author: rajasekartnau@gmail.com

Mulching is the process of covering the soil surface to make favorable conditions for plant growth and development. Mulching reduces the deterioration of soil by way of preventing the runoff and soil loss, minimizes the weed infestation and checks the evaporation of water. Thus, it facilitates for more retention of soil moisture and helps in control of temperature fluctuations there by creating favorable microclimate, improves physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately enhances the growth and yield of crops. Mulching improves the yield by 50-60 per cent over no mulching under rainfed situations (Dilipkumar et al., 1990).

#### Effect of mulching on cotton yield

According to Zhang sigui et al. (1995), mulching with wheat straw was found to delay leaf senescence, prevented pre mature aging of cotton and increased the boll weight and yield. Mulching with rice straw in cotton significantly influenced growth and yield parameters (Virdia and Patel, 2000).

Application of 10 t millet residue ha⁻¹ as surface mulch increased the cotton yield upto 24 per cent over no mulch (Bilbro and Fryrear, 1983). Application of rice straw mulching increased the seed cotton yield up to 18 per cent (Virdia and Patel, 2000). Significantly highest cotton yield (1,749 kg ha⁻¹) and net return of Rs. 19,838/- was obtained by application of 10 t wheat straw mulching ha⁻¹ (Kaswala et al., 2000).

#### Effect of mulching on suppression of weed growth in cotton

Pre emergence application of pendimethalin in combination with mulching reduced the weed growth and ultimately increased the seed cotton yield (Vijayabaskaran and Kathiresan, 1993). Plastic mulching in cotton reduced the weed growth, resulted in less time spent on hoeing and less herbicide use (Longlais, 1993). Straw mulch decreased the weed population significantly over unmulched plot in cotton (Daijing et al., 1997).

#### Effect of mulching on soil temperature

Karikari and Kani (2000) observed that, temperatures were consistently cooler under the mulch during the warmest daily periods. The increased soil moisture in the root zone and the decreased soil temperatures enhanced growth and yield.

#### Effect of mulching on conserving soil moisture

Ground cover through rice straw mulching reduced the soil water evaporation and ensured that a high proportion of the soil water being used on transpiration (Ladlow and Muchow, 1989). According to Virdia
and Patel (2000), favourable soil physical properties such as infiltration rate and water holding capacity under rice straw mulching helped in maintaining favourable soil moisture and consequently better growth and yield of cotton.

Vijayalakshmi (1987) observed that soil moisture at 0 – 15 cm and 15 – 30 cm depth as 10.5 and 12.8 per cent in mulched plots and 8.6 and 10.7 per cent under control plots, respectively.

**Effect of sugarcane trash mulching**

Sugarcane crop produces huge quantity of trash. The trash can be profitably utilized for moisture conservation, weed control and to enrich organic matter status, (Kalaimani and Giridharan, 2000).

The beneficial effect of sugarcane trash mulch in combination with additional dose of K₂O in terms of maximum number of tillers, economic shoots and maximum number of millable canes was highlighted by (Kathiresan and Balasubramanian (1991). Besides, they observed maximum Brix per cent, more pole per cent cane and higher CCS % in the treatment with trash mulch with additional dose of K₂O. However, maximum percentage of purity was recorded with trash mulch coupled with kaolin spray.

**Effect of sugarcane trash mulching on soil properties**

According to Srivastava *et al.* (1994), trash is a source of nitrogen (1.0 – 1.5%), phosphorus (0.005 – 0.01%) and potassium (1.5 – 1.8%). Rita-Dahiya *et al.* (2003) discovered that sugarcane trash could also reduce surface bulk density and electric conductivity by almost 2 and 6 percent, if incorporated with inorganic fertilizers such as nitrogen and phosphorus. Trash mulch could be more efficient in recycling nitrogen and as a result less input of nitrogen fertilizer is required.

01-55

**CROP RESIDUE MANAGEMENT FOR ENHANCING OPPORTUNITY INCOME OF FARMERS IN ANDHRA PRADESH**

*Harikrishna, P.*

Department of Agricultural Microbiology, Advanced Post Graduate Center, Lam, Guntur

Agricultural recycling of organic enables the beneficial recovery of essential plant nutrients to maintain agronomic productivity, to improve soil physico-chemical properties. As nutrient sources, these materials provide effective fertilizer replacements, and their agricultural utilization contributes to the development of a circular economy for nutrients to farmers. Opportunity income is, the income generated by farmers by improving earning opportunities with limited resources. Crop residue, the largest product of agricultural harvests, contains large amounts of assimilated carbon (C) and nutrients such as nitrogen (N), phosphorus (P), and potassium (P); these elements must be recycled for the sustainable development of agriculture. Crop residue management should serve a doubling the farmer income by reducing the cost of chemical fertilizers and pesticides and by utilizing crop residues. Data showed that the major agro-residues of Andhra Pradesh are rice husk, maize stalks and sorghum, which accounts for almost 2/3rd of biomass available in the state. Other biomass agro-residues which are available include groundnut shells, cotton stalks, coconut frond, Bengal gram stalks, sunflower stalks, which contributes around 5.31 million tonnes, only in Andhra Pradesh, as per Biomass knowledge portal, ministry of renewable energy. Research results shows that these major crop residues can be utilized for mushroom production for getting extra income by farmers. And after mushroom production the spent mushroom substrate (SMS) can further reusable for getting opportunity income to farmers. Various other results shown that, sunflower seed hulls, coconut coir and cotton wastes also can be used for mushroom production. After mushroom production the spent mushroom can be reusable for generating further income by reducing cost of cultivation by using for vermicomposting and by direct field application. Farmyard manure is the most preferred
food material for worms, but recent studies conducted at National Research Centre for Mushroom, Solan, have shown that spent substrate from agriculture wastes after oyster and button mushrooms production also suitable for vermicomposting. The SMS can be used as a vermicomposting medium either alone or indifferent combinations either with FYM, agricultural or vegetable farming wastes depending upon their availability. Availability of nutrients from SMS can be enhanced by preparing an organic-mineral fertilizer from the spent mushroom substrate. The absorption capacity of stable ‘humus’ available in SMS helps in retention of nitrogen in the topsoil. Conversion of SMS into an organic-mineral fertilizer is an alternative way of using spent mushroom compost for soil amelioration and to make it a balanced source of nutrition for plant growth. Spent mushroom substrate can be uses as disease management due to the unique chemical constitution and the microflora present in SMS. The actinomycetes, bacteria and fungi inhabiting the compost, not only play role in its further decomposition but also exert antagonism to the normal pathogens surviving and multiplying in the soil ecosystem.

01-56

SPIRULINA–AN ALTERNATE SOURCE OF PROTEIN

Prasanna Lakshmi, P and Vijaya Gopal, A.
Department of Agricultural Microbiology, Advanced Post Graduate Center, Lam, Guntur
Corresponding author: lucky.pathuri70@gmail.com

The protein is an essential component of diet. The greatest problem in the world today is global food protein shortage. In the present scenario agriculture alone cannot feed an ever increasing world population. Hence, there is an urgent need to find alternate protein sources. The best potential is seen in microbial protein or single cell protein (SCP), a new source of protein independent of agriculture. The dried cells of microorganisms such as bacteria, fungi, yeasts and algae that are grown in large scale culture systems as proteins, for human or animal consumption are collectively known as single cell protein. Nutritional studies show that these microorganisms have one of the highest protein contents ever found, high nutritional value, good digestibility, and all essential amino acids in the proportions recommended by FAO, with the exception of methionine. SCP regulate gene expression and counteract oxidative stress.

SCP are characterized by; fast growth rate; high protein content (43-85%) compared to field crops; require less water, land and independent of climate; grow on wastewater; can be genetically modified for desirable characters such as amino acid composition and temperature tolerance. The algae *spirulina* has been considered for use as a supplementary protein. *Spirulina* has been used as a supplementary dietary ingredient of feed for fish, shrimp and poultry and increasingly as a protein and vitamin supplement to aqua feeds. It contained within it everything life needed to evolve. *Spirulina* has 3.6 billion years of evolutionary wisdom coded in its DNA. *Spirulina* is a primitive photosynthesizing cyanobacteria that grows vigorously in strong sunshine under high temperatures and highly alkaline conditions.

*Spirulina* contain antioxidant and it is a probiotic food and it is a nutraceutical too. It loaded with all kinds of phytochemicals. It contains compounds like phycocyanin, polysaccharides, and sulfolipids that enhance the immune system. *Spirulina* contains sulfolipids, found to prevent viruses from either attaching to or penetrating into cells, thus preventing viral infection. It is rich in highly digestible, absorbable and complete protein (65%) in large amounts (per equal wt) when compared to meat. Excellent source of B-complex vitamins. Rare food source of the essential Omega 6 fatty acid and Gamma Linolenic acid (GLA). Good source of Iron in an easily absorbable form. Highest known source of Beta Carotene, a powerful antioxidant sometimes referred to as Pro Vit A because our bodies convert it to vit A. The cyanobacterium *Arthospiraplantensis* can be used to produce single celled protein(SCP) and fatty acids (which can be used for bioenergy). On top of this, *spirulina* delivers more nutrition per acre than any other food on the planet. It is concluded that the use of spirulina can be suggested for the people who are suffering from malnutrition, immuno-suppression, hepatic and neural compromise, etc.
VULNERABILITY OF CLIMATE CHANGE IN ANDHRA PRADESH

Praveen Kumar, N. S., Radha, Y and Subba Rao, D. V.
Dept of Agricultural Economics, Agricultural College Bapatla
Corresponding author: praveen.raj58@gmail.com

Agriculture is crucial for food, nutritional and livelihood security of people of India. It is presently facing several challenges like decreasing yield levels, deteriorating soil health, reducing per capita land availability etc. Additionally a new challenge is of vulnerability of agriculture to climate change (CC). Among the different sectors, agriculture is the most important sector which will be clearly affected by CC. The state of Andhra Pradesh state which is one of the fastest growing economies of India contributes significantly to climate change besides being equally vulnerable to its impacts. There is a pressing need to balance this development by simultaneously acting upon climate change and other issues which are putting tremendous pressure on the environment’s carrying capacity.

Vulnerability to climate change is a comprehensive multidimensional concept affected by large number of related indicators and hence it is necessary to measure the quantum of vulnerability by constructing a Vulnerability Index (VI) for each district. In this backdrop, the present study aims to study the vulnerability to climate change for all districts of Andhra Pradesh. A composite index from the multivariate data was worked out and based on the index, the districts were ranked in terms of their vulnerability to climate change during the period 2006-2015. The values of Vulnerability Index varied from 0.426 to 0.651 with Anantapuram District scoring the highest rank and Nellore District the least. These indices would be useful for the policy makers to initiate suitable remedial measures to mitigate the effects of climate change.

ORGANIC FARMING IN HIGH ALTITUDE TRIBAL ZONE OF ANDHRA PRADESH

Ganapathi, S., Bharathi, S., SreeRekha, M and Jayalalitha, K.
Department of Agronomy, Agricultural College, Bapatla.
Correspondent author: poddu13@gmail.com

Organic farming is done to release nutrients to the crops for increased sustainable production in an eco-friendly and pollution-free environment. It aims to produce crop with a high nutritional value. Organic farming has assumed immense significance in the high altitude tribal zone. Soils and climatic conditions in HAT zone soils make them particularly well suited to organic agriculture. These marginal lands, with their marginal soils do not respond well to intensive farming practice. These are actually better suited to low-input farming systems that make ample use of the biodiversity. These involves using techniques to achieves good crop yields without harming the natural environment or the people live and work it. The material and methods involves recycled and composted crop wastes and animal manures, the right soil cultivation for right time, crop rotation, and legumes and mulching on the surface soil. On an organic farm, each technique would not normally be used on its own. The farmer would use a range of organic methods at the same time to allow them to work together for the maximum benefit. Organic farming with its central focus on maintaining and improving soil health, its avoidance of pollutants, and its reliance on local inputs and labour, can materially advance the economic and ecological health of the HAT zone as well as who live there. HAT zone soils typically are poor in water-holding capacity as well as organic matter. Addition of organic matter, a corner stone of organic farming practices, will not only improve the physical condition of these soils, but also greatly improve their ability to supply balanced plant nutrients. In HAT zone soils there is over-exploitation of natural resources,
Improper land use like shifting cultivation and soil fertility decrease by water erosion leading to unfertile soils or marginal lands. Adaption of organic farming practices suitable for HAT zone can help to ameliorate these condition. The need of organic farming is to provide long-term benefits to people and the environment. Organic farming aims at increasing long-term soil fertility, control pest and diseases without harming the environment, use resources which the farmer already has so that the farmer needs less money to buy farm inputs, produce nutritious food and high quality crops to sell at a good price. Livestock, Organic farming instigates domestic animals use to increase the sustainability of the farm. Genetic Modification, Genetic modification is kept away from this kind of agricultural set up because organic farming focuses on the use of natural ways and discourages engineered animals and plants.

**Key Words:** Organic farming, biodiversity and soil health.

**01-59**

**MILLET FOR CLIMATE-SMART AGRICULTURE: A REVIEW**

*Revathi, T and Sree Rekha, M.*

Agricultural College, Bapatla

Correspondent author: tompala.ravathi@gmail.com

World population is increasing day by day and at the same time agriculture is threatened due to natural resource degradation and climate change. Production stability, agricultural productivity, income and food security is negatively affected by changing climate. Therefore, agriculture must change according to present situation for meeting the need of food security and also withstanding under changing climatic situation. Projected estimates based on food consumption pattern and population growth show that agriculture production will require enhancing by 65% to meet the need of burgeoning population by 2050.

Developing climate resilient agriculture is thus crucial to achieving future food security and climate change goals. It helps the agricultural system to resist damage and recover quickly by adaptation and mitigation strategies. Millets possess several morpho-physiological, molecular and biochemical characteristics which confer better tolerance to environmental stresses than major cereals. Primarily, the short life-cycle of millets assists in escaping from stress as they require 12–14 weeks to complete their life-cycle (seed to seed) whereas rice and wheat requires a maximum of 20–24 weeks. However, the prevalence of stress conditions and their consequences are circumvented by several traits such as short stature, small leaf area, thickened cell walls, and the capability to form dense root system. Also, the C₄ photosynthetic trait is highly advantageous to millets. In the C₄ system, carbon dioxide (CO₂) is concentrated around ribulose-1,5-bisphosphate carboxylase/oxygenase (RuBisCO), which in turn suppresses ribulose 1,5-bisphosphate (RuBP) oxygenation and photorespiration. Thus, C₄ mechanism enhances the concentration of CO₂ in bundle sheath, which suppresses photorespiration (around 80%) depending on the temperature and increases the *in planta* catalytic activity of RuBisCO. Since RuBisCO of C₄ plants works at elevated CO₂ levels, millets have enhanced photosynthetic rates at warm conditions and confers immediate water use efficiency (WUE) and nitrogen use efficiency (NUE) which are ~1.5 to 4-fold higher than C₃ photosynthesis. These attributes of millets make them next-generation crops holding the potential for research to explore the climate-resilient traits and exploit the information for the improvement of major cereals.
INFLUENCE OF DIFFERENT PLANTING DATES ON PRODUCTION POTENTIAL OF SOYBEAN VARIETIES

Ramesh Naidu, C., Krishna Reddy, G., Sumathi, V and Venkatrama Muni Reddy, P.
Department of Agronomy, S.V. Agricultural College, Tirupati

A field experiment entitled “Influence of different planting dates on production potential of soybean varieties” was carried out during rabi, 2015-16 on sandy clay loam soils of dry land farm of S.V. Agricultural College, Tirupati, Acharya N.G. Ranga Agricultural University. The experiment was laid out in a randomized block design with factorial concept and replicated thrice. The treatments consisted of four times of sowing viz., 16th September (second fortnight of September), 1st October (first fortnight of October), 16th October (second fortnight of October) and 1st November (first fortnight of November) and four varieties viz., Basar (V1), JS-93-05 (V2), Bheem (V3) and JS-335 (V4).

The results indicated that among four times of sowing tried, sowing on second fortnight of September (D1) resulted in the highest plant height, leaf area index, total dry matter production, number of effective root nodules plant\(^{-1}\) and initial and final plant population. While, all these growth parameters were at their lowest value with first fortnight of November (D4). The results indicated that among the four varieties evaluated, the tallest plants were produced by the variety JS-335 (V4) followed by Basar (V1) without any significant difference between them, at all the crop growth stages.

While, the shortest plants were produced by JS-93-05 (V2). Maximum leaf area index and highest dry matter production were recorded with JS-335 (V4), which was however comparable with that of Basar. The lowest values of these growth parameters were registered with JS-93-05 (V2). The minimum and maximum number of days to 50 per cent flowering was registered with sowing on first fortnight of November (D4) and second fortnight of September (D1), respectively. Days to 50 per cent flowering were the minimum with soybean variety, JS-335 (V4) and this parameter was maximum with JS-93-05 (V2). The results indicated that number of effective root nodules plant\(^{-1}\) of soybean regarding to times of sowing on second fortnight of September (D1) resulted in higher number of effective root nodules plant\(^{-1}\) and first fortnight of November (D4) recorded the lowest number of effective root nodules plant\(^{-1}\). Among the varieties, higher number of effective root nodules plant\(^{-1}\) was recorded with JS-335 (V4), while the lower number of effective root nodules plant\(^{-1}\) were recorded with JS-93-05 (V2). The soybean variety JS-335 (V4) resulted in the highest values of number of pods plant\(^{-1}\), number of seeds pod\(^{-1}\), hundred seed weight (test weight), which was statistically at par with that of Bheem (V3). Regarding to times of sowing, second fortnight of September (D1) recorded significant improvement in the stature of all the yield attributes of soybean. All the yield attributes of soybean were lowest on first fortnight of November (D4). Second fortnight of September (D1) recorded highest seed yield which was comparable to first fortnight of October (D2). Lowest seed yield was recorded with latest sown crop (first fortnight of November). Variety JS-335 (V4), which was on par with Basar (V1) recorded highest soybean yield. Variety JS-93-05 (V2) recorded lower seed yield which was on par with Bheem (V3). Each successive delay in sowing from second fortnight of September (D1) to first fortnight of November (D4) significantly decreased the haulm yield of soybean. Second
fortnight of September recorded higher haulm yield, while first fortnight of November (D4) recorded significantly lower haulm yield. JS-335 (V4) recorded significantly higher haulm yield followed by Basar (V1) compared with Bheem (V3) and JS-93-05 (V2). The differences between any two times of sowing and varieties were significant. The highest harvest index was produced by second fortnight of September (D1) followed by first fortnight of October (D2) with no significant difference between these two times of sowing. The next best time of sowing was second fortnight of October (D3), which was at par with that of the first fortnight of November (D4) and it has produced the lowest harvest index. Variety JS-335 (V4) recorded highest harvest index, which was on par with that of Basar (V1). Lowest harvest index was recorded by JS-93-05 (V2), which was on par with variety Bheem (V3).

Times of sowing and varieties had significantly influenced the gross returns, net returns and benefit cost ratio. Among the times of sowing, second fortnight of September (D1), recorded significantly superior economic returns than first fortnight of October (D2). The lowest economic returns were recorded with first fortnight of November (D4). Among the soybean varieties, the highest gross returns, net returns and benefit cost ratio were realized with the variety JS-335 (V4), while they were found to be the lowest with JS-93-05 (V2).
Theme - 2
Resource Efficient and Cost Reducing Technologies
RESOURCE EFFICIENT AND COST REDUCING TECHNOLOGIES

K. V. Ramana

Vice Chairman, AP Space Application Centre, Planning Department, Govt. of AP, Vijayawada

Corresponding author: vc.apsac@ap.gov.in

Farmers throughout the world are constantly searching for ways to maximize their returns. The competition for existing resources of land and water from other than agricultural sector demands the situation of adapting the strategy of optimal resource efficiency and product mix for sustained production. The management of limited reserves of surface and ground water level will require a paradigmatic shift from maximizing productivity per unit of land area to maximizing productivity per unit of water consumed. Agricultural advances will include implementation of crop location strategies, conversion to crops with higher economic value or productivity per unit of water consumed, and adoption of alternate drought tolerant crops. The resource efficient and cost reducing technologies assumes importance in both the high input agriculture characterized by the provision of assured irrigation and other agricultural inputs, as well as subsistence farming, which is confined mostly to rainfed, or dry land regions.

The recent tools of Remote Sensing, Geographic Information Systems (GIS), and Global Positioning Systems (GPS) integrated with the field data may provide solutions needed for farmers to maximize the economic and environmental benefits of precision farming. Emerging technologies like GPS based precision irrigation technologies for self propelled sprinklers and microirrigation systems will enable growers to apply water and agrochemicals more precisely and site specifically to match soil and plant status and needs as provided by wireless sensor networks. The most effective means to conserve water appears to be through carefully managed deficit irrigation strategies that are supported by advanced irrigation system and flexible, state of the art water delivery systems.

The value of GPS, GIS and remote-sensing technologies comes from incorporating the data into the management decision process. These tools can help to develop a comprehensive crop and soil nutrient management plan that can help improve production efficiency, increase yields and reduce potential environmental problems associated with crop production. The GIS system provides a means to monitor and evaluate nutrient needs, crop removal, and losses to the environment. In the near future unmanned remote-control drones and helicopters, and on-the-ground robotics will become a part of site-specific precision agriculture. A detailed geo-referenced database with layers of information on fertilizer use, crop yields, and nutrient removal for every field on every farm shall assist the farmer in analysing the cause/effect relationships and guide the development of site-specific nutrient application maps for more efficient nutrient use and protection from over-application, as well as prevention of under-application. The methods of application will see a drastic change in future. The wastage associated with the manual means of application shall be done away through employing drones and variable rate applicators.

In the rainfed areas, the near real time satellite data from coupled with resource inventory help the decision makers monitor the agricultural situation in a more timely and effective manner.
CONSERVATION AGRICULTURE THROUGH CROP RESIDUE MANAGEMENT: POTENTIALITIES AND CONSTRAINTS

Padma, S.
Dept of Agronomy, Agricultural College, Bapatla
Corresponding author: padmasailada@gail.com

Soils, along with water, air and sun, are the major resources that sustain our food supply and terrestrial ecosystems. At present the real challenge, in agriculture is to produce more quality food for the burgeoning population from the same land and water resources, besides sustaining soil health and environmental quality. Future growth in productivity in intensively cultivated systems will come increasingly from the adoption of improved natural resource management practices designed to increase the efficiency of inputs in irrigated semi-arid and sub-humid tropics and improving the productivity in rainfed agro-ecosystems. Thus, the major challenge for the researchers is to develop an alternative system that produces more at less cost with low water and energy and improve farm profitability and sustainability. Conservation agriculture based resource conserving technologies act as driver in enhancing the crop productivity and farm profitability. Conservation agriculture aims to achieve sustainable and profitable agriculture by improving the farmer’s livelihoods through three principles that are minimal soil disturbance, permanent soil cover and suitable crop rotations. The conservation agriculture practices can make efficient use of crop residues. Crop residues have been referred to as ‘wastes’ but as a natural and valuable resource are also considered to be ‘potential black gold.’ Crop residue management (CRM) is a widely-used cropland conservation practice for wind and water erosion control besides providing significant quantities of nutrients for crop production. In addition to affecting soil physical, chemical and biological functions and properties, crop residues can also affect water movement, infiltration, runoff and quality.

The benefits of maintaining crop residues on soil surface are well documented and include reduces soil loss as a result of wind and water erosion. However, a large portion of the residues is burnt on-farm primarily to clear the field for sowing of the succeeding crop. The problem of on-farm burning of crop residues is intensifying in recent years due to shortage of human labour, high cost of removing the crop residues by conventional methods and use of combines for harvesting of crops.

The real success of conservation agriculture can be achieved by usage of second generation planters with précised seed metering and furrow opening systems in addition to seeding in the loose and standing residues. These include Zero till seed drill, double disc coulters, punch planter/star wheel, rotary disc drill, turbo happy seeder and combo happy seeder.

Conservation agriculture implies a radical change from traditional agriculture. There is a need to undertake policy-related research to quantify the benefits under a range of situations to aid policy level decisions. Some important policy considerations such as supplying machineries on subsidized rates to farmers adopting conservation agriculture, introducing C-credit schemes to benefit the farmers, developing and implementing appropriate legislation on prevention and monitoring of on-farm crop residues burnings through incentives and punishment are to be taken for adoption of conservation agriculture on large scale.

Farming in future has to be multi-functional and ecologically sustainable. The country’s food security both in the short- and long-term perspectives can be achieved by making agriculture sustainable only when the soil resource base is strong and healthy. Therefore, conservation agriculture, with crop residues as an integral component, is an effective solution to the aforesaid challenges and provides a strong natural resource base.
02-02

ROLE OF OPTICAL SENSOR BASED NITROGEN MANAGEMENT IN FIELD CROPS

Suresh Kumar, B.
Department of Agronomy, Agricultural College, Naira.
Corresponding author: sureshkumarcbm@gmail.com

Cereal grain production has linearly increased with the use of N fertilizers during the period 1951 to 2004 in India, but the Partial factor productivity (PFP) of N has been decreasing exponentially since 1965. The main reason for low N use efficiency is inefficient splitting of N doses coupled with N application in excess of crop requirements. Oftate, fertilizer N management research has developed new dimension of synchronizing N use with plant N demand through real time N management techniques which include optical sensor based nitrogen application that not only improves N use efficiency but also leads to higher grain yield levels. Reflectance of the NIR electromagnetic spectrum (720-1300 nm) depends upon structure of the mesophyll tissues which reflects as much as 60 percent of all incident NIR radiation. The N fertilizer rates depends on making an in-season estimate of the potential or predicted yield, determining the yield response to additional nitrogen fertilizer, and finally calculating N required obtaining that additional yield.

Using specific reflectance ratios (i.e., leaf reflectance values at 700 or 716 nm divided by reflectance values at 755 to 920 nm) could improve precision and accuracy in predicting cotton leaf N concentration. In maize plant, 50-70 percent of plant N is contained in the chloroplast. The validity of using in-season estimates of grain yield and a response index (RI) to evaluate prescribed midseason N applications compared with uniform rates that simulated farmer practices. Averaged over locations, NUE was improved by >15% in winter wheat when N fertilization was based on optically sensed INSEY and a RI compared with traditional practices at uniform N rates. In-season application of N at rates based on optical sensing diagnostic technique has been successful under irrigated conditions. Spectral index enables real-time and need-specific supply of N to the crop, consequently improving NUE. The yield potential of grain sorghum (Sorghum bicolor L. Moench) was estimated using a hand-held optical sensor. Several researchers have assessed N status and other physiological parameters of field crops using optical sensors and reported that using specific reflectance ratios could improve precision and accuracy in predicting leaf N concentration in several field crops and thereby improved NUE, WUE and grain yield and is thus a superior method than the other two real time N management techniques viz., leaf color chart (LCC) and chlorophyll meter (SPAD).

02-03

NANOPEDOLOGY AND ITS APPLICATIONS IN AGRICULTURE

Nagaraju, K and Prasad, T. N. V. K. V.
Department of Soil Science & Agricultural Chemistry, S.V. Agricultural College, Tirupati.
Corresponding author: nippukrish143@gmail.com

Nanotechnology is the understanding and control of matter of sizes roughly in the range of 1 to 100 nanometers. If one of the dimensions is in this range, it is considered a nanoparticle. Bulk materials when reduced to the nanoscale show some properties such as melting point, physical strength, surface area, penetration power, electric conductance, optical effect, magnetism etc. which are different from what they exhibit on a macro scale enabling unique applications. These materials can be either natural or engineered. At nanoscale, gravity would become less important, whereas surface tension and van der Waal forces would become more important. An example is new emerging disciplines - nanopedology. This is a new off-shoot of pedology; a discipline that involves study of soil as a natural body. Nanopedology converges soil mineralogy with imaging techniques and artificial intelligence. Examples of impending opportunities are in the areas of establishing...
relationships between hereto vaguely-matched properties between bio molecules and polymer, and microscopic atoms and molecules, and establishing relationships between macroscopic properties (thermodynamics) and microscopic properties, where among others kinetics, wave theory, and uncertainty principles find place.

02-04

INFLUENCE OF PSB BIOFERTILIZER ON SOIL MICROBIAL BIOMASS CARBON IN MAIZE

Vinod Babu, S., Triveni, S., Subhash Reddy, R. and Sathyanarayana, J.
Department of Agricultural Microbiology and Bioenergy, College of Agriculture, Hyderanad
Corresponding author: vinodsandamalaa83@gmail.com

Maize (Zea mays L.) is one of the most important cereal grains grown worldwide in a wider range of environments because of its greater adaptability. Maize (Zea mays L.) is one of the main source of cereals for food, forage and processed industrial products. The efficient PSB isolates of 24 phospahte solubilizing bacteria isolated from Maize Research Station and College Farm, Rajendranagar, PJTSAU, Telangana, was used in this study. In this study Soil microbial biomass carbon was recorded at different growth stages viz., vegetative, flowering and harvesting stages of crop in response to different formulation of PSB and their combination. There was an increasing trend soil microbial biomass was noticed from vegetative to flowering stages and a gradual decrease was observed from flowering stage towards harvesting stage in all the treatments studied. However significant by higher soil biomass carbon was recorded in the treatment T7 - Carrier + Liquid + Biofilmed PSB biofertilizer at vegetative (102.06µg kg⁻¹ of soil microbial biomass carbon), flowering (140.33 µg kg⁻¹ of soil microbial biomass carbon) and at harvesting (121.73µg kg⁻¹ of soil microbial biomass carbon) respectively compared to all other treatments. The major outcome of this study was the Carrier + Liquid + Biofilmed PSB biofertilizer treated Maize (Zea mays) plants produces highest biomass carbon than other treatments.

02-05

BIOCHAR: AMENDMENT FOR AGRICULTURAL SOIL MANAGEMENT

Karthik, A and Uma Maheswari, M.
Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu.
Corresponding author: karthik.cicr@gmail.com

Agricultural soil resources are limited and their quality is deteriorating due to urbanization and other human activities. The addition of organic carbon in agricultural soils can improve soil fertility which subsequently can increase crop production. Biochar (a carbonaceous material produced through pyrolysis of biomass) is a unique material that when applied as soil amendment can effectively improve the physical, chemical and biological properties of soil, and thereby solve many of the soil limitations. Biochar is persistent in soils and its beneficial effects are longer lasting when compared to other forms of organic matter such as manure. The unique characteristics of the biochar is its effectiveness in retaining most nutrients and keeping them available to plants than other organic matter such as for example common leaf litter, compost or manures. The long persistence of biochar in soil also makes it a prime material for the mitigation of climate change as a potential sink for atmospheric carbon dioxide. The success of effective reduction of greenhouse gases depends on the associated net emission reductions through biochar sequestration.

Agricultural crop residues form a major source of biomass in India and annually approximately 91–141 million tonnes of surplus crop residues are produced from the six major crops in India. Out of 82 million tonnes surplus residues from the cereal crops, 44 million tonnes is from rice followed by 24.5 million tonnes
from wheat, which is mostly subjected to on-farm burning. In case of fibre crops (33 million tonnes of surplus residue), approximately 80% of the residues are from cotton and are subjected to on-farm burning. The common practice of residue burning in the agricultural field itself provides a fast way to clear crop residues facilitating land preparation and planting for subsequent crop. However, in addition to the loss of valuable biomass and nutrients, crop wastes burning leads to release of toxic gases and greenhouse gases into the atmosphere.

The pH of biochar increases with increasing pyrolysis temperature, therefore, it is sensitive to pyrolysis conditions rather than the type of feedstock used. Conversely, the CEC of biochar is more dependent on the feedstock used rather than pyrolysis temperature. This process can be linked to the loss of some acidic surface functional groups of biochar at higher pyrolysis temperature. Hence, the properties of biochar is mainly depends upon the pyrolysis temperature and feed material used for preparation. Application of biochar has led to improvement in soil fertility and crop productivity and crop response varied with the physicochemical nature. Biochar addition may increase the water retention close to saturation. Biochar has a bulk density much lower than that of mineral soils and, therefore, application of biochar may increase the volume of unit weight soil and thereby reduces the bulk density of the soil. Biochar additions can increase the pH of amended soils by 0.4–1.2 pH units, with greater increases observed in sandy and loamy soils than in clayey soils. It also positively increased the soil pH in acidic red soil. Earthworms and microorganisms are responsible for performing ecosystem engineering tasks in soil, specifically for nutrient cycling, organic matter degradation and soil hydrology. Biochar can promote the activity of microorganisms, but there is little evidence of its effect on soil fauna.

**ENRICHMENT OF RICE WITH MICRO NUTRIENTS: BIOFORTIFICATION OF Fe AND Zn**

*Vinod Kumar Naik, M., Lakshminarayana, R., Vemireddy and Saravanan, S.*

Department of Genetics and Plant Breeding, S. V. Agricultural College, Tirupati

Corresponding author: *drvlnreddy@gmail.com*

Cereals are staple food in most developing low-income countries of Asia and Africa, where they may contribute as much as 60% of the dietary energy (Prasad *et al.*, 2014). Though rice is the predominant source of energy and micronutrients for more than half of the world population, it does not provide enough zinc (Zn) and iron (Fe) to match human nutritional requirements. Dietary deficiency of essential micronutrients such as zinc (Zn) and iron (Fe) affects more than two billion people worldwide. Biofortification of staple crops with essential micronutrients can be a viable solution. Therefore, several investigations were carrying to evaluate the potential for increasing the deposition of zinc and iron in the edible portion of rice (*Oryza sativa* L.) grains, i.e., endosperm.

Micronutrients are known to play an important role in the metabolism and physiological activities of the human body. Over three billion people in the world are malnourished. The development of crops with enhanced mineral concentration is one of the most sustainable and cost effective approaches for alleviating micronutrient malnutrition. This review focuses on the progress made in the genetic enhancement of element mineral concentration in crops through plant breeding strategies. Biofortification is considered as a suitable strategy of increasing the bio available concentrations of an element in edible portions of crop plants through traditional breeding practices or modern biotechnology to overcome the problem of micronutrient deficiencies.

Screening of germplasm for Fe and Zn content is the initial step of Biofortification. Anuradha *et al.* (2012) analyzed brown rice of 126 accessions of rice genotypes for Fe and Zn concentration. Iron concentration
02-07

UTILIZING CROP RESIDUES FOR IMPROVING NUTRIENT AVAILABILITY IN SOILS

Surya Krishna, G. K and Giridhara Krishna, T.
Department of Soil Science & Agricultural Chemistry, S.V. Agricultural College, Tirupati.
Corresponding author: gksuryakrishna1995@gmail.com

Crop residues are parts of the plants left in the field after crops have been harvested and threshed. In India there are 500-550 million tones (Mt) of crop residues are produces annually. Crop wastes includes rice, wheat, jowar, bajra, greengram, blackgram, cowpea, pigeonpea, groundnut, linseed, stalks of maize, cotton, jute, tapioca leaves and other wastes such as rice husk, saw dust, tea waste etc. Globally, the total crop residue production is estimated at 3.8 billion tons per year (Lal, 2005) including 74 % from cereals, 74 % from cereals, 8% from legumes, 3 % from oil crops, 10 % from sugar crops, 5 % from tuber. Incorporation of crop residues into soil or retention on the surface has several positive influences on physical, chemical and biological properties of soil. Continuous addition of crop residue increases organic matter status of soil and crop residues favour carbon sequestration in favour carbon sequestration in soils. Soil OM acts as reservoir for essential plant nutrients, prevents leaching of elements, required for growth and increases CEC.

02-08

RESOURCE CONSERVATION TECHNOLOGIES

Mandeep Singh Patel, Krishna and Alam, M.A.
College of Agriculture, Rewa (M.P.)
Corresponding author: mandeepatel93@gmail.com

Conservation practices play an important role in decreasing food safety risks on the farm. Stream-side vegetation, grassed filter strips, and wetlands help keep our water supply clean by reducing the movement of pathogens, nutrients, and pesticides into streams, rivers, and lakes. Windbreaks and hedgerows reduce the amount of dust and other airborne contaminates blowing onto produce fields. Resources are an important asset for a country. Unfortunately the non judicious use of these has put them in very critical situation. The indiscriminate use of chemicals for increasing productivity and disease controls have polluted water bodies and degraded soils. What is worrying is that there is a gender specific effect to the resource degradation. It is increasing the time required for fulfilment of female responsibilities such as food production, fuel wood collection and soil and water conservation. An array of resource conservation technologies is available. These include zero and reduced tillage. Green manuring, crop rotations etc. Resource conservation technologies aim to produce more at less cost while at the same time enhancing the natural resource base and maintenance of soil quality in fairly good conditions.
02-09

EFFECT OF ORGANIC ACIDS ON PHYSICO - CHEMICAL PROPERTIES OF CALCARCEOUS SOILS

Jagga Rao, I., Ravindra Babu, P., Prasad, P. R. . and Venkata Lakshmi, N.
Department of Soil Science and Agricultural Chemistry, Agricultural College, Bapatla
 Corresponding author: jaggaraoitrajula@gmail.com

A potculture experiment was conducted on “Effect of organic acids on physico-chemical properties of calcareous soils” at Agricultural College, Bapatla, Andhra Pradesh during kharif 2015-16. The experimental soil was calcareous (collected from Vertisol profile), alkaline reaction and low in organic carbon. The treatments comprised of control (T1); FeSO₄·7H₂O @ 0.25% (T2); citric acid @ 0.25% (T3); acetic acid @ 0.25% (T4); oxalic acid @ 0.125% (T5); ascorbic acid @ 0.25% (T6); hydroxyl amine hydrochloride (T7) were replicated thrice in completely randomized design (CRD) with three replications. Foliar application of organic acids were applied to groundnut grown in the respective pots at peak flowering, peg penetration and pod formation stage of the crop growth. The results showed that pH was markedly influenced by the imposed treatments but no significant effect on electrical conductivity (EC), soil organic carbon and cation exchange capacity (CEC) but slight increment was noticed in organic acids treated pots over control.

Key words: Organic acids, physico-chemical properties, calcareous soils.

02-10

EFFECT OF SILVER NANO PARTICLES ON DEFENCE RELATED ENZYMES ACTIVITY IN RICE SEEDLINGS AND PLANT GROWTH PARAMETERS IN POT CULTURE

Chiranjeevi, N., Anil Kumar, P., Sarada, R., Jayalakshmi, K.V., Hari Prasad and Prasad, T.N.V.K.V.
Department of Plant Pathology, S.V. Agricultural College, Tirupati.
 Corresponding author: chiranjeeviag09@gmail.com

Four different defence related enzymes, viz., Peroxidase, Poly Phenol Oxidase (PPO), Phenyl Ammonia Lyase (PAL), Tyrosinase were analysed from rice seedlings obtained from two nano treatments, two biocontrol agents and carbendazim applied either as seed treatment or spray. Experiment was conducted in pot culture. Substantial accumulation was observed as evidenced by the absorbance values indicating induction of resistance mechanism in rice seedlings. The present investigation also revealed increased germination of rice seeds, shoot length, root length, S:R ratio, fresh weight, dry weight and vigour index of rice seedlings with 10% silver bionano preparations applied as seed treatment (wet seed treatment for 10 minutes). These nano preparations alone could increase the growth parameters either on par with respective biocontrol agents or sometimes even better when the rice seeds of cv. NLR 34449 were treated with nano preparations and sown in pathogen uninoculated pots indicating their utility in increasing plant growth in place of even biocontrol agents and fungicide seed treatment.

02-11

TECHNOLOGIES TO BOOST AGRICULTURE PRODUCTION IN INDIA

Vishnuvardhan, P., Areef, M., Krishna Teja, I and Ramakrishna, M.
Department of Agricultural Economics, S.V. Agricultural College, Tirupati.

Indian agriculture has been characterized by many revolutions that changed the very face of this sector. One thing common in all these revolutions was the use of technology our food production which was
merely 50 million tonnes at the time of independence has now reached more than 270 million tonnes. While more than sixty percent of the population depends on the agricultural sector, yet the sector also carries the blot of farmers’ suicides, high food inflation, the low yields, the climate threat. Food production has to be increased in the context of worsening land and water scarcity and climate-change-related weather shocks. The problems in agriculture are not confined to a particular territorial jurisdiction. Some of them have now become universal. Land degradation is also another important factor affecting productivity. Land degradation is worse in areas where poverty and hunger are concentrated. Further the climate change disproportionately affects smallholders as they are more likely to depend on rainfed agriculture and degraded land. All this demands renewed and vigorous efforts towards technologies for agricultural development. Broadly the different types of technologies for agricultural development which are cost reducing are as: resource conserving technologies, high yielding technologies, post-harvest technologies, climate resilient technology, role of information technology in agriculture.

02-12

BLUE GREEN ALGAE IN SUSTAINABLE AGRICULTURE AND ENVIRONMENTAL MANAGEMENT

Nagendra, D., Ashok Mourya, M and Siva Bharathi, B.
Department of Agricultural Microbiology, APGC, Lam, Guntur
Corresponding author: nagendradangeti31@gmail.com

Cyanobacteria are phototrophic and naturally occur in several agro-ecosystems like paddy fields and other marshy areas. They fulfill their own nitrogen requirement by nitrogen (N₂)-fixation, and produce some bioactive compounds, which promote the crop growth/protect them from pathogens and improve the soil nutrient status. Cyanobacteria are also useful for waste water treatment and have the ability to degrade the various toxic compounds even the pesticides.

Several unique features of cyanobacteria such as oxygenic photosynthesis, high biomass yield, growth on non-arable lands and a wide variety of water sources (contaminated and polluted waters), generation of useful by-products and bio-fuels, enhancing the soil fertility and reducing green house gas emissions, have collectively offered these bio-agents as the precious bio-resource for sustainable development.

Cyanobacterial biomass is the effective bio-fertilizer source to improve soil physico-chemical characteristics such as water-holding capacity and mineral nutrient status of the degraded lands. The unique characteristics of cyanobacteria include their ubiquity presence, short generation time and capability to fix the atmospheric N₂. Similar to other prokaryotic bacteria, the cyanobacteria are increasingly applied as bio-inoculants for improving soil fertility and environmental quality. Genetically engineered cyanobacteria have been devised with the novel genes for the production of a number of bio-fuels such as bio-diesel, bio-hydrogen, bio-methane, syngas, and therefore, open new avenues for the generation of bio-fuels in the economically sustainable manner. By this we enlist the valuable information about the qualities of cyanobacteria and their potential role in solving the agricultural and environmental problems for the future welfare of the planet.

02-13

EFFECTS OF SILICON IN RICE UNDER BIOTIC AND ABIOTIC STRESSES

Adhikari Suryakala, V., Radhakrishnamurthy and Sreerekha, M.
Department of Agronomy, Agricultural College, Bapatla.
Corresponding author: adhikarisuryakala@gmail.com

Silicon (Si) is the second most abundant element in the earth’s crust. It is not considered as an essential element, but is a beneficial element for crop growth, especially for Poaceae crops like Rice. Rice is
a typical silicon accumulating plant and it benefits from silicon nutrition. Highly weathered soils are low in available silicon mainly due to leaching loss. Its supply is essential for healthy growth and economic yield of the rice crop.

Considerable damages to plants caused by abiotic stresses such as drought stress, salinity stress, heavy metal stress and nutrient imbalance, as well as biotic stresses like insect pests and pathogens and even herbivorous attacks, have been reported to be reduced significantly by silicon application. Increases biotic stress tolerance pest tolerance Si increases the resistance of plants to many insects in rice like stem borer, leaf folder, brown plant hopper, etc. The deposition of silica on epidermal layers offers a physical barrier to insects by preventing the physical penetration by insects. Sucking and leaf eating caterpillars have a low preference for the silicified tissues than low silica containing succulent parts. Soluble silicic acid (as low as 0.01 mg/ml) in the sap of the rice plant acts as an inhibitor of the sucking activity of the brown plant hopper.

Among rice diseases, blast is recognized as the most devastating one. Silicon fertilization has been reported to be efficacious in controlling and mitigating rice blast severity. Disease tolerance Si has been found to decrease several diseases in rice like sheath blight, brown spot, grain discoloration, etc. Si might form complexes with the organic compounds of cell walls of epidermal cells, thus increasing their resistance to the enzymes expounded by the pathogen. The antifungal compounds like momilactones were found to accumulate in Si treated rice plants.

In humid tropical and subtropical area, iron toxicity is one of the major physiological problems in rice growth. Silicon increases the oxidizing power of roots, which converts ferrous iron into ferric iron, thereby preventing a large uptake of iron and limiting its toxicity. Silicon will regulate Fe uptake from acidic soils through the release of Hydroxyl ions (OH-) by roots. Si application alleviates aluminium toxicity by creating inert aluminosilicates. Silicon (Si) is also known to alleviate manganese (Mn) toxicity in a number of plant species.

Excessive salinity in cropping soil is a worldwide problem due mainly to rising water tables. Si may alleviate salt stress in higher plants either by improved photosynthetic activity, enhanced K/Na selectivity ratio, increased enzyme activity, and increased concentration of soluble substances in the xylem and by increasing cell membrane integrity and stability. The deposition of Si in the culms, leaves, and hulls also decrease transpiration from the cuticle thus increasing resistance to drought stress. Based on all the above benefits, it is concluded that the supply of silicon is most important for plant growth especially for rice to increase its productivity.

02-14

SOIL HEALTH CARD A TOOL TO REDUCE FERTILIZER OVERUSE

*Mandakranta Chakraborty, Martin Luther, M and Mounika, D.*

Department of Agronomy, Agricultural College, Bapatla.

Corresponding author: mandy151294@gmail.com

Soil Health Card (SHC) is a Government of India’s scheme launched in 2015, promoted by the Department of Agriculture & Co-operation under the Ministry of Agriculture and Farmers’ Welfare. SHC is a printed report that a farmer is handed over for each of his holdings. It contains the status of soil with respect to 12 parameters, namely N, P, K (Macro-nutrients); S (Secondary- nutrient); Zn, Fe, Cu, Mn, Bo (Micro-nutrients); and pH, EC, OC (Physical parameters). Based on which the SHC will indicate fertilizer recommendations and soil amendment required for the farm. A Soil Health Card is used to assess the current status of soil health and are used over time, to determine changes in soil health that affected by land management. The card lists soil health indicators that can be assessed without technical or laboratory equipment. Regular use will allow farmers to record long term trends in soil health and to assess the effects of different soil management practices. To support this initiative Indian Space Research Institute (ISRO) has launched mobile application along along with web portal.
Currently, SCHs are now being provided through the BHUVAN portal in six states, namely, Andhra Pradesh, Assam, Haryana, Tamil Nadu, Telangana and West Bengal. These interfaces works together and helps in registrations of soil samples, recording tests results for soil samples and generation of SHCs along with fertilizer recommendation. This app works like other Geotagging apps developed for the RashtriyaKrishiVikasYojana.

Soil Health Card portal aims to generate and issue SHCs based on either Soil Test-Crop Response (STCR) formulae developed by ICAR or General Fertilizer Recommendations provided by State Governments. 100 million Soil Health Card distributed to farmers till 2017. Under this scheme, the Government can help farmers adopt crop diversification. Indian farmers, who commonly overuse fertilisers in almost everything they grow, are being slowly nudged away from the dangerous practice, resulting in productivity gains; a study of the national soil-health-card scheme has shown. Growers who followed scientific recommendations based on their soil profile for at least a year, as part of a national programme, are not only growing more with less inputs, but they also have cut down cultivation costs.

02-15

CARBON SEQUESTRATION IN CROPPING SYSTEMS

Sivaleela, S., Srinivas, M and Pulla Rao, Ch.
Department of Agronomy, Agricultural College, Bapatla.
Corresponding author: sivaleela1236@gmail.com

Carbon sequestration is defined as trapping the carbon in the soil. The importance of carbon is not just about forming the organic matter of soil. It also acts as a source of energy for microbial activities in soil, which is a vital indicator for soil health. It is also responsible for available water capacity in the soil, infiltration rate, aggregate formation, soil bulk density, cation exchange capacity, presence of adequate soil enzymes and the level of activity of bio indicators. Using soil carbon sink can turn the surplus farmlands into natural ecosystems, which can provide various ecosystem services.

Cropping systems, such as crop rotation, intercropping, cover cropping provides an excellent strategy to improve carbon sequestration for mitigation of climate change. It plays a crucial role by influencing the optimal yield, total increased carbon sequestrated with biomass, and that remained in the soil. An ideal cropping system for carbon sequestration should produce and remain the abundant quantity of biomass or organic carbon in the soil. A long-term study with corn and cropping systems indicated that the corn-soybean rotation system had the greatest productivity and returned the largest crop residues in the soil. Mixed cropping of corn, bean and cucurbits provided optimal productivity with corresponding quantity of biomass returns and soil carbon sequestration. In relay cropping of wheat and soybean land can be well covered and efficiently utilised to produce economic yield and improve biomass accumulation. Growing of cover crops like rye, oats and clover also reported the increase in soil organic carbon sequestration by 6-8%. It restores the degraded soils, enhances the land productivity, improves the diversity, protects the environment and reduces the enrichment of atmospheric CO₂, hence shifts emission of GHG and mitigates the climate change.

02-16

A BRIEF REVIEW ON PERFORMANCE OF MILLET VARIETIES TO VARIED LEVELS OF NITROGEN APPLICATION ACROSS DIVERSE RAINFED ECOSYSTEMS

Ramyasri, K.
Department of Agronomy, Agricultural College, Naira

Millets are group of small seeded grasses widely grown around the world. They are important crops in semiarid tropics of Asia and Africa with 97% of millet production in developing countries. They are favoured
due to their productivity and short growing season under dry, high temperature condition. They are known for drought tolerance and also suits to a wide range of soil conditions.

The yield potential of millets are low in India compared to the potentially achievable yield because of inadequate application of fertilizers, conventional cultivation of low yielding cultivars and lack of good management practices. Nitrogen is the major nutrient required by millets which positively increases the growth, yield attributes and yield (Prasad et al., 2014). Number of field trials were conducted across India to understand the responsiveness of improved millet cultivars to nitrogen application and the results were found to be quite encouraging and the findings of some such investigations are reviewed and presented hereunder.

In Madhya Pradesh, Kodo millet responded to varying levels of nitrogen under rainfed conditions (Divya and Mourya, 2013). Variety GPUK 3 showed significantly higher grain yield (17.77 q ha⁻¹) which was on par with RK 48 and RK 80. Highest plant height (71.58 cm), number of tillers m⁻²(349.26) and no of panicles m⁻² (358.55) and grain yield (18.29 q ha⁻¹) were observed with the application of 40 kg N ha⁻¹ at Akola during kharif. JK-36 variety of common millet registered significantly highest Plant height (72.68 cm), number of tillers m⁻²(383.33), number of productive tillers plant⁻¹ (6.72) and grain yield (712 kg ha⁻¹). Among various nitrogen levels tried, application of 60:30:00 kg NPK ha⁻¹ recorded significantly higher grain yield (783 kg ha⁻¹) over rest of fertilizer doses except 40:20:00 NPK kg ha⁻¹ which was found to be at par with 60:30:00 kg NPK ha⁻¹ (Bhomte et al., 2016). While at Kolhapur, Raundal and Patil (2014) PhuleEkadashi variety recorded highest grain yield (13.45 q ha⁻¹) over OLM 203 and 60 kg N ha⁻¹ registered maximum grain yield (13.40 q ha⁻¹) over rest of the levels.

Millets were found to respond significantly to applied nitrogen at varied levels. Among the foxtail millet responded up to 50 kg N ha⁻¹ and SiA3085 conditions was proved to be the best variety for Tirupati while, finger millet gave response up to 60 kg N ha⁻¹ and KOPN 235 performed well at Kolhapur. In case of kodo and small millets response to N varied between 40-60 kg N ha⁻¹ and GPUK 3 in case of kodo and Jk 36 and PhuleEkadashi in case of little millet were found to perform well in rainfed black soils of central India.

02-17

ECOFRIENDLY FARM TRENDS TO CONSERVE SOIL

Vidhyashree Venkatarao, Ch., Goutami, N., Jagga Rao, I and Siva Nagaraju, G
Department of Soil Science and Agricultural Chemistry, Agricultural College, Bapatla
Corresponding author: chintadavidhyashree@gmail.com

Plant science plays an important role in helping farmers use our planet’s precious natural resources wisely to feed a growing world population. Sustainable agricultural practices, such as no tillage, and technologies that mitigate extreme climatic conditions, help protect the soil. Herbicide-resistant biotech seeds and crop protection products allow for reduced or no tillage, which can preserve soil moisture and greatly reduce soil erosion. By taking fewer passes over the field with tractors to control weeds, farmers can ensure topsoil and soil moisture stay in the field. Continuous no-till can also make soil more resistant to erosion over time. And the more soil, the more carbon retention; no-till farming decreases greenhouse gas emissions by 90 to 95 per cent or more compared to conventional tillage practices. Up to 50,000 square kilometers of soil is lost every year worldwide, primarily through erosion. This makes protecting soil, one of the most important natural resources, a key priority in global agriculture. If left unprotected, half of our current cropland is predicted to become unusable due to desertification and land degradation. The latter can damage both ecosystems and food supplies as arable land becomes obsolete. Until 2050 global food production must be doubled for satisfying global needs. Our scenarios should help to preview future changes, to counterbalance and to mitigate possible negative impacts, thus sustaining global food security. Farmers everywhere are facing a major challenge. They must adapt to changing climate conditions such as increased frequency of drought, extreme temperatures and flooding while also reducing their environmental footprint.
MUNICIPAL SOLID WASTE MANAGEMENT IN INDIA

Amani, J., Srikanth, M. and Tejadeep, P.
Department of Environmental Sciences, APGC, Lam, Guntur
Corresponding author: jampanaamani@gmail.com

Municipal solid wastes may be defined as the organic and inorganic waste materials produced by various activities of the society and which have lost their value to the user. Rapid industrialization and population explosion in India has led to the migration of people from villages to cities, which generate thousands of tons of municipal solid waste (MSW) daily. In India nearly 377 million people living in urban areas as per the 2011 census. Per capita waste generation ranges between 0.2 kg per day in the Indian cities amounting to about 1.52 lakh MT of waste per day, 55 million MT annually. The MSW amount is expected to increase significantly in the near future as the country strives to attain an industrialized nation status by the year 2020. Solid waste generally comes from household garbage and rubbish, street sweepings, construction debris and sanitation residues etc. Solid waste management is one among the basic essential services provided by municipal authorities in the country to keep urban clean. However, it is among the most poorly rendered service-the systems applied are unscientific, outdated and inefficient.

Municipal solid waste management (MSWM) involves activities associated with generation, storage, collection, transfer and transport, processing and disposal of solid wastes. But, in most of the cities, the MSWM system comprises only four activities, i.e., waste generation, collection, transportation, and disposal. Therefore, MSWM is one of the major environmental problems of Indian cities. Technologies available for processing, treatment, and disposal of solid waste are Composting, Vermicomposting, Anaerobic digestion and biomethanation, Incineration, Gasification and Pyrolysis, Plasma pyrolysis, production of Refuse Derived Fuel (RDF) - also known as pelletization and sanitary land filling /landfill gas recovery. Poor collection and inadequate transportation are responsible for the accumulation of MSW. Various studies reveal that about 90 % of MSW is disposed of unscientifically in open dumps and landfills, creating problems to public health and the environment.

EFFECT OF HUMIC SUBSTANCES ON NUTRIENT UPTAKE AND DRY MATTER PRODUCTION OF AEROBIC RICE (ORYZA SATIVA L.)

Eshwar, M., Srilatha, M., Bhanu Rekha, K. and Harish Kumar Sharma, S.
Department of Soil Science and Agricultural Chemistry, College of Agriculture, Hyderabad

The pot culture experiment was conducted in greenhouse, College of Agriculture, Rajendranagar, during kharif 2016 to study the effect of humic substances on nutrient uptake and dry matter production of aerobic rice (Oryza sativa L.) with following imposed treatments T1-Control, T2-Fulvic acid, T3-Humic acid, T4-Soil application of Fe-chelate @ 2.5 mg Fe kg⁻¹ soil, T5-Soil application of Fe-fulvate @ 2.5 mg Fe kg⁻¹ soil, T6-Soil application of Fe-humate @ 2.5 mg Fe kg⁻¹ soil, T7-Soil application of FeSO₄ @ 2.5 mg Fe kg⁻¹ soil, T8-Foliar application of Fe-chelate @ 0.25 % at vegetative stage and panicle initiation stage, T9-Foliar application of Fe-fulvate @ 0.25 % at vegetative stage and panicle initiation stage, T10-Foliar application of Fe-humate @ 0.25 % at vegetative stage and panicle initiation stage, T11-Foliar application of FeSO₄ @0.25 % at vegetative stage and panicle initiation stage. Humic and fulvic acid was applied along with iron as Fe-fulvate and Fe-humate prepared in 1:1.5 molar ratio along with Fe-chelate and FeSO₄ with recommended dose of fertilizers (180-60-40 kg/ha N, P & K). The results concluded that nutrient uptake was increased from (7.59 to 51.96 g pot⁻¹) in case of nitrogen, phosphorus (1.16 to 5.14 g pot⁻¹), potassium (9.17 to 47.81 g pot⁻¹).
g pot⁻¹), iron (24.73 to 187.70 µg pot⁻¹) & dry matter production was increased from (7.23 to 21.42 g pot⁻¹) with treatment T₁₁ foliar application of FeSO₄ @ 0.25 % at vegetative and panicle initiation stage among other imposed treatments.

02-20

REMOTE SENSING- APPLICATIONS IN AGRICULTURE

Kiran, B.V.S. and Murthy, V.R.K.
Department of Agronomy, Agricultural College, Bapatla,
Corresponding author: sagalkiran94@gmail.com

Remote sensing refers to obtaining information about objects or areas at the earth’s surface without being in direct contact with the object or area. Remote sensing uses a part or several parts of the electromagnetic spectrum. It records the electromagnetic energy reflected or emitted by the earth’s surface. Remote sensing imagery has many agricultural applications such as crop identification, area acreage, yield estimation, detection of nutrient deficiencies, detection of crop pests and diseases, crop water condition, water management, soil mapping, weather forecasting and crop insurance etc. However, remote-sensing technology provides many advantages over the traditional methods in agricultural resources survey. Remote sensing applications in agriculture have progressed to a stage where information from remote sensing imagery is being used for a number of policy level decisions related to food security, poverty alleviation and sustainable development.

Remotely sensed data from satellite-based sensors have proved useful for large-area land Use Land Classification (LULC) characterization due to their synoptic and repeat coverage. Remote sensing technology has potential to estimate crop area and forecast productivity at district and regional level due to its multispectral, large area and repetitive coverage. Crop production forecasting includes identification of crops, acreage estimation and forecasting yield. Crop identification and discrimination is done based upon the spectral signature (each crop has its own reflectance pattern in different parts of the electromagnetic spectrum).

Crop yields are estimated by analyzing satellite based vegetation indices. The remotely sensed data used for generating vegetation indices correspond to the maximum vegetation stage of the crop. Nutrient deficiencies can be identified by remote sensing which affect pigment concentration and subsequent leaf colour. Remote sensing is used for monitoring some disease and insect pests of crops. Remote sensing techniques are used to detect specific insect pests and to distinguish between insect and disease damage on crops.

Remote sensing is important for monitoring crop water conditions. The thermal infrared region is useful for stress detection and quantification, where plant canopy temperature is used as an indicator of crop stress. Crop canopy temperature can be measured both from aircraft and satellite platforms. Currently, Landsat, NOAA and INSAT provide data in thermal infrared channels. In soil mapping application of satellite remote sensing data has reduced fieldwork to a considerable extent and soil boundaries are more precisely delineated than in conventional methods.

The developments in satellite meteorology enabled the retrieval of basic agro-meteorology parameters viz., cloud cover, solar radiation, air temperature, rainfall, absorbed photo-synthetically active radiation, soil moisture, evapo-transpiration etc., which contribute significantly to the understanding of agricultural production forecasting. Agricultural insurance provides safety nets against unwanted and unpredictable weather adversaries. By knowing the crop condition, yield assessment and weather conditions every 12 days, it is easy for releasing crop insured money to farmers. The State Government or insurance companies can make part payment of insurance to farmers without waiting till the end of season. Considerable efforts have been made to estimate yield loss for large area using coarse resolution remote sensing weather and vegetation index data.
WATER POLLUTION: CAUSES, EFFECTS AND PREVENTIVE MEASURES

Raliengoane Tebesi Peter, Teja Deep, P and Srikanth, M.
Department of Environmental Sciences, APGC, Lam, Guntur.
Corresponding author: traliengoane@gmail.com

The growth of industry and of the population gave rise to several undesirable conditions, including pollution to water bodies. Water is a critical resource in the lives of people who both benefit from its use and who are unfortunately harmed by its misuse and unpredictability (flooding, droughts, salinity, acidity, and degraded quality). Water is a vulnerable natural resource. The consumption of polluted water puts lives and livelihoods at risk because water has no substitute. There are many ways in which water intended for human and animals’ consumption can get polluted. These include wastes from industries like mining and construction, food processing, radioactive wastes from power generating industries, domestic and agricultural wastes, various microbiological agents, sewage released in fresh water and runoff. The problems of water pollution are important that they affect not only the health of the population and animals but also the interest of farmers and fishermen. Attention has been directed to the need for satisfactory methods of preventing or reducing pollution by the entire world. To prevent the concentration of water pollution, efficient safety measures have been employed that prevent point-source and nonpoint-source pollution. An effective way to deal with the water pollution problem is to use the least harmful ways to prohibit contaminants.

INM FOR ENHANCING NUTRIENT USE EFFICIENCY AND FARMER’S INCOME

Vinayak, T., Narasimha Rao, S.B.S., Murthy, V.R.K and Prasad, P.R.K.
Agricultural College, Bapatla.
Corresponding author: tatrani.vinayak@gmail.com

In Indian agriculture, nutrient management has played an important role in accomplishing the enormous increase in food grain production from 52 million tons in 1951-52 to 270 million tons during 2016-17. Since green revolution till now the fertilizers consumption per year has been increased from 5.5 to 28.5 million tons in 1970 to 2017 respectively. However, application of imbalanced and/or excessive application of N, P and K fertilizers led to declining nutrient-use efficiency (NUE), fertilizer consumption uneconomical and producing combat effects on soil microorganism, soil enzymes activities, and atmosphere (Aulakh and Adhya, 2005) and groundwater quality (Aulakhet et al., 2009) causing health hazards and climate change. There is a need for Integrated Nutrient Management (INM) approach which is based on optimizing nutrient inputs by taking all possible nutrient sources of both organic and inorganic into consideration, matching nutrient supply in root zone with crop requirements spatially and Temporally, reducing Nutrient losses in intensively managed cropping systems, and taking all possible yield-increasing measures into consideration.

Improving nutrient efficiency is a worthy goal and fundamental challenge facing the fertilizer industry and agriculture in general. The opportunities are there and tools are available to accomplish the task of improving the efficiency of applied nutrients. However, we must be cautious that improvements in efficiency do not come at the expense of the farmers’ economic viability or the environment. INM maintains or enhances soil productivity through a balanced use of fertilizers combined with organic and biological sources of plant nutrients, that improve the stock of plant nutrients in the soils and finally improve the efficiency of plant nutrients, thus, limiting losses to the environment. INM is the most efficient and practical way to mobilize all the available, accessible and affordable plant nutrient sources in order to optimize the productivity of the crops/cropping systems and economic returns to the farmer. Three years data collected from 267 sites in India under different crops convincingly show a 22% increase in yield of rice by following INM rather than farmer’s practice consisting of application of fertilizers only (Govil and Kaore, 2016).
AGRONOMIC BIOFORTIFICATION OF RICE

Hemasravanthi T and Radha Krishna, Y.
Department of Agronomy, Agricultural College, Bapatla.
Corresponding author: hemasravanthithaninki@gmail.com

Soil micronutrient deficiencies limit crop productivity and nutritional quality of foods, which together affect nutrition and human health. The micro-nutrient malnutrition in rice is a common phenomenon due to deficiency of iron, zinc, iodine and vitamin A and may cause lower resistance to diseases in children and reduced the probability of child survival at birth.

Under nutrition and micronutrient deficiencies account for 3 million child deaths each year; nutritional deficiencies and their synergy with infectious diseases increase the risk of child deaths by pneumonia, diarrhea, malaria and measles. Micronutrient deficiencies or “hidden hunger” affect about 38% of pregnant women and 43 % of preschool children worldwide and are most prevalent in developing countries. More than 30% of the world’s population is anemic.

Biofortification is a feasible and cost-effective means of delivering micronutrients to populations that may have limited access to diverse diets and other micronutrient interventions. Biofortified crops can help to alleviate micronutrient deficiency in at-risk populations in a sustainable manner.

The major difference between bio fortification and standard fortification is that the latter involves additives that are mixed with the food, whereas bio fortification embeds the nutrients inside plant cells. Agronomic bio fortification can be effective in increasing yields and nutritional quality. Agronomic bio fortification - the application of mineral micronutrient fertilizers to soils or plant leaves to increase micronutrient contents in edible parts of crops.

The sources of micro nutrients are inorganic, synthetic chelates or natural organic complexes. Foliar fertilization has many advantages over soil application due to lower requirement and immediate crop response. Organic amendments, especially FYM, increase the concentrations of many nutrients and can be seen to enhance the nutritional value and nutrient balance of plant foods. Zn deficiency can be corrected by either foliar or soil applications of ZnSO₄ or Zn EDTA. Application of Zn on soil is more effective than foliar applications.

The application of micronutrient-enriched fertilizers should have no serious negative environmental effect when used at appropriate rates and generally has agronomic benefits as it improves soil fertility and crop health. Based on the above aspects there is a need of biofortification of rice to provide nutritional security and help to eradicate hidden hunger.

Key words: Rice, Malnutrition, Hidden hunger, Micronutrient fertilizers.

ZERO-TILL MAIZE: NITROGEN MANAGEMENT

Sravanthi, S., Aliveni, A and Sree Rekha, M.
Department of Agronomy, Agricultural College, Bapatla
Corresponding author: sravanthi0128@gmail.com

Maize (Zea mays L.) is one of the most important cereals of the world’s agricultural economy both as food for human consumption and feed for animals after rice and wheat. In India, maize occupies 11.98 M ha of area producing 21.57 Mt (Ministry of Agriculture, Government of India,2012-13). In Andhra Pradesh, it
is grown in an area of 7.86 lakh ha with a production of 4.15 M t and thus contributing to the tune of 22 per cent to total maize production of India (Venkata Rao et al., 2014).

Conventional tillage has long been contributing negatively to soil quality by fracturing the soil, disrupting soil structure, accelerating surface runoff and soil erosion. On the other hand, conservation tillage with proper crop rotation helps in maintaining soil organic carbon level due to least amount of soil disturbance (Varvel and Wilhem, 2010). Zero tillage technology not only has short term benefits like saving of 25-30 % of energy for field preparation, advancement in sowings by 20-25 days but also offers long term benefits like improvement in soil organic carbon content, checking soil erosion etc. Timsina et al. (2010) summarized that the establishment of maize after rice with reduced or no tillage and retaining crop residues could help conserving soil organic matter (SOM) and maintain soil fertility if improved nutrient management is practiced.

Potentiality of maize for its growth and development can be fully exploited by adopting suitable agronomic practices such as maintenance of optimum crop stand, adoption of proper nutrient and weed management strategy etc. and among them nutrient management holds the key. In zero tillage technology, fertilizer application is challenging and therefore to derive complete benefits of zero tillage with maize crop, a high nutrient feeder, there is an immense need to draw appropriate nutrient management strategy that takes into account the micronutrients management as well. Among different essential nutrients, N is highly limiting in Indian soils that exerts a profound effect on plant growth and development owing to its metabolic and physiological needs. The beneficial effects of nitrogen on crop production are well documented. However, nitrogen mining by crops for optimum productivity widely vary on account of different agro-climates, soils, cultivars, management practices and other factors.

The results of the field experiment conducted on clay loam soils of Agricultural College Farm, Bapatla to study the effect nitrogen levels on zero till maize revealed that significantly higher dry matter accumulation (179.3 q ha⁻¹) and maximum kernel and stover yield (83.3 and 98.3 q ha⁻¹ respectively) were obtained with application of 300 kg N ha⁻¹ over 120 kg N ha⁻¹ (62.9 and 80.8 q ha⁻¹ respectively) (Venkata Rao et al., 2014).

Application of 250 kg N ha⁻¹ recorded significantly higher kernel and stover yield (6513.20 and 9460.16 kg ha⁻¹ respectively) compared to lower levels of nitrogen i.e. 200 and 150 kg N ha⁻¹ on sandy loam soils of Agricultural College Farm, Mahanandi, ANGRAU (Thimmappa et al., 2014).

Increase in N level from 0 to 240 kg ha⁻¹ significantly increased the zero till maize kernel yield (from 3500 to 7130 kg ha⁻¹) and maximum gross (Rs. 60,605 ha⁻¹) and net returns (Rs. 47,330 ha⁻¹) and benefit cost ratio (3.56) than lower nitrogen levels on sandy clay loam soils of Agricultural Research Station, Kampasagar, Nalgonda (Latheef Pasha et al., 2012).

Increase in growth parameters, yield with enhanced levels of nitrogen might be due to the critical role being played by vital macronutrient (N), a key factor responsible for cell division and cell elongation. Adequate levels of N supplied to crop plants also increase the amount of cell plasma and chlorophyll which are very essential for supporting plant growth. Nitrogen also plays a crucial role in enhancing the auxin levels in the plant that enables increased internodal length and in turn increased plant height, drymatter production and there by yield.

Summarizing the review undertaken, it is understood that the sustainable productivity of maize could be achieved through high N levels. In this context, the present review would show the way to improve the productivity of zero till maize in order to get more net returns.
CROP RESIDUES AS BIOCHAR

Rentapalli Balaji
Department of Agronomy
Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. UP

Biochar is a high-carbon, fine-grained residue that today is produced through modern pyrolysis processes; it is the direct thermal decomposition of biomass in the absence of oxygen (preventing combustion), which produces a mixture of solids (the biochar proper), liquid (bio-oil), and gas (syngas) products. The specific yield from the pyrolysis is dependent on process condition, such as temperature, and can be optimized to produce either energy or biochar. Temperatures of 400–500°C (752–932°F) produce more char, while temperatures above 700°C (1,292°F) favor the yield of liquid and gas fuel components. Due to relatively stable biological state of biochar, its production for soil application has been proposed as a way of diverting waste biomass carbon from a rapid to a slow carbon-cycling pool in soil. In recent years, increased concerns for healthy food production and environmental quality and increased emphasis on sustaining productive capacity of soils have raised interests in the maintenance and improvement of soil organic matter through appropriate land use and management practices.

In the past few years, there has been growing interest in the use of synthetic biochar as an amendment worldwide. Application of synthetic biochar in soil may provide a novel soil-management practice because of its potential to improve soil fertility, enhance soil carbon, mitigate soil greenhouse gas emissions, reduce leaching of nutrients and chemicals, increase fertilizer use efficiency and enhance agricultural productivity. Enormous quantities of rice straw, rice husk and other surplus residues available in India could potentially be pyrolysed to produce bioenergy, thereby reducing field burning and use of fossil fuels and biochar by-product could help to improve soils, avoid methane emissions and sequester carbon in soils. Because of its reactive surfaces and recalcitrant aromatic structure; soil biochar can influence a number of biogeochemical processes and serves as a sink for CO₂. Owing to its greater stability against microbial decomposition and its superior ability to retain nutrients compared to other forms of soil organic matter. Biochar can stimulate native soil microbial activity, provide favorable habitat for microbes and encourage mycorrhizal fungal colonization for improved plant water and nutrient supply and may promote rhizobia for N₂ fixation in leguminous plants. Currently, very little research has been done on various aspects of biochar application in different cropping systems in India. Long-term studies on biochar in field trials seem essential to better understand biochar effects and to investigate its behaviour in soils.

INTEGRATION OF BIOCHAR, FYM WITH INORGANIC FERTILIZERS AND ITS EFFECT ON SOIL PROPERTIES AND SWEET CORN YIELD

Sivadevika, O., Ratna Prasad, P., Prasuna Rani, P and Lakshmipathy, R.
Department of Soil Science and Agricultural Chemistry, Agricultural College, Bapatla.
Corresponding author: shivadevika990@gmail.com

A field experiment has been conducted in field number 28 of northern block, Agricultural College farm, Bapatla, Andhra Pradesh to study the influence of biochar on soil properties and yield of maize (sugar cane-var. sugar 75) during kharif season of 2014-15. The experimental soil was clay loam in texture, slightly alkaline reaction, low in organic carbon, low in available nitrogen, medium in available phosphorus and high in available potassium. All the micronutrients were sufficient in the soil with values above their critical limits. The treatments comprised of control (no fertilizers) (T₁), RDF (T₂), RDF+Azophos(T₃), 75 % RDF+biochar @
5 t ha\(^{-1}\) (T\(_4\)), 75 % RDF+biochar @ 5 t ha\(^{-1}\)+Azophos (T\(_5\)), 75 % RDF+FYM @ 5 t ha\(^{-1}\) (T\(_6\)), 75 % RDF+FYM @ 5 t ha\(^{-1}\)+Azophos (T\(_7\)) were replicated thrice in Randomised Block Design (RBD). Biochar, FYM and Azophos were incorporated one week before sowing. Entire phosphorus was applied as basal dose in the form of SSP, nitrogen and potassium were applied in 3 and 2 splits, respectively in the form of urea and MOP as per the treatments. The influence of various treatments on soil properties and performance of sweet corn were determined by standard procedures at different stages.

Among all the treatments, plots supplied with biochar resulted in significantly lower bulk density at harvesting stage of the crop growth. Water holding capacity and porosity were significantly improved by application of biochar. There was no significant change in pH and EC due to imposed treatments. But significantly higher organic carbon content was discernible in biochar treated plots followed by FYM treatments. At harvesting stage of crop growth, CEC values were significantly higher in the treatments supplied with biochar as compared to control. Integrated application of organics and inorganics showed numerically proximate values with the treatments supplied with RDF in N, P, K contents. Availability of Ca, Mg and Mn was maximum in treatments incorporated with biochar and were found significantly superior to rest of the treatments. Iron, zinc and copper contents not differed significantly by imposed treatments, however numerically slight decrease was observed in Fe and Zn contents in soils treated with biochar. Application of 75 % RDF + biochar @ 5 t ha\(^{-1}\)+Azophos favoured the yield and its attributes besides increasing the content, uptake and postharvest soil fertility with reference to N and P. The results further showed that combined application of 75 % RDF and Azophos along with either biochar or FYM have been proved to be superior treatments for the best management of soil fertility in clay loam soils.

02-27

PERFORMANCE OF SORGHUM HYBRIDS UNDER DIFFERENT NITROGEN LEVELS IN RICE-FALLOW CONDITIONS OF NORTH COASTAL A.P.

_Sri Sai Siddartha Naik, B., Ramana Murthy, K.V., Ramana A. V and Gurumurthy, P._
Department of Agronomy, Agricultural College, Naira.
Corresponding author: siddunaik08@gmail.com

Sorghum (_Sorghum bicolor_ L. Moench) is traditionally grown for food in semi-arid tropics of India and occupies an area of 6.32 m. ha with a total production of 6.03 m.t and a productivity of 1,004 kg ha\(^{-1}\) (ASG, 2011). As per the latest estimates, the crop is being grown under rice-fallow in an extent of 24,000 ha with a productivity of 6.5 t ha\(^{-1}\) (Chapke et al., 2014).

Of late, Sorghum is emerging as a potential alternate food, fodder and bio-energy crop owing to its tolerance to high temperature and drought thus making it suitable for different agro climatic zones of Andhra Pradesh.

Role of Nitrogen is considered the most limiting factor for plant growth after water. When nitrogen interacts with residual soil moisture (water) strongly to bring about crop development, it play a vital role in gauging the economic and environmental viability of agro ecosystems.

It exploits genotypic differences in N demand and efficiency have been proposed as possible alternatives for reducing the cost and reliance upon fertilizer N (Gardner et al. 1994).

Response of grain sorghum to N is high and N fertilizer application is a major factor determining grain yield in sorghum.
Sorghum hybrid CSH-16 in rice-fallow recorded highest grain yield (8.4 t ha\(^{-1}\)) with the application of nitrogen \(\times 150\) kg ha\(^{-1}\) and at a spacing of 40 cm x 20 cm on clay loam soils of Ananthavaram village of Guntur district of Andhra Pradesh during rabi season under zero-tillage conditions (Mishra et al., 2009).

Patil et al. (2012) conducted an experiment on sorghum in rice-fallow and reported that the highest number of panicles m\(^{-2}\) (12.6) and grain yield (11.78 t ha\(^{-1}\)) were obtained with the hybrid CSH 16 at a nitrogen level of 150 kg ha\(^{-1}\) as compared to other hybrids.

Chapke et al. (2014) recorded maximum plant height at harvest (227 cm), panicles m\(^{-2}\) (9.0), 100 grain weight (3.20 g), grain yield (9.05 t ha\(^{-1}\)) and stover yield (14.13 t ha\(^{-1}\)) with the sorghum hybrid (cross 456A X CB134) with the application of nitrogen \(\times 150\) kg ha\(^{-1}\) on clay loam soils under zero-tillage conditions as compared to other hybrids.

Gautami et al. (2015) conducted an experiment on sorghum with different nitrogen levels at Agricultural College Farm, Bapatla with the MLSH-151 and recorded the highest plant height (161 cm), panicle length (22.8 cm) and number of grains per panicle (1125) with the application of nitrogen \(\times 150\) kg ha\(^{-1}\) under rice-fallow conditions.

Hence from the above, it can be concluded sorghum can be successfully grown by choosing sorghum hybrid CSH 25 (V3) and with application of 120 kg N ha\(^{-1}\) (N4) for obtaining highest yield making it technically feasible and economically profitable proposition under the resource constrained rice-fallow conditions of North Coastal Zone of Andhra Pradesh.

02-28

**SWEETCORN - A BETTER OPTION FOR HIGH MONETARY RETURNS**

**Kavya. T., Venkateswarulu, B. and Prasad, P. V. N.**

Department of Agronomy, Agricultural College, Bapatla.

Corresponding author: kavya.cherri9@gmail.com

Sweet corn (Zea mays L. Saccharata) also known as sugar corn, is a hybrid of maize specifically bred to increase the sugar content. In India, maize is grown in 9.2M. ha, with an annual production of 24.2Mt with a productivity of 2632kg/ha. In Andhra Pradesh it is grown in an area of 3.03lakh hectares with a production of 19.38lakh tonnes (Andhrapradeshstat.com).

Sweet corn is not a staple food, it is favourable for fresh consumption because of its delicious taste, delicate crust, soft and sugary texture compared to other corn varieties. Sweet corn has been expended widespread in the world. When the moisture content is higher than 74 percent, the cobs are immature and below 70 percent, they lose the sweetness and develop an unpleasant taste and texture. It has a thinner pericarp than the normal corn making it tender (Pradeep et al., 2005). The green cobs are eaten, roasted or boiled. In sweet corn best nutritional quality depends on moisture (72.7%) and total solids (22.3%) comprising of carbohydrate (81%), protein (13%) and lipids (3.5%). At optimum market maturity, sweet corn will contain 5 to 6 % sugar, 10 to 11% starch, 3% water-soluble polysaccharides and 70% water (Gulgun et al., 2005). Sweet corn is relatively high in oil content which predominantly rich in linoleic (50%) and oleic (30%) acid. It also contain moderate levels of protein, vitamin A (yellow varieties) and potassium.

Most of the sweet corn is grown for the processing sector ending up on the super market shelves as products which include canned kernels, frozen cobets and frozen kernels.

Sweet corn can be harvested within 80 to 90 days after sowing and thereby field duration could be reduced earlier by 35 to 45 days compared to normal grain corn. Presently, greater emphasis is given to the cultivation of sweet corn due to increasing demand. After harvesting green cobs, the plants of sweet corn are used as green fresh or dry fodder. This speciality corn with its high market value is gaining popularity and now
a day’s its cultivation is the first choice of the farmers. Recently, few sweet corn varieties have been released by private and public sector. Since there is limited scope to increase the area under sweet corn cultivation because of competition from other cereals and cash crops, the only alternative is through enhancement of productivity by various management factors.

02-29

PERFORMANCE OF BLACKGRAM (Vigna mungo L.) TO DEFICIT IRRIGATION AND FOLIAR NUTRITION

Vijaya Lakshmi, K., Prathibha Sree, S., Venkata Lakshmi, N and Madhu Vani, P.
Department of Agronomy (Water Management), APGC, Lam, Guntur.
Corresponding author: vijjukaviti92@gmail.com

A field experiment was conducted on sandy loam soils of Agricultural Research Station, Jangamaheswarapuram during rabi, 2016-17 to study the effect of irrigation and foliar nutrition on yield and water productivity of black gram. The experiment was laid out in split plot design and replicated thrice. The treatments comprised of four main plots viz., No irrigation (I₁), Irrigation at 0.3 IW/CPE (I₂), 0.4 IW/CPE (I₃) and 0.5 IW/CPE (I₄) ratios and four sub plot treatments viz., foliar spraying of 2% urea (F₁), 2% DAP (F₂), 1% KNO₃ (F₃) and 2% 19-19-19 (F₄) twice at pre-flowering and pod filling stages.

The data recorded on seed yield and haulm yield and harvest index of black gram revealed that the highest seed yield was recorded with 0.5 IW/CPE which was significantly superior to other irrigation levels. Among foliar treatments, 1% KNO₃ recorded the highest seed yield which was on a par with 2% DAP. The highest haulm yield was recorded at 0.5 IW/CPE which was on a par with 0.4 IW/CPE ratio. Maximum haulm yield was recorded with 1% KNO₃ which was significantly higher over other foliar nutrition treatments. Irrigation at 0.5 IW/CPE ratio recorded significantly higher seed yield (959 kg ha⁻¹) and haulm yield (1935 kg ha⁻¹). Among sub plot treatments, 1% KNO₃ sprayed twice at pre-flowering and pod filling stages (F₃) recorded significantly higher seed yield (833 kg ha⁻¹) which was comparable with 2% DAP (F₂). Significantly higher haulm yield (1828 kg ha⁻¹) was recorded with 1% KNO₃ (F₃). The influence of irrigation levels and foliar nutrition on harvest index of black gram was found to be non-significant.

The highest water productivity was recorded in control plot (0.48 kg m⁻³) followed by 0.3 and 0.5 IW/CPE ratios coincided with pod filling (57 DAS) and pre flowering stages (33 DAS). The lowest was recorded with 0.4 IW/CPE (0.38 kg m⁻³) coincided with pod formation stage (43 DAS). Foliar application of 1% KNO₃ recorded the highest water productivity which was significantly superior to other foliar treatments. Control (I₁) and 1% KNO₃ sprayed twice at pre-flowering and pod filling stages (F₃) recorded significantly higher water productivity (0.48 kg m⁻³). Overall, the study revealed that irrigation at 0.5 IW/CPE ratio and foliar spraying of 1% KNO₃ twice at pre flowering and pod filling stages was found to be better in increasing the yield and water productivity of rabi black gram.

02-30

PHYTOREMEDIATION IN SALINE SOILS

Chandrakanth, A., Pramila Rani, B., Sreerekha, M and Madhuvani, M.
Department of Agronomy, Agricultural College, Bapatla.

Phytoremediation can be defined as “the efficient use of plants to remove, detoxify or immobilise environmental contaminants in a growth matrix (soil, water or sediments) through the natural biological, chemical or physical activities and processes of the plants”. Phytoremediation involves growing plants in a contaminated matrix, for a required growth period, to remove contaminants from the matrix, or facilitate immobilisation (binding/
containment) or degradation (detoxification) of the pollutants. Phytoremediation is an *in situ* remediation technology that utilises the inherent abilities of living plants. Phytoremediation can be used to clean up metals, pesticides, solvents, explosives, crude oil, polycyclic aromatic hydrocarbons. Phytoremediation is an environmentally friendly technique the uptake of contaminants in plants occurs primarily through the root system, in which the principal mechanisms for preventing contaminant toxicity are found. The root system provides an enormous surface area that absorbs and accumulates the water and nutrients essential for growth, as well as other non-essential contaminants. Researchers are finding that the use of trees (rather than smaller plants) is effective in treating deeper contamination because tree roots penetrate more deeply into the ground.

Halophytes are plants that can tolerate and grow on soils having high salt concentration. While growing on salt contaminated soils some halophytes are known to accumulate salts in plant parts. *Atriplex patula* is an example of halophyte which accumulates salts. A number of researchers have investigated *Atriplex* species in the recent past to look at their potential in removing contaminants and reclaiming soils. *Atriplex parviflora* could be used as a biofilter to remove nutrients from saline aquaculture effluents. *Atriplex nummularia* is a vegetative cover in a salt affected land in southeast Australia. However, low transpiration rate (0.3 mm/d) of these plants had little hydrologic effect on the shallow water table. *Atriplex griffithii* variety stocksgrown in pots with varying concentrations of NaCl had high Na+ and Cl- content in plant parts and the ash content increased to 39% of the dry weight in leaves. Thirty *Atriplex* lines recognized for potential habitat improvement and phytoremediation of selenium contaminated sites. *Atriplex patula* was found to be one of the top selenium accumulators and grew well in saline soil.

**02-31**

**RESIDUAL EFFECT OF INTEGRATED NUTRIENT MANAGEMENT TO SUCCEEDING RABI JOWAR**

*Mounika, B., Pulla Rao, Ch., Martin Luther, M., Prasad, P. R. K and Ashoka Rani, Y.*

Department of Agronomy, Agricultural College, Bapatla.

Corresponding author: bonu.mounika45@gmail.com

In Krishna agroclimatic zone of Andhra Pradesh, jowar crop is emerging as a potential alternate feed, fodder and bio-energy crop due to its tolerance to high temperature and drought makes it suitable for dry climatic condition. Previously, rice is succeeded by blackgram which is slowly replaced by either jowar or maize due to severe YMV infestation to blackgram. Hence, farmers of this region are showing interest in view of its low water requirement and withstands to harsh climatic conditions. A field experiment was conducted during *rabi* for two consecutive years (2015-2016 and 2016-2017) on sandy clay loam soil of Agricultural College Farm, Bapatla. The treatments consisted of different combinations of nitrogen during *kharif* preceding rice crop (T1:100% RDN, T2:75% RDN + 25% Farmyard manure, T3:50% RDN + 50% Farmyard manure, T4:25% RDN + 75% Farmyard manure, T5:75% RDN + 25% Poultry manure, T6:50% RDN + 50% Poultry manure, T7:25% RDN + 75% Poultry manure, T8:75% RDN + 25% Vermicompost, T9:50% RDN + 50% Vermicompost, T10:25% RDN + 75% Vermicompost, T11:75% RDN + 25% Green manure, T12:50% RDN + 50% Green manure and T13:25% RDN + 75% Green manure) and three nitrogen levels applied during *rabi* no till jowar crop (0% N, 50% N and 100% N) The experiment was laid out in a split plot design with thirteen main plots (preceding *kharif* rice) split in to three sub plots (*rabi* no till jowar) total 39 treatments and replicated thrice. Data collected on growth parameters (plant height, dry matter accumulation), yield attributes, grain yield, stover yield and harvest index of no till jowar were subjected to statistical analysis and results indicated that all the characters studied were significantly higher with application of 100% RDN through inorganic fertilizer (T1) during *kharif* in combination with 100% N level applied during *rabi* however...
it was on a par with that of application of 50% RDN+ 50 % Green manure (T12) and 50% RDN + 50%
Poultry manure (T6) with 100 % N level during rabi in both the years of study.

02-32

FOLIAR FERTILIZATION FOR IMPROVING WATER PRODUCTIVITY IN PULSES

Mallikarjuna Reddy, K., Prathibha Sree, S., Prashant Mourya, G and Manoj Naidu, S.
Department of Agronomy (Water Management), APGC, Lam, Guntur.
Corresponding author: kmkreddy17@gmail.com

India is the world’s largest producer and consumer of pulses with a production of 22.6 million tonnes. The World Health Organization recommended a per capita consumption of 80 g pulses per day but at present the per capita availability of pulses is only 40 g per day in India. The productivity of pulses in our country is not sufficient to meet the domestic demand of the population. Hence there is a need for enhancement of the productivity of pulses by proper agronomic practices.

The yield potential of pulses is very low because of the fact that the crop is mainly grown in rainfed conditions with poor management practices and also due to various physiological, biochemical as well as inherent factors associated with these crops. Under rainfed conditions, when the availability of moisture becomes scarce, the application of fertilizers as foliar spray may result in sufficient absorption and usage. To exploit the full genetic potentiality of pulses, use of improved crop management technology can invariably increase the productivity by 50-100 %. Apart from the genetic makeup, the physiological factor viz., insufficient partitioning of assimilates , poor pod setting due to the flower abscission and lack of nutrients during critical stages of crop growth, coupled with a number of diseases and pests were the reasons for the poor yield in pulses.

Foliar application of nutrients is the fastest way to boost of crop growth. The fertilizer elements which are absorbed through roots can also be absorbed with equal efficiency through foliage. Foliar applied calcium, boron, copper and zinc alone or in combination helps to enhance acclimation or repair of stress injured tissues. The maximum impact of foliar spray can be seen under adverse soil conditions and low nutrient availability in soil through adverse interactions such as calcium and phosphorous. Foliar application has been found favourable in short duration crops because the soil applied fertilizers may not become fully available before maturity of the crop. Foliar application is credited with the advantage of quick and efficient utilization of nutrients; eliminate the losses through leaching, fixation and regulating the uptake of nutrients by plants. The causes for increase in yield with foliar nutrition were the increased dry matter production and efficient translocation of assimilates to the developing sink which in turn leading to increase in number of pods , number of seeds per pod and test weight.

Water productivity in pulses can be enhanced by proper supplementation of nitrogen, phosphorous, potassium and micro nutrients through foliar application under rainfed situations along with limited irrigations at critical periods.

02-33

AIR POLLUTION WITH SPECIAL EMPHASIS ON STONE CRUSHING UNITS

Tejadeep, P., Amani, J and Srikanth, M.
Department of Environmental sciences, APGC, Lam, Guntur.
Corresponding author: tejdeep.333@gmail.com

Stone crushing Industry is an important industrial sector in the country engaged in producing crushed stone of various sizes depending upon the requirement which acts as raw material for various construction activities such as construction of roads, highways, bridges, buildings, canals etc. Stone crusher dust deposition
on soil and plants affects the yields of crops. Its alkaline constituents such as oxides of calcium, potassium and sodium are responsible for the alkalinization of soil.

Stone crushing dust have been known to contribute pollution on streams and rivers from the degraded runoff discharges from atmospheric deposition of contaminated particulate matter. The stone crushing dust is the source of particulate matter deposit on the plant leaves resulting decline in transpiration and photosynthetic activity. Air pollution causes damage to plants by inhibiting many enzyme systems and metabolic processes of plants.

In recent years, the stone crusher industry in India has been taking several measures in adopting environmental friendly measures for dust control such as sprinkling of water by fixed sprinkling post on permanent roads, development of green belt including low height shrubs to arrest dust on the haul roads, dust extraction and filtration systems during drilling, dry fog system and atomized water spray in crushing plant and dust encapsulation system conveyors.

However, there exists a great scope for improvement of dust containment and suppression measures in stone crusre units in India. For units operating in stone crusher zones, due to lack of adequate dust control measures and lack of awareness, a combined effort of stone crusher industry and pollution control board is required to implement dust control measures.

**02-34**

**UTILIZATION OF MICROORGANISMS FOR BETTER CROP PRODUCTION**

*Ashok Mourya, M., Lakshmipathy, R., Vijaya Gopal, A and Nagendra, D.*

Department of Agricultural Microbiology, APGC, Lam, Guntur.

Corresponding author: ashokmourya.1995@gmail.com

Soil micro-organisms play a pivotal role as the main driving forces to enhance plant growth by improving soil health. There are many diverse groups of nitrogen fixing microorganisms involved in converting atmospheric N₂ to ammonia and make it available for plants. The nitrogen fixing microorganisms includes free-living bacteria (*Azotobacter*) fix typically < 5 kg N ha⁻¹ yr⁻¹ while bacteria intimately associated with plant roots (*Azospirillum*) fix up to 50 kg N ha⁻¹ yr⁻¹ whereas root nodule-forming symbioses of *Rhizobium* can fix considerable amounts. The Rhizobium association with legumes is of significance to practical farming. It provides the main source of N in farming especially in legume-based systems. Soil algae are also involved in atmospheric nitrogen fixation especially in aquatic and marshy environment. Further, algae by having symbiotic association with water fern (Azolla) fix the atmospheric nitrogen. There are certain actinomycetes (Frankia) also involved in nitrogen fixation by having symbiotic association with some of the tree species.

The soil microbial biomass SMB is a living component of the soil (1-3% of soil organic C, 2-6% soil organic N), comprising mainly of fungi and bacteria including micro-fauna and algae. The microbial decomposer community is extremely diverse and bacteria and fungi are the major decomposers. Actinomycetes are responsible for residue breakdown mainly at high temperatures whereas bacteria and fungi function at lower temperatures. The decomposition processes involve the mineralization and immobilization (or humification) of residue C compounds with the ultimate release of CO₂ to the atmosphere and N as ammonium (NH₄⁺) and nitrate (NO₃⁻) and other associated nutrients. Microorganisms are also involved in phosphorous solubilization (*Aspergillusawamori, Bacillus subtilis, B.megaterium, Pseudomonas putida* etc.), zinc solubilization (*Bacillus sp.*) and potash solubilization / releasing from organic sources and inorganic insoluble sources.
present in soil. Another group of microorganism called phosphorous and other immobile nutrient mobilize i.e. mycorrhizal fungi especially AM fungi present in soil is also involved in better crop growth.

02-35

ARBUSCULAR MYCORRHIZAL FUNGI DISTRIBUTION PATTERN IN DIFFERENT RICE FARMING SYSTEMS IN SELECTED AGRO CLIMATIC ZONES OF ANDHRA PRADESH

Saikumar, P., Lakshmipathy, R and Vijaya Gopal, A.
Department of Agricultural Microbiology, APGC, Lam, Guntur.
Corresponding author: saikumar.p1845@gmail.com

Mycorrhizae are symbiotic associations between a fungus and a root of a living plant essential for one or both the partners. The term “Mycorrhizae” was coined by A. B. Frank. These fungi promote phosphorous uptake and help plants in coping with different forms of stress. The present study was undertaken to study the occurrence of arbuscular mycorrhizal fungi (AMF) in rice crop distributed in selected agro climatic zones of Andhra Pradesh viz., North Coastal Zone, Godavari Zone, Krishna Zone and Southern Zone and in turn in different farming systems viz., organic farming, natural farming and intensive farming. A total of 24 soil samples along with root bits were collected in each rice farming system of selected agro climatic zones of Andhra Pradesh and used for the enumeration of arbuscular mycorrhizal fungi (AMF) spore density, per cent root colonization and spore types.

The AMF spores density was highest in case of soil samples collected from paddy fields of Godavari zone (2337 spores/100 g soil) and least in case of NC Zone (1344 spores/100 g soil) of Andhra Pradesh. The AMF spores density among different farming systems selected, was more in soils collected from natural farming (2496 spores/100g soil) and least in case of intensive farming (1954 spores/100 g soil). The AMF per cent root colonization was more in case of root samples collected from paddy fields of krishna zone (77.11) and least in case of southern zone (65.44). The AMF per cent root colonization among different rice farming systems selected, was more in root samples collected from intensive farming (71.00) and least in case of organic farming (68.87). The AMF spore types were more in NC zone (8) and least in Southern zone (6). Among the different farming systems, AMF spore types were more in organic farming (8) and least in intensive farming (6). This study clearly showed a variation in AM fungal activity in different agroclimatic zones and in turn in different farming systems.

02-36

FERTILIZER USE PATTERN BY THE FARMERS IN GUNTUR DISTRICT OF A. P.

Shaik Mohammad Irfan and Rupa, K.V.N.S.L.
Institute of Agribusiness Management, Tirupati.
Corresponding author: irfan48.ag@gmail.com

Urea, DAP and Complex fertilizers were used by more than 95 per cent of the farmers, while SSP and MOP were used by 75 per cent and 88 per cent respectively. About 97 per cent of farmers were found to use organic manures and the average quantity was 20.175 tonnes/ha. 89 per cent of the selected farmers preferred grey coloured DAP and the reason for using coloured DAP was the quality assurance of the product. About 59 per cent of the farmers were aware of availability of Zincated DAP and 72 per cent of the farmers used SSP in granular form. Regarding the farmers’ choice in using a particular fertilizer was mostly self-driven. Other factors in the order were influence of peer group cum self-assessment and dealers’ advise cum self-
assessment. Among the non-price factors influencing the preference of a fertilizer grade was the quality, as expressed by 55 per cent of the farmers. Regarding micronutrients, 89 per cent of farmers were using zinc, while 81 per cent of farmers used boron. 88 per cent were found to use speciality fertilizers in the form of water solubles. 94 per cent of the sample farmers were found to receive a farm income of less than Rs. 3 lakh/annum. Another observation was that only 68 per cent of the farmers reported that the farm income was adequate to meet the family expenditure. The farmers enjoyed the privilege of seeking the technical information from the government sources like department of agriculture, were 88%. On the activities front, the most useful activity that the farmers desired was regular farmers’ meetings, closely followed by field demonstrations and field visits. About 57% farmers were found to travel more than 5 km for their farm input requirement. Cent per cent of farmers prefers to purchase agriculture inputs from co-operative outlets if such facility was available. All the farmers unanimously were in favour of the existing/new products even by paying more, if their efficacy was tested.

02-37

PHYTOREMEDIATION OF HEAVY METALS IN CONTAMINATED SOILS

Dakshayani, T., Vasundhara, K., Amani, J and Neeraja, K.
Department of Environmental Sciences, APGC, Lam, Guntur.
Corresponding author: dakshayanithangi1995@gmail.com

Phytoremediation is a green emerging technology used to remove pollutants from environment components. It can be defined as the process, which uses green plants for the relief, transfer, stabilization or degradation of pollutants from soil, sediments, surface waters, and groundwater. Mechanisms used to remediate soils contaminated by heavy metal are: phytoextraction, phytostabilisation, phytovolatilization and rhizofiltration. The two first mechanisms are the most reliable. It depends on soil properties, heavy metal levels and characteristics, plant species and climatic conditions. Some plants can be used to clean up heavy metal contaminated sites like willow (Salix viminalis L.), maize (Zea mays L.), Indian mustard (Brassica juncea L.), and sunflower (Helianthus annuus L.) has been found to be highly tolerant to heavy metals. Vetiver grass (Vetiveriazizanioides) showed tolerance to Pb and Zn and it can be used for revegetating Pb/Zn mine tailings. Such plants have characteristics of rapid growth, large amount of biomass, strong resistance, effective stabilization to soils and ability to remediate different types of soils. Phytoremediation, like other remediation technologies, has a range of both advantages and disadvantages. The most positive aspect of using phytoremediation is cost-effective, more environmentally friendly, and applicable to a wide range of toxic metals and more aesthetically pleasing method. On the other hand, phytoremediation presents some limitations. It is a lengthy process, thus it may take several years or longer to clean up a site and it is only applicable to surface soils. Thus research should focus on developing agricultural techniques to enhance phytoremediation efficiency and reduce time and cost of heavy metal removal from soils.

02-38

ORGANIC FARMING IN INDIA

Giriraj Char, Priyanka Pusham and Shruti Singh
Department of Horticulture, College of Agriculture, Rewa, M.P
Corresponding author: girirajcharksg@gmail.com

Organic farming has been practiced in India for thousands of years. The great Indian civilization thrived on organic farming. In traditional India, the entire industry of agriculture was practiced using organic techniques, where the fertilizers and pesticides were obtained from plant and animal products. Organic farming was the backbone of the Indian economy and cows were worshiped (as is still done) as sacred animals from God.
The cow not only provided milk but also provided bullocks (for farming) and dung (which was used as a fertilizer). During the 1950s and 1960s, the ever-increasing population of India, along with several natural calamities, led to a severe food scarcity in the country. As a result, the government was forced to import food grains from foreign countries. The Green Revolution (under the leadership of M. S. Swaminathan) became the government’s most important program in the 1960s. Several hectares of land were brought under cultivation. Hybrid seeds were introduced. Natural and organic fertilizers were replaced by chemical fertilizers and locally made pesticides were replaced by chemical pesticides. Large chemical factories such as the Rashtriya Chemical Fertilizers were established before the Green Revolution, it was feared that millions of poor Indians would die of hunger in the mid 1970s. However, within a few years, the Green Revolution had shown its impact. The country, which greatly relied on imports for its food supply, reduced its imports every passing year. In the 1990s, India had surplus food grains and had once again become an exporter of food grains to the rest of the world. As time went by, extensive dependence on chemical farming has shown its darker side. The land is losing its fertility and is demanding larger quantities of fertilizers to be used every season. Pests are becoming immune to pesticides, requiring the farmers to use stronger and costlier pesticides that can do more damage to the environment. Due to the increased cost of farming, farmers are falling into the trap of money lenders, who are exploiting them to no end, even forcing some to commit suicide. Both consumers and farmers are now gradually shifting back to organic farming in India. It is believed by many that organic farming is the much healthier and sustainable option. Although the health benefits of organic food are yet to be proven fully, consumers are willing to pay a higher premium for organic crops.

02-39

CONSERVATION AGRICULTURE: A NEW PARADIGM FOR IMPROVING RESOURCE USE EFFICIENCY

Vinaya Lakshmi, P and Aruna Kumari, H.
Agricultural College, Bapatla.
Corresponding author: vinaya.podapati126@gmail.com

Food security is a multidimensional theme, which directly hits the poor and needy and, in turn, the quality of life. Modern agriculture is facing a serious problem of the decline in crop yield and deterioration in soil quality despite the use of improved varieties, adequate fertiliser nutrition and plant protection chemicals. Hence, synchronising the food demand of the ever-growing population can only be achieved through an alternative production system which can maintain high yields in consonance with maintenance of ecological equilibrium. The agriculture sector is the starting point for finding sustainable solution to overcome the food crisis. It is imperative to manage critical inputs and resources for a higher food production. Therefore, a paradigm shift in farming practices through eliminating unsustainable parts of conventional agriculture (ploughing/tilling the soil, removing all organic material, monoculture) is crucial for future productivity gains while sustaining the natural resources.

Conservation agriculture (CA), a concept refers to a set of agricultural practices encompassing minimum mechanical soil disturbance, diversified crop rotation and permanent soil cover with crop residues to mitigate soil erosion and improve soil fertility besides soil functions. CA offers an opportunity for arresting and reversing the downward spiral of resource degradation, diminishing factor productivity, decreasing cultivation costs and making agriculture more resource – use-efficient, competitive and sustainable. The three principles of conservation agriculture are minimum soil disturbance, continuous soil cover and crop diversification can be met through the adoption of various need based practices like zero tillage, minimum tillage, strip tillage, bed planting, laser land levelling, crop residue management, legume incorporation etc. also, energy efficient and cost effective system based resource conservation technologies (RCTs) are vital for improving system
productivity, profitability, soil health and environmental quality, and ultimately sustaining intensive cropping systems. Therefore there is a need for conservation agriculture that makes farmers specific and economically viable.

02-40

POTASSIUM SOLUBILISING MICROORGANISMS FOR SUSTAINABLE SOIL MANAGEMENT

Goutami, N., Vidhyasree, Ch., Venkata Lakshmi, M and Deekshitha, D.K.D.
Corresponding author: goutami2007@gmail.com

Potassium (K) is the third major essential nutrient for crop production after nitrogen (N) and phosphorus (P) and seventh among all the elements on the earth crust. As a result of increased crop production due to rapid development and the use of modern intensive agriculture in the world and in India in particular, soil nutrients level have dropped due to mining through crop removal without replenishing soil through fertilisation. The case for K is more pronounced in India as most of the farmers have mainly focused on the application of N mainly as urea and P as DAP. The current estimated average net depletion per ha from India’s 143 m ha of net sown area comes to 16 kg N, 11 kg P2O5 and 42 kg K2O. The cost of K fertilizers is very high, particularly in India because there is no reserve of K-bearing minerals suitable for manufacturing of conventional K-fertilizers and the whole consumption of K-fertilizers is imported. The bulk of total soil K is in the mineral fraction. Major portion of soil K (92-98%) exists as a part of mineral of mineral structure and in a fixed or non-exchangeable form. Sum of solution and exchangeable forms of K are considered as readily available forms which constitute about 1-2% of the total K in soil. There are many microorganisms in soil which are able to solubilise unavailable form of K-bearing minerals to bring the K into available form. These microorganisms are commonly known as Potassium solubilising bacteria (KSB), Potassium dissolving bacteria (KDB) or silicate dissolving bacteria (SDB). It is possible to use the locally available feldspar minerals in combination with silicate dissolving bacteria as a bio-fertilizer to replace chemical fertilizer and reducing the cost of crop production. Bacterial intervention of mica improves the water-soluble, exchangeable and non-exchangeable K pools in soils, thereby influences the K dynamics in soils into those pools which are relatively more available to plant. Co-inoculation of potassium solubilising and N fixing strains to waste mica could be a promising and alternative option for supplying potassium and nitrogen to crops and maintaining greater nutrient availability in soil.

02-41

ORGANIC MANURING IN GRAPE VINE CULTIVATION IN MAHARASHTRA - AN ECONOMIC ANALYSIS

Walke Shivaji, S., Munikanth, K and Sushmitha Reddy, Ch.
IABM, S.V Agricultural College, Tirupati
Corresponding author: wshivaji8055@gmail.com

A study on Grape growers revealed that 55 per cent amount was spent on chemical fertilizers, 41 per cent on organic manure and 4 per cent on bio-fertilizers. The study showed that the 38 per cent of the respondents felt that organic manure (FYM) was costly and 44 per cent of them replied that FYM was not of good quality which put farmers in to problem like infestation of weeds, fungal diseases attack etc. About 16 per cent the respondents said that organic manure (FYM) was difficult to apply as it required more time and many labours and the remaining 2 per cent of the respondents complained other problems like unavailability of organic manures. Grape farmers of about 66 per cent were aware of Bhagyalaxmi Bioscience products and
28 per cent were not aware about Bhagyalaxmi Bioscience products. Eighty per cent of grape farmers did not use Bhagyalaxmi Bioscience products. Only 20 per cent grape farmers used Bhagyalaxmi Bioscience products, out of which Microrich’s (Liquid Plant Growth Enhancer) share was 14 per cent followed by Agrifeed (Farm Yard Manure) with 4 per cent and Goldmine (Phosphate Rich Organic Manure) with 2 per cent.

02-42

SOIL ACIDIFIERS AND CHELATES – A WAY TO AMELIORATE LIME INDUCED MICRONUTRIENT DEFICIENCY IN CROP PRODUCTION

SaiBhargavi, N.V.L., Prasad, P.R.K and Rajyalakshmi, B.
Corresponding author: nerellabhargavi13@gmail.com

Soil, the natural resource plays a major role in determining the productivity of sustainable agriculture which involves the successful management of resources with particular reference to soils that have calcareousness as one of the limitation which often poses problem in the micronutrient nutrition of crops. Calcareous soils cover an area of 69.4% of the total geographical area of the country. The availability of Fe, Zn, Cu, Mn and B to plants is reported to be restricted due to presence of lime in soils. Deficiency is due to precipitation of micronutrients with calcium carbonate as their respective insoluble carbonates. Using of chelating agents (EDDHA, DTPA, citrates etc.) and soil acidifiers is a new way to overcome lime induced micronutrient deficiency by decreasing the pH of soil and increasing the micronutrient availability to plants. Chelating agents forms a complex with micronutrients and prevent the formation of insoluble carbonate. Chelates can be applied either through soil application or foliar spray.

Soil acidifiers are organic matter (plant residues, sphagnum peat etc.), ammonium fertilizers (ammonium sulphate), sulphur compounds like elemental sulphur, iron sulphate, aluminiumsulphate etc., and thiosulphates (ammonium thiosulphate and potassium thiosulphate). On application of soil acidifiers, microbial oxidation takes place which leads to the release of organic acids, H⁺ ions and sulphuric acid which in turn decreases the soil pH. Organic matter, ammonium fertilizers, elemental sulphur, iron sulphate and aluminiumsulphate can be directly applied to the soil whereas dilute sulphuric acid, thiosulphates like ammonium thiosulphate and potassium thiosulphate which are liquid fertilizers can be applied through fertigation process.

Appropriate method of fertilizer application not only improves the crop yield but also improves the fertilizer use efficiency. Decisions regarding the rate and frequency of subsequent applications of acidifier can be based on desired changes in soil pH and visible plant response. Sulfur products that act as soil acidifiers can potentially improve nutrient availability in calcareous soils by decreasing soil pH.

02-43

PGPR CHARACTERISTICS OF Pseudomonas fluorescens ISOLATED FROM RHIZOSPHERIC SOILS OF TELANGANA

Suman, B., Vijaya Gopal, A and Triveni, S.
Department of Agricultural Microbiology and Bioenergy, College of Agriculture, Hyderabad.
Corresponding author: suman.biyyani123@gmail.com

The Plant Growth Promoting Rhizobacteria (PGPR) are naturally occurring soil bacteria that aggressively colonize plant roots and enhance plant growth by a wide variety of mechanisms. The use of PGPRs is steadily increasing in agriculture and offers an attractive way to replace chemical fertilizers, pesticides, and supplements. Inoculation of crop plants with certain strains of PGPR at an early stage of development
improves biomass production through direct effects on roots and shoots growth. *Pseudomonas fluorescens* one among them which not only enhances the plant growth but also controls the fungal pathogens by production of antifungal metabolites. In the present study thirty *P. fluorescens* isolates were isolated, from the rhizospheric soils of rice fields from the Rangareddy district of Telangana state and the isolates were screened and characterized for the PGPR characters like phosphate solubilization, siderophore production, ammonia production, HCN and Indole Acetic Acid (IAA) production. Results revealed that 76.67% i.e., 23 isolates solubilized phosphorous and produced siderophores. About 93.33% i.e., 28 isolates produced Indole Acetic Acid and all the thirty isolates i.e., 100% produced ammonia and HCN. Results revealed that rice rhizospheric soils are the rich source of *Pseudomonas fluorescens*, which have a potential to be used as a biocontrol agent.

02-44

ANTAGONISTIC ACTIVITY OF *PSEUDOMONAS FLUORESCENS* AGAINST SHEATH BLIGHT OF RICE

Vijaya Gopal, B. A and Triveni, S.

Department of Agricultural Microbiology and Bioenergy, College of Agriculture, Hyderabad

Corresponding author: suman.bivyani123@gmail.com

Sheath blight is a devastating disease caused by *Rhizoctonia solani* Kuhn., in rice crop. Biocontrol agents have great demand now-a-days as they are replacing chemical pesticides to a large extent as they are cost effective, eco-friendly and easily available. *Pseudomonas fluorescens* one among them which not only enhances the plant growth but also controls the fungal pathogens by production of antifungal metabolites. In the present investigation thirty fluorescent *Pseudomonas* isolates have been isolated from rice rhizosphere of Rangareddy district of Telangana and have been morphologically, culturally and biochemically characterized and identified as fluorescent *Pseudomonas*. All the isolates were further screened for assessment of antagonism viz., siderophore production, HCN production and dual culture method. Except eight, all the isolates produced siderophores and strong production was found with the nine isolates. HCN production was observed in all the thirty isolates and strong production was seen in four isolates. In the dual culture method all *Pseudomonas fluorescens* isolates inhibited *Rhizoctonia solani* and maximum inhibition was found with the isolates DMP1 (53.43%), DBP (51.53%) and followed by PVP2 (48.26%). The isolates inhibited the *R. solani* in dual culture method due to the production of secondary metabolites.

02-45

USE OF INDUSTRIAL WASTE WATER FOR AGRICULTURAL PURPOSE

Heenakausar, P and Sandhya Rani, P.

Department of Crop Physiology, S.V. Agricultural College, Tirupati.

Corresponding author: reachheena49@gmail.com

Industrial wastes and effluents are being discharged at random without treatments directly to soil, canals, and rivers. The most toxic heavy metals are lead, mercury and chromium. It was estimated that the estimated that global impact of lead is 18-22 million people and of mercury 15 to 19 million people at 2010 according to Blacksmith Institute’s World worst pollution problems. Contamination of the water resources with these elements, leads to polluting of the entire food chain and represents a real threat to the ecosystem. Thus, pure water shortage becomes a crucial problem worldwide. Among the most important research that can contribute to solving the problem of those related to water purification and improving the quality and recycling even in agriculture. In areas where irrigation water is scarce, the recycling of industrial wastewater is
an important source for supplementing water resources. Furthermore, recycling may help alleviate industrial disposal problems by reducing the volume of industrial wastewater involved. The ultimate effect of wastewater in Agriculture improves the soil physical and biological properties. It will also have positive effect on most the crops because of higher amounts of organic carbon and nutrient content.

**02-46**

**ISOLATION AND CHARACTERIZATION OF PGPR ISOLATED FROM SALINE SOILS OF TELANGANA**

*Suman, B and Triveni, S.*

Department of Agricultural Microbiology and Bio energy, College of Agriculture, Hyderabad

Corresponding author: suman.bivyani123@gmail.com

Salinity is one of the most brutal environmental factors limiting the productivity of crop plants because most of the crop plants are sensitive to salinity caused by high concentrations of salts in the soil, and the area of land affected by it is increasing day by day. Microorganisms could play a significant role in this respect, if we exploit their unique properties such as tolerance to saline conditions, genetic diversity, and synthesis of compatible solutes, production of plant growth promoting hormones, bio-control potential, and their interaction with crop plants. Plant-growth-promoting rhizobacteria (PGPR), beneficial bacteria that live in the plant root zone named the rhizosphere, is one of the solutions to solve this issue. Indeed rhizobacteria counteract saline stress and help plant growth. In the present study 80 PGPR have been isolated from the saline soils of Telangana. They have been isolated from the respective medium enriched with salt and they were further characterized culturally, morphologically and biochemically and 40 among the isolates were identified as *Bacillus* spp., 20 of them were identified as *Pseudomonas* spp., 12 were identified as *Azotobacter* spp. and 8 were identified as *Rhizobium* spp. and all the isolates were confirmed according to Bergey’s manual of systemic bacteriology.

**02-47**

**CLIMATE- SMART AGRICULTURE THROUGH SOIL MANAGEMENT PRACTICES**

*Deepika, J and Sudha Rani, Y.*

Department of Soil Science and Agricultural Chemistry, Agricultural College, Bapatla.

Corresponding author: jangamdeepika24@gmail.com

Climate change, which is widely accepted as the single most pressing issue facing society on a global basis, affects agricultural performance by altering the range and magnitude of climatic parameters which in turn affect the food security. Climate change multiplies the challenges of achieving the needed growth and improvements in agricultural systems and its effects are already being felt. Climate-Smart Agriculture (CSA) is an approach to dealing with these interlinked challenges in a holistic and effective manner.

The objectives of CSA includes sustainably increasing agricultural productivity, adapting and building resilience agricultural systems to climate change and reducing and/or removing greenhouse gas emissions. Making agriculture more climate smart is possible through crop management practices like minimum tillage, agroforestry, terracing, mulching, growing drought-tolerant crops, water harvesting techniques and soil management practices like improved methods of fertilizer application, use of crop residues, organic manures, control soil loss due to erosion and soil carbon sequestration.

Improved methods of fertilizer application viz. need based fertilizer application based on leaf colour chart and chlorophyll index are effective in increasing the nutrient use efficiency and increasing yields of crops. Application of nitrification inhibitors like neem coated urea and dicyandiamide were effective in mitigating the
nitrous oxide emissions by inhibiting the nitrification process and thereby reducing the availability of nitrate-N for denitrification process.

The application of organic manures and crop residues are effective in reducing the greenhouse gas emissions and improving carbon sequestration than chemical fertilizer. To reduce greenhouse gas emissions from rice farming, it is recommended that organic manures be used instead of chemical fertilizer. Biochar can also be used for reducing the emissions of methane and nitrous oxide from fields. Lower \( \text{CH}_4 \) emissions with biochar alone amended soils was due to that biochar addition combined with subsequent frequent drainage and irrigation of the paddy soils may have improved the soil aeration status, due to the higher C/N ratio of biochar which might have slowed down the nitrogen decomposition and may enhance NH\(_4\)-N in the soil and plant uptake.

**USE OF CROP RESIDUE BIOCHAR FOR ENHANCING SOIL HEALTH AND MITIGATION OF CLIMATE CHANGE**

Gowthami, B., Gurumurthy, P and Sujani Rao, Ch.
Dept. of Soil Science & Agricultural Chemistry, Agricultural College, Bapatla.
Corresponding author: gowthamibendalam95@gmail.com

In India, the availability of crop residues is approximately 500 million tons/year. Studies sponsored by the Ministry of New and Renewable Energy (MNRE), Govt. of India have estimated surplus biomass availability at about 120–150 million tons/ annum. Of this, about 93 million tons of crop residues are burned in each year. Among different crops, cereals generate maximum residues, followed by fibres, oilseeds, pulses and sugarcane. The cereal crops (rice, wheat, maize, millets) contribute 70% while rice crop alone contributes 34% to the crop residues. Crop residues in fields can cause considerable crop management problems as they accumulate.

Residue burning traditionally provides a fast way to clear the agricultural field of residual biomass but it leads to a loss of other nutrients (e.g. N and S), organic matter and microbial activity required for maintaining better soil health. Hence, conversion of organic waste to produce Biochar using the pyrolysis process is one viable option that can enhance natural rates of carbon sequestration in the soil, reduce farm waste and improve the soil quality. The use of biochar in agriculture is not new; in ancient times farmers used it to enhance the production of agricultural crops. One such example is the slash and burn cultivation, which is still being practiced in some parts of North East India.

Biochar is a fine-grained, carbon-rich, porous product remaining after plant biomass has been subjected to thermo-chemical conversion process (pyrolysis) at low temperatures (350–600°C) in an environment with little or no oxygen. Biochar is not a pure carbon, but rather mix of carbon (C), hydrogen (H), oxygen (O), nitrogen (N), sulphur (S) and ash in different proportions. It can be prepared by several methods like Heap method, Drum method, Pit method.

Soil health, quality and fertility can be enhanced by the application of Biochar. Several researches reported that Biochar can act as a soil conditioner by improving the physical and biological properties of soils such as water holding capacity and soil nutrients retention, enhancing plant growth, increase soil pH, Increase cation exchange capacity, decrease aluminum toxicity, decrease soil tensile strength, improve soil conditions for earthworm populations, enhance microbial biomass and improve fertilizer use efficiency.

Biochar produced from different feed stocks had pH ranged from 8.2-13.0. So it can be used as a soil amendment for reclamation of acid soils. The central quality of biochar that makes it attractive as a soil amendment is its highly porous structure, potentially responsible for improved water retention and increased soil surface area.
Total carbon content in biochar materials produced from different feedstock varied from 33.0 to 82.4%. Soil C sequestration is the removal of atmospheric CO2 through photosynthesis to form organic matter, which is ultimately stored in the soil as long-lived, stable forms of C. In order to sequester carbon, a material must have long residence time and should be resistant to chemical processes such as oxidation to CO2 or reduction to methane; since the biomass is protected from further oxidation because of pyrolysis that would otherwise have degraded to release CO2 into the atmosphere. Such partially burnt products, more commonly called pyrogenic carbon or black carbon, may act as an important long-term carbon sink i.e., Carbon sequestration because their microbial decomposition and chemical transformation are probably slow.

By sequestering carbon in the soil, CO2 (major greenhouse gas) release into atmosphere can be reduced. Reduction of N2O and CH4 emission as a result of biochar application is seen to attract considerable attention due to the much higher global warming potentials of these gases compared to CO2. So, with the application of biochar mitigation of climate change can be possible by reducing the emissions of harmful greenhouse gases.

Key Words: Crop residues, biochar, soil health, amendment, carbon sequestration, climate change

02-49

SUPPRESSIVE COMPOSTS IN PROMOTING PLANT GROWTH AND SUPPRESSING DISEASES

Divyamani, V and Prasanna Kumari, V.
Department of Plant Pathology, Agricultural College, Bapatla.
Corresponding author: v.divyamani31@gmail.com

Soils supports plant roots and provides water and nutrients to plants also acts as a hostile environment that harbors plant pathogens. The lack of reliable chemical controls, the occurrence of fungicide resistance in pathogens, and the breakdown of host resistance by pathogen populations are some of the reasons to develop new disease control measures. In the case of soil borne plant pathogens, cultivation and biological practices include cover crops incorporated as green manures, organic amendments, crop rotation, minimal tillage practices, soil solarisation, and the application of single bio control agents, such as Trichoderma or in combination.

Composts are the product of oxidative aerobic microbial decomposition of organic matter under controlled conditions. Suppressive soils are the soils in which the pathogen does not establish or persist, establishes but causes little or no damage, or establishes and causes disease for a while but thereafter the disease is less important, although the pathogen may persist in the soil.

A compost pile has a life cycle; it goes through several rather distinct decomposition phases: Initial microbial adaptation phase, Thermophilic phase, Stabilization phase, Cooling/Maturation Phase, Maturity Phase, Over Maturity phase. During composting at maturation stage, readily available organic substrates are already oxidized by microbial community; remaining slowly biodegradable materials favour the rise of a competitive and antagonistic microbial community. Suppression is related to the stage of the composting process. Suppressive compost provides an environment in which plant disease development is reduced, even when the pathogen is introduced in the presence of a susceptible host. Plant disease suppression by compost is a widespread and ubiquitous phenomenon that occurs when diverse types of compost are applied for the control of a variety of pathogens. Plant disease suppression is the direct result of the activity of antagonistic microorganisms that naturally recolonize the compost during the cooling phase of the process. Understanding compost microbiology is a necessary first step to better understand the link between pathogen suppression and microbial population dynamics.

Keywords: Suppressive compost, antagonism, diseases control
INTEGRATED PHOSPHORUS MANAGEMENT IN BLACKGRAM

Charishmaa, N and Kavya, T.
Department of Soil Science and Agricultural Chemistry, Agricultural College, Bapatla.
Corresponding author: charishma3010@gmail.com

Blackgram (*Phaseolus mungo*) is the third important pulse crop grown throughout India. It occupies about 3.25 million ha area in the country producing 1.5 million tones of seed with the average productivity of 462 kg/ha. Blackgram seed is rich in protein and phosphoric acid content. Blackgram is generally grown in soils with low fertility status or with application of low quantity of organic and inorganic sources. But imbalance use of chemical fertilizers not only lower productivity but also adversely affects soil health by decreasing soil organic carbon, microbial flora and hardening of soil. The integrated nutrient management ensures higher productivity, minimizes expenditure on costly fertilizer inputs, improves physical properties of soil, efficiency of added nutrients and at the same time ensures good soil health and is also an environmental friendly.

Among the major elements, phosphorus is the key element involved in various functions in growth and metabolism of pulses. It favors healthy root growth by helping translocation of carbohydrates and promotes seed setting and seed yield. Phosphorus nutrition is also necessary for the reduction of nitrates and protein formation. But the efficiency of phosphatic fertilizers is very low due to chemical fixation within the short period of application resulting in buildup of insoluble phosphorus in the soil. Some heterotrophic microorganisms possess ability to solubilise phosphorus into available form and also have the capacity to mineralize organic phosphates present in the soil or added through organic manures. Seed inoculation with such phosphorus solubilising bacteria may be beneficial to the crop in utilizing the phosphorus and hence increasing crop production.

The effectiveness of bio-fertilizers also depends on physico-chemical condition of soil which can be improved with the use of organic sources. The activity of PSB can be improved by the addition of farmyard manure to the soil, since it acts as a source of carbon and also contribute some amount of nutrients to the soil through mineralization process.

Keywords: Blackgram, phosphorus, PSB, organic matter

MICRONUTRIENT SEED PRIMING- AN EFFECTIVE WAY TO REDUCE THE COST OF FERTILIZERS

Vijaya Durga, P.
Department of Soil Science and Agricultural Chemistry, Agricultural College, Bapatla.
Corresponding author: vijayadurgapasupuleti11@gmail.com

Crops grown in most soils of India suffer from deficiencies of one or more micronutrients. Their impact on crop production and changes in micronutrient concentration in seeds and fodders thereby influences on animal and human health. The nutrient priming has been reported to be a useful strategy in overcoming these micro nutrient deficiencies. Germination and seedling emergence are the critical stages in the plant life cycle. Insufficient seedling emergence and inappropriate stand establishment are the main constraints in the production of crops which receiving less rainfall. Nutrient seed priming is a technique in which seeds are soaked in a mineral nutrient solution with subsequent re-drying to the initial moisture content. Nutrient seed priming has been shown to enhance the speed of germination and stress tolerance. The general purpose of seed priming is to partially hydrate the seed to a point where germination process begin, but they would exhibit rapid germination when re-imbibed under normal or stress conditions. It is one of the physiological
methods, which improves seed performance and provide faster and synchronized germination. Treating seeds with micronutrients potentially provides a simple inexpensive method for improving micronutrient plant nutrition. The final goal is an improvement of germination rate, early seedling growth and stress resistant and improved micronutrient status and a pre activation of metabolic pathways which are important for germination.

**Keywords:** Seed priming, germination, micronutrient

02-52

**ECO-FRIENDLY AND CLIMATE SMART VERMICOMPOST TECHNOLOGY WITH COTTON STALKS**

*Madhuravani, G.S., Lalita Kumari, A., Ramachandra Rao, G and Narasimha Rao, K.L.*

Department of Environmental Sciences, APGC, Lam,Guntur

Corresponding author: madhuravani gs26@gmail.com

A survey was conducted in the intensive cottoncropped areas of Guntur division and documented data on quantity of fertilizers, pesticides, other inputs, yield, and cost of cultivation, net returns, and benefit cost ratio. Cotton, chilli, paddy, maize and vegetables are the major crops grown in this area. Excessive use of fertilizers, pesticides and other agricultural chemicals is prevalent in this area. Twenty locations were selected out of which fifteen locations were high input and five locations were from low input and marginal areas which were considered as check or control for comparison with intensively cropped locations.

Cost of cultivation of 15 locations of heavy input usage areas viz., Etkuru, Pulladigunta, Vinjanampadu, Lemellapadu, Prathipadu, Pedanandipadu, Peddivaripalem, Koyavipalem, Tikkaredypalem, Dokiparru, Visadala, Medikonduru, Lam, Amaravathi, Pedaparimi under cotton growing areas. Cost of cultivation in these villages ranged from 24100 to 34400 rupees with a mean of 28480. Gross returns ranged from Rs 50000 to 80000 with a mean of Rs 65666. Net returns ranged from 16,800 to 46,700 rupees with a mean of 31,987. B:C ratio ranged from 1.50 to 2.55 with a mean of 1.96.

Cost of cultivation of 5 locations of low input usage areas viz., Pedaparimi, Krosuru, Velpuru, Achampeta and Utkuru of cotton growing areas ranged from Rs 20300 to 24300 with a mean of 21500. Gross returns ranged from Rs 35000 to 50000 with a mean of Rs 41000. Net returns ranged from Rs 8,300 to 20,500 with a mean of Rs 14,300. BC ratio ranged from 1.31 to 1.69 with a mean of 1.52.

By the survey we concluded that the cost of cultivation, net returns, and benefit cost ratio were high in 15 locations of heavy input usage areas when compared to 5 locations of low input usage areas, to reduce the cost of cultivation to protect our soil environment by reducing the usage of fertilizers, eco friendly vermicompost technology was suggested to use cotton stalks in vermicomposting instead of burning wastefully or as firewood. The burning of cotton stalks is also harmful to environment which will cause air pollution resulting in acid rains ultimately effect the whole environment such as the land, water, and air which affect the other living things.
SOIL INFORMATICS – AS A TOOL FOR LAND EVALUATION

Raghu, R. S.
Department of Soil Science and Agril. Chemistry, Agricultural College, Bapatla.
Corresponding author: Raghu, R. S.

Land evaluation is a process of assessment of land performance for specified use. It requires extensive knowledge for fulfilling different conditions and also specialized information as well as scientist expertise to analyze and interpret the information. It is only part of the process of land use planning. The function of land use planning is to guide decisions on land use in such a way that the resources of the environment are put to the most beneficial use for man, while at the same time conserving those resources for the future. Land evaluation involves qualitative and quantitative systems of classification. Qualitative system includes classification of land for its capability, irrigability and suitability. Whereas, Quantitative systems having land and soil productivity index. Now a days, due to over exploitation of technology the conventional methods for land evaluation and mapping were not preferable. So, Soil Informatics is a solution that uses advanced sensors and intelligent targeting and geo-processing algorithms to produce high resolution, accurate soil and topographic information. Soil informatics is a computerized database system where soil and related data can be organized, stored, retrieved, analyzed and processed to make it accessible to end-users in the form of maps and tables. It produces highly accurate soil and topographic information which outputs a variety of three dimensional data models using some tools such as Global Positioning System (GPS), Remote Sensors and Geographic Information System (GIS). GPS is space based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the earth where there is an unobstructed line of sight to four or more GPS satellites. Remote sensors have emerged as a vital tool which has been extensively utilized for inventory, mapping and assessment of natural resources. GIS is a powerful tool to input, storage and retrieval, manipulation and analysis, and output of spatial and non-spatial data which is useful in land evaluation. Many of the research finding have showed that the present lands can be converted into profitable ones for better economic returns and sustainable resource management by using soil informatics. So, land evaluation can be done by soil informatics which is more accurate and time saving technology as compared to conventional methods.

Key Words: Soil informatics, land evaluation, GIS, GPS and remote sensors
Theme - 3
Crop Improvement and Management for Biotic and Abiotic Stresses
STRESS ADAPTATION OF CROPS- AN OVERVIEW

Prof. M. Udaya Kumar
Department of Crop Physiology,
University of Agricultural Sciences (UAS-B), GVKV, Bengaluru.

Drought stress is the most overriding constraint that limits the productivity of our crops. The yield losses could be more than 50 - 60%. Such a scenario is often prevalent in the rainfed ecosystems. However, with diminishing allocation of water to agriculture and greater demand for irrigated areas, the crops experience moderate to severe stress in several irrigated ecosystems. However, the paradox is the crops like rice and sugarcane consumes almost 75% of irrigated water. Water is the most over-riding input and we need new address the different scenarios to optimize productivity.

Drought Scenario:
Over 70% of area is rainfed in India, and 54% of cultivated area of India faces high water stress. Drought years very frequent: seven between 1951 – 1980 and four between 1981 – 2010. Around 337 districts in the country are drought prone (National commission of agriculture). In 2016, 266 districts in 11 states are drought affected. In a state like Karnataka 93% of the districts are affected by drought. Rainfed area contributes only 36% of the total production signifying the importance of improving productivity of rainfed agriculture.

Diminishing water resources for agriculture:
Available water annually in India: Surface water potential is 614 KM³; Ground water potential is 423 KM³ and Total – 1107 KM³. Per capita availability of water: in the year 1951 it was 3008 (M³/capita/year); in 1991, 1283 (M³/capita/year); in 2010, 938 (M³/capita/year); in 2025, 819 (M³/capita/year); 2050 – 687 (M³/capita/year). Allocation of water for agriculture is diminishing. It was more than 90% 3 decades ago whereas, it is 78% in 2010 and likely to diminish to 73 and 68% in 2020 and 2050 respectively. Percentage of water requirement based on caloric food consumption (3400 k cal) is 912 M³/y whereas, the available is only 729 M³/y. Since ~90% of water used for food production, only option is to reduce water requirement for food production by increasing water productivity and enhance WUE.

Rice consumes maximum irrigation water:
Globally, allocation of irrigation water for rice cultivation is around 35-45%. Total irrigation water allocated for rice cultivation in India is 59.7%. In general, rice crop consumes 3,500 – 5,000 liters for the production of 1 Kg of rice. Aerobic rice can save irrigation water by 40-50%. Semi irrigated aerobic rice (with increased intervals of irrigation) is an option to save water up to 60%.

The scenario of withdrawal of water away from agriculture and erratic monsoons triggered by global climate change, agriculture and hence food production is expected to be severely affected. Unlike during the green revolution era, agriculture research now faces an unprecedented challenge of producing “more” food with “less” resources, especially water. In this context, the slogan “more crop per drop” has the greatest relevance. Therefore, agriculture research should focus on devising strategies for sustaining productivity with less irrigation water under irrigated systems and to improve productivity under rainfed dry land conditions.

Drought is a complex phenomenon and its occurrence is unpredictable and hence a comprehensive approach is necessary to improve the productivity under water limited conditions.

The major emphasis is now to increase the adaptation of crop plants to water limited conditions and to develop crop genotypes that would produce more with less water. Plants have evolved diverse
adaptive strategies to tolerance leading to adaptation in response to stress and/or specific growth behaviours (inherent traits) that avoid stress effects at cell level to whole plant level. The critical inputs to achieve the complex task of improving crop adaptation to drought are, 1) identification and characterization of drought tolerant traits 2) genetic and genomic resources like trait donor lines, genes/QTLs linked to the traits 3) novel and comprehensive biotechnological approaches/strategies to pyramid these traits.

Plant adaptive traits and their relevance

Among a large number of traits that have been demonstrated to have relevance in boosting productivity under water limited conditions, traits associated with maintenance of water relations, sustaining cellular metabolism under decreasing cell turgor and maintaining positive carbon gain deserve the highest emphasis. Significant progress was made in the last couple of decades to innumerate traits that have specific influence on reducing the water requirement of a given yield potential both under optimum and resource limiting conditions. Maintenance of positive tissue turgor is associated with effective extraction of soil water coupled with a superior ability to conserve water under conditions of high transpiration demand. While better and deeper root system is associated with water mining from deeper soil profiles, avoiding excess heat load through the accumulation of epicuticular waxes have great relevance in maintaining positive tissue turgor.

Furthermore, several acquired tolerance traits such as oxidative stress tolerance mechanisms, ability to sustain protein turnover, maintenance of membrane stability and permeability, cell survival under stress also seem to have paramount relevance. The most important prerequisite for capturing genetic variability in the acquired tolerance traits is the ability to develop precise approaches for imposition of moisture stress so that exactly similar stress levels are provided to any genotype even differing in water mining and transpiration characteristics.

Phenomics – an indispensible step for drought research

In spite of significant progress made in understanding the stress response at cellular and whole plant level, the success in improving the drought tolerance of our crops is very marginal. The important reason being, inadequacy in accurate assessment of the genetic variability in stress response of plants, capture variability in drought adaptive traits and even the productivity.

Lack of precise phenotyping tools and technologies has been the bottle neck. Drought research is “phenocentric” and “drought adaptome”, can be characterized only with efficient phenotyping technologies. Besides, the phenotyping techniques should be high throughput to map the genes/QTLs for specific traits. In spite of the fact that the several QTLs were discovered, many were not translated. A significant gap exists between QTLs discovered and their use. The constraint is the lack of high throughput phenotyping techniques.

Genetic enhancement of crops for drought tolerance centers on exploiting the existing genetic diversity of germplasm accessions for stress response, diverse adaptive traits/mechanisms and productivity. The scientific strategy to achieve this goal is to develop phenotyping technologies which involve precise imposition of moisture stress and quantifying variability in drought adaptive traits/mechanisms. This forms the basis to identify superior drought tolerant breeding lines and finally to map the genes/QTLs associated with drought tolerance mechanisms.

It is now evident that phenotyping is principal step in crop improvement program. With this background, several phenomics platforms were established globally, to utilize the vast genetic and genomic resources developed in recent years. The Indian initiatives to bridge the phenotype-genotype gap is quite encouraging. One of the Indian initiatives in this direction is establishing phenotyping platform at University of agricultural Sciences, GKVK, Bengaluru designed for drought research.

Genetic enhancement of stress adaptive mechanisms – Approaches to pyramid traits

The recent progress in understanding the stress responses of the crops lead to consensus that improving the productivity under moisture stress conditions can be achieved only by bringing together
diverse drought adaptive mechanisms/traits. While identifying relevant drought adaptive traits and the genes and the QTLs regulating these traits, in recent years emphasis is to pyramid these traits by diverse approaches. The existing options are: Conventional breeding, Molecular breeding, Transgenics, Double haploids and Grafting.

**Conventional breeding** is still a potential option to introgress traits. In this direction, a physiological breeding programme was initiated at our centre to combine WUE and water mining traits by developing a RIL population by crossing contrasting parents Thanu (high WUE) and IET15963 (high root). A superior trait introgressed line KMP175 was identified with improved WUE and water relations leading to enhanced productivity under aerobic conditions. KMP175 has been released for farmers cultivation in southern dry zone of Karnataka (Zone-6) with the name DHAKSHA.

**Molecular breeding** is another option Introgress QTL associated with drought adaptive traits. The strategy we adapted was to introgress the QTLs for WUE, root traits and canopy leaf area into an elite cultivar IR64 with an aim to improve the productivity of IR64 under aerobic conditions. Initially, robust QTLs governing the drought trait were identified. These QTLs were introgressed into mega variety IR64 adopting multiparent marker assisted backcross strategy. In BCF3F5 several promising trait introgressed lines with more than 98% of genome recovery were identified, the selected trait introgressed lines showed 32% more yield under aerobic conditions.

**Transgenics** is a relevant option for pyramiding adaptive traits besides, conventional and molecular breeding strategies especially to improve acquired tolerant traits. Several acquired cellular level tolerant mechanisms are associated with sustained cell growth under stress. These acquired tolerant mechanisms are up-regulated under decreased cell turgor and are involved in maintaining of redox homeostasis including scavenging of ROS, osmotic homeostasis, membrane/protein stability and maintenance of protein turnover etc. Amongst them the translation and stability of proteins and retaining their active state is crucial to sustain cell metabolic activities under water limited conditions. Stress induced effects on translation process and protein stability and protein inactivation predominantly by primary and secondary cytotoxic compounds are the crucial factors. Our studies provide leads in identifying the relevant mechanisms and the genes regulating them in sustaining the translation and maintaining the protein stability and preventing the protein inactivation. Our studies also provides leads that simultaneous improvement of the mechanism involved in the protein turnover and function by co-expressing relevant genes improves plant tolerance under water limited conditions. Besides, we provided evidences that transgenics is a potential option to combine diverse traits regulating water mining and cellular tolerance. However, it is crucial that one should adopt desirable approaches for pyramiding the traits, depending on the traits to be pyramided. Besides transgenics, the potential of several of these techniques like molecular breeding, double haploids and even grafting are well established.

In a nutshell, we need a comprehensive approach to improve the productivity under water limited conditions. Novel genomics and phenomics based initiatives are crucial to achieve the goal. To exploit the genetic variability of desired traits the need is to develop phenotyping technologies. Trait based breeding – trait pyramiding will provide the desired solutions.
PLANT HORMESIS MANAGEMENT: A NOVEL TOOL TO ENHANCE PLANT PERFORMANCE

Sandhya, M and Ramana, J. V.
Dept. of Molecular Biology and Biotechnology, APGC, Lam, Guntur.

Hormesis can be defined as a biphasic response in which high doses of a toxic agent could cause inhibition while low dose of the same toxin can cause stimulation (Calabrese, 2009). The factors responsible for inducing hormesis are known as hormetins or stressors. In plants it has been established that the challenge with different levels of stress constitutes an adaptive process, having reminiscence with the phenomenon of hormesis. This stress can be established as “eustress” (beneficial stress) if the effect is similar to the hormetic effect in low doses of a toxin, or “distress” (harmful stress) if the level of this generates an irreversible or negative damage in the plant (Hidieg et al., 2013).

The Plants, due to the lack of mobility, are exposed to adverse environmental factors that cannot be avoided, but have a direct influence on their development. The recent findings suggest that immunization as a type of hormesis, can be induced by host responses to pathogen challenge, and even when the source of stress response is not a pathogen, appears to be driven by the expression of genes associated with immunity (McClure et al., 2014). Controlled treatment of plants with stressors lead to development of resistance by activating multiple signalling pathways of intracellular defence.

Primed/Immunizing plants by the use of hormetins (Conditioning) is the process when an organism is first exposed to low doses of a stress factor, it has the ability to activate or up-regulate existing cellular and molecular pathways that allows it to withstand subsequent stresses that are more severe (Calabrese et al., 2007). Primed tomato plants with stressors such as chitosan (CHT), SA, and jasmonic acid (JA) have the ability to promote resistance in plants against a higher stress provoked by Ralstonia solanacearum, reducing vascular browning and wilting symptoms of tomato (Mandal et al., 2013). Chitosan is able to induce physiological and morphological responses that allow corn seedlings to survive under a hypoxic condition (Boonlertnirun et al., 2010). When plants are primed by different stress factors various types of systemic plant immunity can be induced, including SAR and ISR (Aranega-Bou et al., 2014; Pieterse et al., 2014).

Another promising strategy is the use of stress conditions that turn on the defence responses and produce the synthesis and accumulation of bioactive compounds (Naznin et al., 2014; Shrivastava et al., 2015). A myriad of secondary metabolites are produced by the plant immune system in order to get adaptation to new environments that provoke stress. Resveratrol can be induced in grapes by both abiotic or biotic factors (Hasan and Bae, 2017). Many substances have been discovered that work as stressors like jasmonates (such as methyl jasmonate and jasmonic acid (JA)), salicylic acid (SA), benzothiadiazole (BTH), Etephon, hydrogen peroxide, and oligosaccharides such as chitosan.

A search for new sources of stressors will provide the basis to induce plant defence responses in a controlled manner by understanding the signal transduction pathways induced. Determination of hormetic dose response model in plants can lead to the determination of the stressor concentration in which the highest adaptive response is observed. Determination of the limits of hormesis is a strategy that allows taking advantage of the crops, managing an adequate balance of yield and nutraceutical production. The effect of hormetins also depend on many factors such as concentration of the hormetin, time of exposure, and stage in which hormetin is applied (Jeong et al., 2005). The responses, which can be evaluated in hormesis, are disease resistance, production of some secondary metabolites and yield (Calabrese and Blain, 2005; Mattson, 2008; Calabrese and Mattson, 2011).

This strategy represents an ecologically important adaptation to face environmental challenges. Another advantage for agricultural application is that the priming characteristic in plants can pass down generations, showing progeny enhanced defence responses. Changes in chromatin structure in responses to environmental stresses are inherited through mitotic and meiotic divisions (Avrampova, 2015).
Nevertheless the use of these compounds requires further research to get the approval of more hormetins for agricultural use, and overcome the disadvantage of their high cost. Additionally, farm worker safety could be improved. Hence, Hormesis management is a powerful tool to generate adaptive responses, to improve food nutraceutical quality in crops and has well-established economic, social, and environmental implications.

03-02

NECESSITY OF INTROGRESSING BIOTIC AND ABIOTIC STRESS RESISTANT GENES IN EXISTING CULTIVARS FOR FUTURE CROP IMPROVEMENT PROGRAMMES

Virender Jeet Singh, T and Gauri Shankar, V.
Department of Genetics and Plant Breeding, College of Agriculture, Hyderabad
Corresponding author: thakurvirender.ts@gmail.com

With the expected increase in world population outstripping the land available for cropping, maximizing utilizable yields by breeding for resistance to biotic and abiotic stresses is becoming an imperative. It is therefore important that plant breeders should identify the most important constraints on production in a particular crop and region. Agriculture is potentially very sensitive to climate change but there are clearly many uncertainties, which create difficulties for plant breeders who are making a long-term investment. However, breeding for disease resistance may not only be beneficial in adaptation to climate change, it may have a role in limiting greenhouse gas emissions. The reductions in emissions that could be achieved from disease control: with current cultivars and fungicide use, there is the potential to save up to 1.14Mt CO₂ eq. per annum. This saving could be improved through the use of more effective disease resistance cultivars. Even with modern techniques which can speed up the breeding process, plant breeders have to determine their objectives many years in advance of a cultivar being released. This has never been easy but with the pressures on production systems described above and the largely unpredictable effect of a number of them, determining the importance of specific traits 10-15 years ahead of the release of a new cultivar is a real challenge. To add to the difficulty, a whole range of traits alongside resistance to biotic and abiotic stresses have to be considered. There is also a need to try and ensure that the sources of resistance to pathogens employed are durable, to escape from the ‘boom and bust’ cycle common with some pathosystems. Many sources of durable resistance are controlled by a number of genes which makes breeding much more challenging. Molecular biology has developed rapidly in the past two decades and this is benefiting resistance breeding programmes. The production of markers for resistance genes and other traits is developing rapidly and will enable much more effective selection to take place. In addition to this, there is a greater understanding of the mechanisms of resistance, through the cloning and characterization of resistance genes and in understanding of biotic and abiotic stress signaling pathways. These scientific developments have the potential to provide new strategies for effective breeding for host resistance to stresses in the future.

Keywords: Climate change, pathosystems, green house emissions, disease and stress resistance genes.

03-03

GENETIC DIVERSITY AND POPULATION STRUCTURE OF A DIVERSE SET OF RICE GERmplASM FOR ASSOCIATION MAPPING

Swarajya Lakshmi B., Jeevul, N.B, Eswar, G and Laksmi Narayana Reddy, V.
Department of Molecular Biology and Biotechnology, IFT, RARS, S.V Agricultural College, Tirupati.
Corresponding author: vhlreddi@gmail.com

Rice (Oryza sativa L.) is life for more than half of the global population. Rice is also an excellent model crop plant owing to its small genome size (Indica- 390 Mb and Japonica- 430 Mb), availability of
high quality reference genome and innumerable transcriptomic and proteomic resources. Rice yield is often determined by three important agronomic traits viz., grain number per panicle, number of panicles and grain weight. Among them, grain weight in turn governed by grain size is drawing great attention in recent days due to its importance as yield as well as quality trait. Like other yield component traits, grain size is also governed by innumerable genes/QTLs located on different chromosomes. The key genes among them are GS3, qSW5, GS5, GW2, GW8, TGW6 and GLW7. Uncovering of various alleles of these genes and their effect in different genetic background is the need of the hour for developing high yielding varieties suitable to diverse consumer preferences. Hence, allele mining- a process of identifying different alleles of a gene is gaining much importance.

In the present investigation, an attempt was made to uncover various alleles of known grain size genes existed in Indian rice germplasm and assess their allelic diversity using the markers derived from them. The screening of the 124 rice genotypes with eight gene-specific markers viz., GS3, qGRL7.1, GS2, GS5INDEL1 GLW7, SLG7, qsgw7 specific marker revealed two alleles each while qSW5 specific marker revealed four alleles, with substantial variation in the germplasm.

Eight marker-trait associations were identified by screening 124 genotypes with grain size specific primers for GL, GW, L/B and TGW traits. One GS3 gene-specific marker, GS3RGS1 found to be associated with GL, GW, L/B and TGW traits with their PVE as 15.2%, 16.9%, 10.3% and 7.8%, respectively. Earlier results by Fan et al., (2006), Lu et al., (2013) and Xuet al.,(2016)also reported that the GS3 is the major gene governing the grain length and minor gene for grain width. Similarly, one SSR marker, RM505 was showed association with GL, GW, L/B and TGW traits with their PVE as 4.4%, 2.6%, 1.9% and 3.8%, respectively.

The allelic diversity elucidation, a dendrogram consisting of 124 rice genotypes was drawn using unweighted pair group method using arithmetic averages (UPGMA) based on genotyping data using NTSY spc -2.02e software. The dendrogram revealed that all the total 124 genotypes can be made into two groups, A and B. The group A exclusively includes the extra-long grain length basmati genotypes. However, the group B can be again divided into two groups i.e., B1 and B2. The group B1 includes mostly long grain genotypes. The group B2 comprising of all classes of grain length and size genotypes.

Based on the population structure Q matrix data the 124 accessions are divided into four clusters/subpopulations, viz., from POP1 to POP4. POP1 subpopulation was grouped under extra-long grain type, POP2 was grouped under long grain type, POP3 and POP4 includes all the four grain size classes.

03-04
FLOW CYTOMETRIC ANALYSIS FOR IDENTIFICATION OF INDUCED PLOIDY LEVEL IN BAJRA NAPIER HYBRID

Swathi Lekkala and Babu, C.
Centre for Plant Breeding and Genetics, TNAU, Coimbatore.
Corresponding author: swathi.lvs@gmail.com

Fodder production is “harbinger” of white revolution through less favoured areas. About 90 per cent of the milk is produced by small and marginal farmers and landless agricultural labourers. In the available fodder crops, Bajra Napier hybrid belonging to the genus Pennisetum is an important crop, produced by the inter-specific cross between Elephant grass (2n = 4x = 28, A’A’BB) and pearl millet (2n = 2x = 14, AA). The triploid hybrid is “seeded yet sterile”. Chromosome doubling restores the fertility. Colchicine was used at different concentrations viz., 0.05%, 0.07%, 0.09%, 0.10%, 0.15%, 0.17% and 0.20% to treat single noded buds for genome doubling. The ploidy level of treated plants was checked by using flow cytometry. LB 01 buffer was used for the nucleus extraction and it was stained with PI. No variants were recovered at 0.05%, 0.07% and 0.9% concentrations. Variants were recovered at 0.10% and 0.15%. Beyond 0.15% the lethality is high. The untreated plants were used as control and its mean value was 133797.96. Most of the variants
were recorded to be mixoploids (tetraploids with mean value 153660.58 and pentaploids with mean value 311225.67). Some of the variants were shown to have chromosomal elimination and hence diploids with mean value 120571.39 were also recovered.

**Key words:** Colchicine, Bajra napier, LB 01 buffer and flow cytometry

---

**03-05**

**MATING TYPE AND AVIRULENCE GENE DIVERSITY IN *Magnaporthe oryzae*: A MAJOR CHALLENGE IN RICE BLAST RESISTANCE BREEDING**


ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad.

Corresponding author: bhaskarblast23@gmail.com

Rice blast caused by *Magnaporthe oryzae* is distributed in almost all rice growing regions of the world and is present approximately in 85 countries throughout the world. Yield losses due to blast disease are in the range of 20 to 100 % and have a direct impact on the welfare of farm households as well as on the national economy. Host cultivars, resistant to blast, are most widely used method of disease control. The major genes (R) governing the host resistance often fail in field condition, since the chances of sexual recombination between the opposite mating types and avirulence gene diversity among *M. oryzae* population.

Breeding for durable resistance against blast disease would be more effective with a prior knowledge of the pathogen populations from the country or place where the future cultivar will be cultivated. Hence, in the present investigation, a study on the mating type distribution and avirulence gene diversity among *M. oryzae* population collected from major rice growing areas of South India was envisaged.

Mating type distribution of *M. oryzae* isolates was studied with the mating type specific SSR primers. Among the 50 isolates collected from different rice growing areas of Andhra Pradesh, Telangana, Karnataka and Tamilnadu states, 78% of the isolates were mating type 1-1 and remaining 22% isolates were mating type 1-2. Only one mating type was found in most of the geographic regions viz., Krishna (Mat 1-2), Guntur (Mat 1-1), West Godavari (Mat 1-1), Vishakapatnam (Mat 1-1), Srikakulam (Mat 1-1) districts of Andhra Pradesh, Karnataka (Mat 1-1) and Tamilnadu (Mat 1-1). The remaining regions (Chittoor, Nellore, Kurnool, East Godavari regions of Andhra Pradesh and Hyderabad in Telangana) were found with both mating types. The presence of both mating types in a particular region suggesting the chance of sexual recombination among the *M. oryzae* population in nature.

Diversity of three major Avr genes *i.e.*, *PWL-2*, *Avr-Piz-t* and *Avr-Pii* was studied among the 50 isolates. 78% of the isolates were positive for *PWL-2*, where as 90% and 36% of the isolates were found positive for *Avr-Piz-t* and *Avr-Pii* respectively. *AvrPiz-t* and *PWL-2* genes in rice blast isolates had no genetic variation (Presence or absence polymorphism) or genetic diversity. The low level of genetic variation of the *PWL-2* gene and *Avr Piz-t* was probably due to the important function of the *PWL-2* and *Piz-t* gene products in pathogenicity. *Avr Pii* gene was found only in the isolates from the cultivars of BPT-5204 and Swarna cultivars, which were cultivated in Godavari and Coastal Andhra districts of Andhra Pradesh region. The loss of *Avr Pii* frequency in rice blast isolates indicated changes of the genome in the fungal population. Presence of these Avr genes (*PWL-2*, *Avr Piz-t* and *Avr Pii*) in isolates assuming the lack or inexpression of corresponding R genes in the respective cultivars. Absence of Avr genes in the isolates inferred the loss of particular gene from that particular *M. oryzae* genome. Hence, the present results are suggesting the continuous verification of *M. oryzae* population for mating type and avirulence genes distribution in major rice growing areas for fruitful breeding programmes.
MORPHOLOGICAL AND REPRODUCTIVE CHARACTERS OF PULSE BRUCHID, *CALLOSOBRUCHUS MACULATUS* (LINNAEUS) DUE TO NANO BASED BOTANICAL SEED PROTECTANTS

Mounica, D and Natarajan, N.
Department of Agricultural Entomology, TNAU, Coimbatore.
Corresponding author: mounicaagri47@gmail.com

Studies have been conducted on morphological (weight of adults, changes in appendages) and reproductive (sex ratio) characters of adult bruchids, *Callosobruchus maculatus* (Linnaeus) emerging from the seeds treated with nano based botanical seed protectants (Plain and ball milled turmeric powder at 5g/1 kg seed, plain and nano emulsions of neem and pungam oil at 10ml/1 kg seed). Ball milled powder resulted in an unusual ratio with predominance of males to females and also the insect to stretch legs backward and elytra to be partially separated. Mass of dead adults was least when treated with turmeric powders followed by oils while the adults weighed significantly more in absolute check (0.1g/10 adults).

**KEY WORDS:** *Callosobruchus maculatus*, morphological modifications, pulses, reproductive biology, sex ratio, treatments, weight of adults

*Callosobruchus maculatus* (Linnaeus)(Bruchidae: Coleoptera) is the most serious one and attacks invariably all the pulses under storage conditions with the mild infestation in the field as well. Grain protective potential of different plant derivatives including the plant oil against major stored product pests were found very promising and could reduced the risks associated with the use of insecticides. These plant materials are potentially suitable for use in integrated pest management (IPM) effectively. Yesteryear chemicals/insecticides were used to control stored insects which resulted in leaving objectionable residues in treated commodity and generally are hazardous to handle and apply. Some of the stored product insects have also developed resistance to these insecticides. In order to manage the storage pests attacking grains and seeds, newer eco-friendly management methods have to be developed. Plain and nano forms of turmeric powder, oils of neem and pungam which need to be tested against this pest. The present investigations were carried out on emerging adults of *C. maculatus* morphological and reproductive characters due to nano based botanical seed protectants under laboratory conditions.

**MATERIALS AND METHODS**

The present investigations were carried out by randomly collecting samples each of ten live adults (five replications) from nano based botanical treated seeds and kept for 20 min in refrigerator at 4°C to bring down the active adults into insensible condition to measure the sex ratio as well as the mass of the adults. Sex ratio could be assessed by counting the number of males and females present in each sample. Adults mass (10 adults/sample) was determined with electronic weighing machine besides observing the changes in the morphological features particularly the orientation of antennae, legs and elytra in all the treated adults through image analyzer.

**RESULTS AND DISCUSSION**

Adults emerging from the treated seeds were found to have reproductive and morphological variations due to the treatment of various test materials imposed. Interestingly a wide variation in the sex ratio was observed when treated with ball milled powder resulting in female proposition of 0.34 indicating the dominance males. In contrast, the female proposition was the maximum (3.90) with plain turmeric powder, which was followed by nano neem oil (3.80) which were not statistically significant. Sex ratio could not be assessed in the treatments with plain neem and pungam oils as no adults emerged after the application. Ravinder Singh(2011)
reported the effect of the leaf powders and oils of Thymus vulgarus (L.), Santolina chamaecyparissus (L.) and Anagyris foetida (L.) plants on the biology of C. chinensis such as fertility, longevity and sex ratio. Shorter life span of females compared to the males leads to the inhibition of oviposition. However Dipali Rani et al. (2006) observed no difference in the sex ratio of T. castaneum due to nimbicidine. Mass of the emerging adults also exhibited variation due to various test materials as 10 adults of standard check weighed 0.1 g while nanoneem and pungam oil treatments significantly reduced the mass to 0.06 and 0.05 respectively wherein the latter two were on par. However the turmeric powder treatments resulted in the lowest adult mass of 0.03 and 0.02 due to plain and ball milled powder respectively. Reduced mass of the emerging adults in case of turmeric powders may be to making the insect to desiccation while nano formulation could have altered the seed physiology (Senthilkumar, 2011) which might have favoured a significant increase in the mass compared to the turmeric powders. Morphological postures of dead adults varied due to treatment of the seeds with test materials. Male and female due to ball milled turmeric powder treatment exhibited similar postures as that of plain form, but the difference was in the incomplete closing posture of elytra and antennae which were deflexed and curved. Females died due to neem oil either plain or nano formulation displayed protruded abdomen and antennae closely appressed to the head. In case of males legs were compressed forwards, antennae projected laterally. Adults died due to nano neem, females died with slightly protruded abdomen and males died in the view of legs stretched backwards and fused. Surprisingly dead adults due to pungam oil (plain and nano formulation) took lateral posture as against the dorsal in the other treatments by stretching legs and antennae backwardly. Preliminary investigation made in this investigation on the sex ratio, mass and postures indicates the necessity for a detailed dig into in order to understand the mode of action and the possibility accordingly fitting in the bruchid management programme.

03-07

MARKER ASSISTED SELECTION FOR PHOSPHORUS DEFICIENCY IN RICE

Kavitha, G
S.V. Agricultural College, Tirupati.

Phosphorus is the most important inorganic plant nutrient. It is least available in most of the soils because of its tendency for tight binding. As a consequence, phosphorus deficiency is widespread in many rice-growing areas, particularly where farmers do not have access to phosphate fertilizers and, in most cases, because these soils have high P-fixing capacity. Breeding efficient cultivars capable of effectively mining the large pool of P already fixed in most soils will help increase and sustain yields in low-input agricultural systems, particularly for cereal crops.

Wissuwa et al. (1998) reported a major QTL on chromosome 12 for P uptake, P-use efficiency, shoot dry weight, and tiller number by using backcross inbred population derived by using Nipponbare (Japonica, sensitive) as recurrent parent with the landrace Kasalath (Indica, tolerant). For P uptake, this QTL had a LOD score of 10.7 and explained about 28% of the phenotypic variation. Ni et al. (1998), using RILs from the cross of IR20 (tolerant) with IR55178-3B-9-3 (sensitive), found a similarly strong QTL in the same location. They measured P uptake efficiency as relative tillering ability, relative shoot dry weight, and relative root dry weight. Moreover, an intermediate QTL on chromosome 6 and several other minor QTLs were mapped to several chromosomes. The QTL on chromosome 6 accounted for 25–34% of the variance for the above traits. But it has much less effect (R2 = 9.8%) in the field study of Wissuwa et al. (1998). Subsequent studies focused on the major QTL for phosphorus uptake, located on chromosome 12, designated as “PUP1”.

Wissuwa and Ae (2001a) transferred this QTL by three backcrosses into the japonica variety Nipponbare. The resulting lines containing the tolerant allele showed a 170% increase in P uptake and 250% increase in yield when grown under low-P conditions. The NILs with the PUP1 allele from Kasalath had increased root growth under low-P conditions, but the differences in root growth and P uptake were not
observed under anaerobic soil conditions. This QTL explained close to 80% of the phenotypic variation in a secondary mapping population (Wissuwa et al. 2002). Additional cycles of fine mapping further reduced the \( PUP1 \) interval to about 145 kb (Heuer et al. 2009). Subsequent sequencing of the corresponding chromosomal region in the donor parent “Kasalath” showed that \( PUP1 \) locus in Kasalath is much larger (278 kb), with large numbers of transposon- and retro-transposon-related elements (Heuer et al. 2009). None of the genes annotated in the \( PUP1 \) locus were found to be related to previously known genes involved in P uptake or metabolism, and detailed analyses of the putative candidate genes are currently ongoing. A marker assisted backcrossing system was developed and is being used to transfer this QTL into three popular upland rice varieties that were sensitive to phosphorus deficiency, particularly in acid soils (A. Ismail, M. Wissuwa, S. Heuer, unpublished). The significance of this QTL in enhancing P-uptake efficiency will further be validated after completing the development of these near isogenic lines.

**03-08**

**NEW ERA IN GENE EDITING CRISPER- Cas9 & ITS UTILIZATION IN CROP IMPROVEMENT**

*Kavya, P., Satyanarayana Rao, V and Shruti, K.*

Department of Genetics and Plant Breeding, Agricultural College, Bapatla.

Corresponding author: kavya.pati@gmail.com

Crop improvement is a dynamic process for improving the food crops for the human kind. Earlier it’s is the Traditional plant breeding followed by the cytogenetical techniques and next progressed by Molecular breeding, biotechnological tools and now the path paved for new generation technique i.e is genome editing.

ZFNs (Zinc Finger Nucleases) a known word but the practical utility was not so feasible with the previous available techniques which is one of the oldest gene editing technologies, developed in the 1990s and owned by Sangamo BioSciences. ZFNs are premeditated restriction enzymes having sequence specific DNA binding zinc finger motifs and non-specific cleavage domain of Fok1 endonuclease. An array of 4–6 binding modules combines to form a single zinc finger unit. Each module recognizes a codon. A pair of ZFNs together identifies a unique 18–24 bp DNA sequence and double stranded breaks (DSBs) are made by Fok1 dimer. FokI nuclease are naturally occurring type IIS restriction enzymes that introduce single stranded breaks in a double helical DNA. Hence FokI functions as a dimer, with each catalytic monomer (nickase) cleaving a single DNA strand to create a staggered DSB with overhangs. ZFNs have been successfully employed in genome modification of various plants including tobacco, maize, soybean, etc. It was taken back due to some drawbacks such as time-consuming and expensive construction of target enzymes, low specificity and high off-target mutations that eventually made way for the new technology.

TALENs turned out to be a substitute to ZFNs and were identified as restriction enzymes that could be manipulated for cutting specific DNA sequences. TALENs contain a customizable DNA-binding domain which is fused with non-specific FokI nuclease domain. TALENs compared to ZFNs, involve the interaction of individual nucleotide repeats of the target site and amino acid sequences of TAL effector proteins. They can generate overhangs by employing FokI nuclease domain to persuade site-specific DNA cleavage. It has been widely used to generate non-homologous mutations with higher efficiencies in diverse organisms.

The emergence of CRISPR (CLUSTERED REGULARLY INTERSPACED SHORT PALINDROMIC REPEATS) technology supersedes ZFNs and TALENs and used widely as a novel approach from “methods of the year” in 2011 to “breakthrough of the year” in 2015 for their captivating genome editing. This prokaryotic system is promptly accepted for genome editing in eukaryotic host cells. In the first attempt 45 CRISPR-associated (Cas) protein families that are categorized into core proteins (Cas1, Cas2, Cas3, Cas4, Cas5, Cas6), 8 CRISPR/Cas subtypes were defined and RAMPCRISPR has an added advantage of gene knockout over RNAi, which is a well-known technique for gene knockdown. CRISPR
targets the endogenous genes that are impossible to specifically target using RNAi technology with more precision and simplicity. RNAi gene regulation is governed by the endogenous microRNAs (miRNAs). Any displacement of these miRNAs from the exogenous miRNAs can lead to hypomorphic mutations and off-target phenotypes. Cas9 stimulates the DNA repair mechanism by introducing Double stranded strands in the target DNA. Repair mechanism involves error prone nonhomologous end joining (NHEJ) or homologous recombination (HR) to produce genomic alterations, gene knockouts and gene insertions. NHEJ by far is the most common DSB repair mechanism in somatic plant cells. Random insertions or deletions by NHEJ in the coding region lead to frame shift mutations, hence creating gene knockouts. CRISPR technology holds potential for loss-of-function, gain-of-function, and gene expression analysis.

CRISPR has versatile applications in plant biology and is readily applied to produce high quality agriculturally sustainable products. There are many plants which are in the process of getting altered through CRISPR/Cas9. The CRISPR edited tomatoes will be expected to have enhanced flavor, sugar content and aroma as compared to modern commercial varieties, corn is made resistant to drought with high yield per hectare, wheat is edited against powdery mildew disease, and mushrooms are targeted to reduce the melanin content. CRISPR/Cas9 system can generate stable and heritable mutations without affecting the existing valuable traits. This results in the development of homozygous modified transgene free plants in only one generation and it’s stable transmission to successive generations. Cas9 continued to be a better tool with relatively high cleavage efficiency when compared to TALENs and ZFNs.

Classic works are being done for producing acrylamide free potatoes, non-browning apples, mushrooms and potatoes by mutating Polyphenol oxidase (PPO) genes and low phytic acid in maize. Multiple disease resistance plants have been obtained using CRISPR/Cas9 technology. Some highlights involve the resistance against rice blast disease by targeting OsERF922 gene in rice, transgene free mutant lines from T1 and T2 generations were selected by segregation and further examined. Transgenic lines showed a significant reduction blast lesions formed due to pathogen infection, Bacterial blight of rice by targeting OsSWEET11, OsSWEET14. Introduced mutations using site-specific endonucleases in homeoalleles encoding Mildew-resistance locus (MLO) proteins of hexaploid bread wheat. In cotton for Cotton leaf curl disease CLCuD IR and Rep Regions.

Generally, CRISPR/Cas9 DNA constructs are delivered into plant cells by Agrobacterium-mediated infiltration, particle bombardment and protoplast transfection. However, the extra DNA delivered along the sgRNA, Cas9 and selectable marker genes frequently integrate into the plant genome and may cause side effects like gene disruption, plant mosaicism and off target disruptions. The importance of this system lies in its relative ease of use, high precision, and low start-up cost. The most distinct feature of CRISPR technology, i.e., DNA cleavage recognition through Watson and Crick base pairing drastically simplifies the DNA targeting.

Researches in the advancement of legendary technology are deliberately going on but one stubborn and constantly following pitfall related to off-targets in plants, which could be executed by doing whole genome sequencing. The products, which are obtained by editing through CRISPR-Cas9, have no exogenous DNA and furthermore editing can be done in such a way, which abides by all the rules and regulations that are compliance to withstand against Genetically Modified issues and can get an easy approval by the Indian government.

In conclusion, CRISPR-Cas9 technology boasts of a promising future in making the desired mutation in plants because it has transformed and metamorphosed our potential to modify and regulate prokaryotic and eukaryotic genomes. The prevalent use of this technology will surely expedite its pace.

Keywords: Genome editing, ZFN’S, TALEN’S, CRISPER-Cas9.
03-09

GENETIC DIVERSITY ANALYSIS IN MAIZE (Zea mays L.) INBREDS USING MAHALANOBIS’ D² ANALYSIS

Mounika, K., Lal Ahamed, M., Vijaya Lakshmi, B and Shaik Nafeez Umar
Agricultural College, Bapatla.
Corresponding author: monikakorada@gmail.com

Assessment of a large number of germplasm for genetic diversity is of immense importance in selection of diverse genotypes for hybridization programme. The crosses between parents with maximum genetic divergence are generally the most responsive for genetic improvement. With this objective the present investigation was carried out to assess 47 Maize inbred lines for genetic diversity during rabi 2016-17 at Agricultural college farm, Bapatla, Guntur district in a Randomized Block Design with three replications using 10 quantitative characters viz., days to 50% tasseling, days to 50% silking, days to maturity, plant height (cm), ear length (cm), ear height (cm), 100-seed weight (g), kernel rows per ear, number of kernels per row and grain yield per plant (g).

Mahalanobis’ D² statistic is a powerful tool for quantifying genetic divergence among the available genotypes with respect to characters considered together. The analysis divided the 47 genotypes into seven clusters using Tocher’s method. Among all the clusters, cluster I is the largest with 12 genotypes followed by cluster III with 11 genotypes, cluster VII with 8 genotypes, cluster IV with 7 genotypes, cluster II with 4 genotypes, cluster V with 3 genotypes and cluster VI with 2 genotypes.

Intra-cluster D² values ranged from 0.00 (cluster III, V, VI and VII) to 45.59 (cluster IV). The high intra-cluster distance in cluster IV indicates the presence of wide genetic diversity among the genotypes present within this cluster. The inter-cluster distances were worked out considering 10 characters and minimum inter-cluster distance was seen between clusters I and III. The genotypes grouped in cluster V are having maximum genetic diversity with the genotypes placed in the cluster VII. This indicates that crosses between the genotypes present in these two clusters are expected to be much heterotic. But as a rule along with genetic distance, per se yield and yield contributing characters should be taken into consideration. So, hybridization between the lines of clusters V and VII which are having maximum inter-cluster distance, in consideration with per se yield and yield contributing characters (genotypes PDM-4251K, CDM-342, C-2703-1 from cluster V and the genotypes CDM-311 AND CDM-119 from cluster VII) is having a good chance of producing heterotic hybrid varieties in presence of dominance and may result in good transgressive segregants if additive component of gene action is predominant.

Key words: D², genetic diversity, maize.

03-10

VARIOUS APPROACHES FOR DEVELOPING RESISTANT VARIETIES FOR YELLOW STEM BORER IN RICE

Nagamallikadevi, M., Shilpa M Naik and Bhargavaramireddy, Ch.
IRRI SAHub, ICRISAT, Hyderabad
Corresponding author : minnu.nagamallikadevi@gmail.com

Rice is a staple for nearly half of the world’s seven billion people. One of the major yield limiting factors of paddy is the attack of insect pests that cause 20-30% losses every year. Yellow stem borer, Scirpophaga incertulas(Walker), is one of the most serious pests in rice ecosystem causing yield loss of 15-20% and even reaches up to 60% in severe out breaks. Although many insecticides were in available but they
are not able to manage the pest effectively. Using classical plant breeding techniques, breeders have developed many cultivars adapted to different rice growing regions worldwide. However, still the problem of incidence exists causing the severe losses due to its polygenic trait. Development of improved variety for insect through breeding is more effective and sustainable approach. Here, summarized information on conventional breeding to molecular progress and transgenic approaches is provided. Despite cost effectiveness in development, application of appropriate new techniques will open a new avenue to develop next generation resistant rice variety for this pest, resulting in full understanding of genes and their interactions within their genomic environment.

**Key words:** Yellow stem borer, marker assisted selection, transgenics, RNA interference

Yellow stem borer (YSB) is considered as one of the most economically important pests which attack the rice crop at all growing stages. Globally, causing yield loss of 27 - 34% every year. It is one of the widely distributed, dominant and monophagous pests of paddy. It causes dead hearts during active tillering stage and white ears at panicle initiation stage leading to complete failure of the crop. The population of YSB increases in subsequent generations and causes serious damage. Modern IPM practices like cultural, mechanical, biological and chemical management may minimize the pest infestation but it is difficult to manage YSB with insecticides as the larvae and pupae are concealed inside the stem and the eggs are also minimally killed. Progress on the development of rice varieties with resistance to YSB has been slow due to the lack of suitable germplasm and poor understanding of the genetics of resistance. Hence, it is urgent to find out strategies for developing durable resistance varieties to the pest by various approaches.

**Conventional breeding**

Conventional breeding is important for producing novel genetic variants, conserving wild germplasm. Many rice varieties are available with moderate levels of resistance during the vegetative stage (Chaudhary et al. 1984, Heinrichs 1988). Most of the IR varieties have moderate levels of resistance inherited from TKM6, W1263, Ptb18, *O. nivara*, PTB 33and Ptb 21 (Kush and Virk, 2005). More than 39,000 varieties of rice have been screened against YSB at IRRI (Khan et al., 1991), and many national agricultural research systems screened hundreds of cultivars and breeding lines (Fig. 1). All types of resistance from moderate to high are seen in rice genotypes but so far none of them were long-lasting for highly resistant. Studies on evaluation of rice germplasm/ varieties against YSB had been conducted by earlier research workers (Chaudhary et al. 1984, Padhi, 2002). Conventional method of developing resistance to YSB is labour intensive, time consuming, and weather dependent and there is a need to opt for different approaches like pyramiding genes for resistance using molecular tags and by development of transgenics. Genetic analysis had shown that the resistance is polygenic in nature (Khan et al., 1991). Certainly, more distantly related wild *Oryza* species like *Oryza officinalis* Wall. ex Watt, *O. brachyantha* and *O. ridleyi* Hook. f. have been found to be highly resistant to YSB during the vegetative phase as compared to domesticating varieties. These may be promising sources of resistance that could be transferred to cultivated rice using appropriate wide hybridization programs.

**Molecular Breeding**

Marker Assisted Selection is an extremely fast and efficient way of screening a population for gene/s of any trait of interest (Mohan et al., 1997). The complex genetics of the trait and the inherent difficulties in screening have made breeding for YSB resistance difficult. In such situations, screening of breeding population with molecular markers is preferable to phenotypic evaluation of breeding populations. Many morphological, anatomical, physiological and biochemical factors have been reported to be associated with resistance, each controlled by different sets of genes (Chaudhary et al., 1984). In rice, no complete source of resistance to YSB has been identified (Chaudhary et al., 1984; Khush, 1977). There were very few reports (Khush, 1977, 1992) on the number of genes contributing to host tolerance of YSB or of molecular markers linked to resistance. Selvi et al. 2003 reported that marker, RM241, located on chromosome 4, was also found to be
associated with the trait and is closed to the genes for YSB resistance. (Hemalatha et al., 2014) identified and phenotypic data inferred that RM104 on chromosome 1 has resistance to dead heart incidence. Recent rapid advances in molecular marker technology will enable the researchers to clone the resistance genes for understanding the resistance mechanism against YSB. Hence, more experiments ought to be conducted with markers for previously recognized resistant genes to perceive whether the resistance noticed in rice germplasms is a result of existing resistant genes or new genes to keep away from genetic homogeny of YSB resistance in rice.

**Transgenic approaches**

Given the progress of the technology, rice can be no exception and various Bt rice lines have been developed, harboring Cry-toxins, with moderate to high resistance to target pests in laboratory and in field conditions. Some rice transgenic lines of japonica and indica types resistant to YSB have been developed (Chen et al. 2005). Wu et al. (2002) reported the developed Japonica transgenic lines carrying cry1Ab showed stable resistance to YSB under field conditions. Gene pyramiding is an effective strategy to deal with insect resistance developed against Cry proteins. Several previous studies have shown that the Cry2A and Cry1A proteins have different binding sites and exhibit no cross resistance (Karim and Dean, 2000; Alcantara et al., 2004; Gouffon et al., 2011). Ling et al. 2016 studied the marker free transgenic rice expressing Cry2A protein, which showed different binding sites with Cry1A protein in the midgut of YSB. Although transgenic lines with Bt show promise against YSB, there is concern about the durability of Bt-based insect resistance (Gould et al., 1998). Recently, the RNAi technology has been demonstrated to be helpful in understanding the functional genomics of valuable crop traits for resistance against insect pests.

**RNAi approach**

Some of the reports revealed (Vinay et al., 2011) that gene knockdown in several insects can be induced successfully through feeding with dsRNA. Interference in expression of the targeted genes results various disturbances like stunted growth, moulting defects, immune gene and insect mortality (Thakur et. al., 2014) by silencing some of the vital genes that play an important role in growth & development. Identification of a suitable gene for RNAi is very important because the gene that selected should not only have insecticidal effects on the target pests, but should also be safe to the non-target pests, natural enemies and to human beings. To control YSB, it is essential to understand its biochemical and molecular mechanisms associated with its life cycle. This study opens a new avenue to develop next generation resistant rice using RNAi or genome editing approaches.

**Conclusion**

Many research works have been conducted on the resistance mechanism against YSB, but still information regarding the resistance pattern yet to be known that which genes confer resistance. Hence, there is a need for identification and characterization of novel genes from natural wild type sources like *Oryza ridleyi* Hook. f. which confer resistance against YSB have to be done. There is an urgent need to clone the resistance genes and utilise them effectively by introgressing into the cultivated germplasms. Not only in the host plant aspect but also need to identify the genes involved in key processes during growth and development of the insect will help the researchers to innovate and move in new direction for developing next generation resistant rice variety for sustainable crop production.
Fig: Varieties released so far in India against YSB

03-11

PUSH PULL STRATEGY FOR STEM BORERS MANAGEMENT IN MAIZE

Ravi Kumar, V and Madhumati, T.
Department of Entomology, Agricultural College, Bapatla
Corresponding author: vanamaravikumar76@gmail.com

Stem borer (Chilo partellus and Sesamia inferens) infest maize and sorghum crops, causing yield losses of 30-40% of potential output. Stem borers are difficult to control, largely because of the cryptic and nocturnal habits of the adult moths and the protection provided by the stem of the host crop for immature stages.

The ‘push-pull’ strategy, a novel tool for integrated pest management programs, uses a combination of behaviour-modifying stimuli to manipulate the distribution and abundance of insect pests and/or natural enemies. In this strategy, the pests are repelled or deterred away from the main crop by using stimuli that mask host appearance or are repellent or deterrent. The pests are simultaneously attracted (pull), using highly apparent and attractive stimuli, to other areas such as traps or trap crops where they are concentrated, facilitating their control. The push-pull strategy for cereal stem borers involves trapping stem borers on highly attractant trap plants (pull) while driving them away from the main crop using repellent intercrops (push). Plants that have been identified as effective in the push-pull tactics include Napier grass (Pennisetum purpureum), Sudan grass (Sorghum vulgare sudanense), molasses grass (Melinis minutiflora), and desmodium (Desmodium uncinatum and Desmodium intortum). Napier grass and Sudan grass are used as trap plants, whereas molasses grass and desmodium repel ovipositing stemborers. Molasses grass, when intercropped with maize, not only reduced infestation of the maize by stemborers, but also increased stemborer parasitism by a natural enemy, Cotesia sesamiae.

Key words: Maize, stem borers management, push pull strategy, trap plants, intercrops

03-12

IN VITRO REARING OF TOBACCO CATERPILLAR, Spodoptera litura (FABRICIUS)

Pattapu Sreelakshmi and Thomas Biju Mathew
Kerala Agricultural University, Trivandrum

The present research was aimed to study the development of artificial diet for tobacco caterpillar, Spodoptera litura (Fabricius) and its comparative study with other artificial and natural diets. The results revealed that populations reared on castor based diet showed a significant reduction in total larval period (13.08 days) and total life period (32.66 days) with high development indices and survival per cent (73.26) when compared to populations raised on natural diets.

Keywords: Spodoptera litura, artificial diet, natural diet, mass rearing, tobacco caterpillar

India is an agrarian country with more than 60 per cent of its population directly or indirectly dependent on agriculture which contributes nearly 18% to country’s GDP. However, ensuring food security for a population of more than 1.27 billion with diminishing cultivable land resource is a herculean task. Apart from the contributions of high yielding varieties in the name of green revolution which made a drastic increase of food production, we are still in deficit of 450 million tonnes of food grains to feed 1.65 billion people by 2050. One major constraint in sustainable food production is insect pests which are most dominant species on earth with significant mechanisms for survival of the fittest to the changing evolutionary pattern. By managing the insect pests, we can improve the food production at least by 30 per cent.

Spodoptera litura commonly known as tobacco caterpillar or armyworm or Indian leaf worm or cluster caterpillar is a polyphagous insect pest causing more than 26-100% yield loss in South Asia (Dhir et al., 1992) and enormous loss to many economically important crops worldwide (Qin et al., 2004). In India,
plagues of *S. litura* have been reported in Maharashtra and Rajasthan on soybean (Dhaliwal and Koul, 2010). *S. litura* is cosmopolitan in distribution causing severe damage to more than 100 species of economically important crop plants including pulses, cotton, cabbage, cauliflower, castor, groundnut and oilseed crops (Ahmad et al., 2013). In order to develop sustainable pest management programs, it is highly essential to mass rear the insect to meet the requirement of various bioassay studies. Also, it is important to rear the insects to study their life history, behaviour, feeding habits and their susceptibility and resistance to chemical and biological pesticides. The present research was aimed to study the development of castor based oligidic diet for tobacco caterpillar, *Spodoptera litura* (Fabricius) and its comparative study with other artificial and natural diets.

**Methodology**

The egg mass and larva of *S. litura* collected from the infested vegetable fields of various experimental locations were used for mass rearing on artificial diet. Ingredients of diet-I includes chickpea flour (200g), yeast powder (20g), ascorbic acid (3.5g), methyl-p-hydroxybenzoate (2g), sorbic acid (1g), formaldehyde solution (1.5ml), agar (10g) and 500ml distilled water. Modified diet (diet-II) contained 50 g of dried castor leaf powder, 150 g chickpea flour and added multivitamin capsules while keeping the other ingredients constant. All the dry and wet ingredients of the diet were weighed/measured carefully, and kept in separate containers. Half of the total water was taken in a steel vessel, brought to boil and agar was added. The total quantity of gram flour was added to the boiling agar. Remaining water was poured and stirred continuously to reduce the clump formation. Then, all the dry and wet ingredients were added to the mixture and thoroughly homogenized using blender. The prepared diets were then poured into the sterilized plastic boxes and allowed for solidification. Diet was left over for whole night and used next day for feeding to *S. litura*. The diet was cut into small pieces of size 2 x 2 cm and introduced to the plastic rearing troughs. The *S. litura* larvae were introduced to the diet piece in the trough. The same procedure was used to rear the larvae using diet-2 also. Based on good palatability and reduced duration of life stages, the best diet was selected for further rearing of *S. litura*. Along with two artificial diets, certain natural hosts of *S. litura* like amaranthus, cowpea and castor were also selected for the rearing based on its host preference.

**Results**

The results of the study on duration of life stages of *S. litura* are given in Table 1. Total mean larval duration was found to be the lowest in the case of *S. litura* reared on castor based diet with 13.08 days and was statistically significant. However, total duration observed in the case of larvae fed on diet-1 and castor leaves were 14.50 and 14.08 days, respectively and were statistically on par. Mean duration was the highest in larvae raised on cowpea leaf (20.83) followed by the amaranthus (18.33) and were significantly different.

Pupal duration recorded with castor based diet was 6.41 days and was statistically on par with pupal duration on castor (5.91 days). This was highest in *S. litura* raised on amaranthus cowpea leaves with 8.16 days followed by cowpea with 7.66 days and diet-1 with 6.66 days. Pupal duration of *S. litura* raised on amaranthus leaves was statistically on par with both cowpea and diet-1. The highest longevity of adult (6.33 days) was recorded in *S. litura* raised on castor based diet followed by castor with 6.16 days and diet-1 with 5.83 days and were statistically on par with those reared on diet-2. Longevity of adults recorded on cowpea was 5.50 days and was on par with diet-1 (5.83) and amaranthus (5.00). Lower incubation period was recorded with castor and castor based diet was 3.16 days and 3.25 days, respectively and were statistically equal. Incubation period was found to be higher in *S. litura* raised on cowpea (4.16) followed by amaranthus leaves with 4.00 days and diet-1 with 3.50 days and statistically equal with amaranthus. Lower total life cycle of 32.66 and 33.58 days was recorded for *S. litura* raised on castor based diet and diet-1 and were statistically on par each other as well as with castor. Total life cycle was the highest for *S. litura* raised on cowpea with 37.58 days. Amaranthus and castor recorded the next highest duration of 34.91 and days 34.16 and were statistically on par.
<table>
<thead>
<tr>
<th>Life stages</th>
<th>Mean number of days taken in different diets</th>
<th>CD (0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Diet-1</td>
<td>Diet-II</td>
</tr>
<tr>
<td>First instar</td>
<td>1.75± 0.62 c</td>
<td>1.91± 0.67 bc</td>
</tr>
<tr>
<td>Second instar</td>
<td>2.83± 0.58 bc</td>
<td>1.91± 0.83 c</td>
</tr>
<tr>
<td>Third instar</td>
<td>2.58± 0.67 bc</td>
<td>2.83± 0.83 b</td>
</tr>
<tr>
<td>Fourth instar</td>
<td>2.50± 0.52 b</td>
<td>2.33± 0.65 b</td>
</tr>
<tr>
<td>Fifth instar</td>
<td>2.66± 0.65 a</td>
<td>3.00± 0.43 a</td>
</tr>
<tr>
<td>Sixth instar</td>
<td>2.16± 0.83 bc</td>
<td>1.66± 0.49 c</td>
</tr>
<tr>
<td>Total larval period*</td>
<td>14.50± 2.11 c</td>
<td>13.08± 1.31 d</td>
</tr>
<tr>
<td>Pre-pupa</td>
<td>1.58± 0.51 c</td>
<td>1.16± 0.72 d</td>
</tr>
<tr>
<td>Pupa</td>
<td>6.66± 0.65 b</td>
<td>6.41± 0.67 bc</td>
</tr>
<tr>
<td>Adult</td>
<td>5.83± 0.94 ab</td>
<td>6.33± 0.89 a</td>
</tr>
<tr>
<td>Egg</td>
<td>3.50± 0.67 ab</td>
<td>3.25± 0.45 b</td>
</tr>
<tr>
<td>Total life cycle**</td>
<td>33.58± 2.91 bc</td>
<td>32.66± 2.02 c</td>
</tr>
</tbody>
</table>

Mean ± SD followed by identical letters are not significantly different for comparisons between treatments within each row (P <0.05)
GENOME EDITING FOR CROP DISEASE RESISTANCE

Sandhya, Y., Padmodaya, B and Ranga Rani, A.
Department of Plant Pathology, S.V. Agricultural College, Tirupati.
Corresponding author: ysandhya74.sry@gmail.com

Genome editing with engineered nucleases (GEEN) is an effective genetic engineering method that uses ‘molecular scissors’, or artificially engineered nucleases, to target and digest DNA at specific locations in the genome. Genome editing can modify, remove specific regions and can add transgenes. Genome-editing technology is based on designed nucleases that produce site-specific DNA double-strand breaks (DSBs), that enables precise and efficient targeted genetic modifications in various cells and organisms, including plants. Four kinds of sequence-specific nucleases (SSNs) are currently used in genome editing. Zinc finger nucleases (ZFNs), Transcription Activator-Like Effector Nucleases (TALENs), Meganucleases, CRISPR/Cas system. Transcription activator–like effector nuclease (TALEN) technology were used in hexaploid bread wheat to introduce targeted mutations in the three homoeoalleles that encode Mildew-Resistance Locus (MLO) proteins. TALEN-induced mutation of all three TaMLO homoeologs in the same plant confers inheritable broad-spectrum resistance to powdery mildews. The resistance against Cotton Leaf Curl Disease using CRISPR/Cas9 sgRNA where a Cassette of sgRNA is designed to target not only the whole CLCuD-associated begomovirus complex but also the associated satellite molecules. The strategy provides a comprehensive approach to control CABs and their associated DNA–satellites simultaneously. Among all the nucleases the simplicity and accessibility of the CRISPR/Cas9 technology platform provides many advantages over other genome editing methods. CRISPR/Cas9 system is advantageous over ZFNs and TALENs since it allows simultaneous editing at multiple sites across the genome.

POTY VIRUS THE SEVERE THREAT ON CROP PLANTS

Saratbabu, K., Sayiprathap, R. B., Ganesh, T and Mahendra, K.
Department of Plant Pathology, Agriculture College, Bapatla.
Corresponding author: sarathpatho@outlook.com

The Potyviridae is the largest and economically most important plant virus family with over 200 species described. It constitutes about 25% of known plant viruses and causes substantial losses in crop plants of economic importance such as cereals, millets, fruits, vegetables, sugarcane, oilseeds, ornamentals, fodder and pasture in different parts of the world. Causes devastating yield losses in crop plants as well as fruit crops ranges from 40-100%. The Potyviridae are divided into six recognised genera, namely Poty virus, Bymo virus, Maclura virus, Tritimo virus, Rymo virus and ipomo virus. Members of the poty virus genus are transmitted by aphids in a non-persistent manner and some are also seed transmitted (Bean common mosaic virus). Poty virus named after Potato virus Y (PVY) and it comprise the largest genus of plant viruses. It consist of a single flexuous rod-shaped particle 680 to 900 nanometers long and 12 nanometers in diameter. They have a single positive RNA species (~10kb) and one kind of coat protein subunit. Some of the most important plant diseases caused by Poty viruses are Bean Common Mosaic, Bean Yellow Mosaic, Lettuce Mosaic, Plum Pox, Papaya Ring Spot, Potato Virus Y, Sugarcane Mosaic, Zucchini Yellow Mosaic etc. In India Papaya Ring Spot, Potato Virus Y, Sugarcane Mosaic, Zucchini Yellow Mosaic and Bean Common Mosaic are the main diseases caused by the poty viruses. Symptoms induced by poty virus infections are
generally similar (Shukla et al., 1994). Longitudinal chlorotic or necrotic streaks or both are frequently induced in monocotyledonous plants, while mottling, necrosis and distortion of leaves are common symptoms on dicotyledonous plants. Proper detection is important for development of effective evidence-based disease management strategies. Detection tools so far developed are ELISA, lateral flow immune assay, dot blot hybridization, RT-PCR, Multiplex PCR, Real time PCR and RT-LAMP etc. Management of Poty virus diseases is difficult but development of transgenic crops, cross protection, pathogen derived resistance are some of the alternate ways for controlling of poty virus diseases.

Keywords: Potyviridae, ELISA, PCR, RT-LAMP.

03-15

SCREENING OF RICE GENOTYPES – A MULTIVARIATE APPROACH

Chinni, D., Shaik Nafeez Umar, Srinivasa Rao, V and Venkata Krishna, V.
Department of Statistics & Computer Applications, Ag. College, Bapatla.

Rice (Oryza sativa L.) is the most important cereal food crop in the world and globally around three billion people depend on rice which provides 50 to 80 per cent of daily calories. For meeting the dietary requirements of increasing population, genetic improvement of rice with higher yield, good grain quality, resistance to biotic and abiotic stresses is the most logical and promising approach. Genetic improvement mainly depends upon inclusion of genetically diverse parents having wider variability for different yield and quality characters in hybridization program. The present investigation aimed to assess the nature and magnitude of genetic divergence present in the 48 rice genotypes on plant height, number of ear bearing tillers, panicle length, test weight and grain yield. With the help of different multivariate tools viz., PCA, cluster analysis, factor analysis, path coefficient analysis, D-square analysis etc., the genotypes were analysed and the various multivariate techniques were compared based on the parameters studied. The d- square statistics reveals that there are 11 clusters and the parameter test weight contributed 34.5% and the grain yield contributed 33.7%.

Keywords: Diverse parents, PCA, cluster analysis, path coefficient analysis, D2- analysis.

03-16

SCREENING OF VARIOUS GROUNDNUT GENOTYPES FOR THEIR REACTION TO GROUNDNUT LEAF MINER

Peeru saheb, Y., Hari Prasad, K. V., Swarajya Lakshmi, K and Sailaja Rani, J.
Department of Entomology, S. V. Agricultural College, Tirupati.
 Corresponding author peeru9@gmail.com

Reaction of different genotypes of groundnut, (Arachis hypogaea L.) to groundnut leaf miner was carried out at S. V. Agricultural College, Farm, Tirupathi, Andhra Pradesh during 2014 kharif. Forty one genotypes of groundnut which were procured from Agricultural Research Station, Kadiri and Regional Agricultural Research Station, Tirupathi, were used in the present investigation. From the results of screening experiment the genotypes TCGS-894 and TCGS-1097 were ranked as highly resistant, ASK-2013-1 was ranked as moderately resistant and Narayani, K-1563, K-4 and Dharani were ranked as susceptible towards their reaction to groundnut leaf miner.
EFFICACY OF INSECTICIDES IN MANAGEMENT OF BROWN PLANT HOPPER 
(*Nilaparvata lugens* S.) ON PADDY

**Ambati Gouri Harishchandra Prasad**
Department of Entomology, Agricultural College, Naira.

India ranks first in the world in rice area with 44.3 million ha followed by China with 29.3 million ha. Paddy (*Oryza sativa*) is the second highest produced grain in the world after corn (maize). Rice is the most important grain with regard to human nutrition and calorific intake. This unique grain is the lifeline for nearly two-thirds of the world’s population. Rice cultivation is the principal activity and source of income for about 100 million households in Asia and Africa. Andhra Pradesh has its area 45.63 lakh ha under paddy cultivation contributing 69.1% of total food grain production of state which is lower than the productivity of Punjab. Major paddy growing districts in Andhra Pradesh are Krishna and Godavari delta regions and are called as “Rice Bowls” of A.P.

The major reason for low productivity in India is the losses due to insect pests and diseases. The overall losses due to insect damage in rice have been estimated to be 25%. Paddy is the host for number of insect pests viz., Yellow Stem Borer (*Scirpophaga incertulas* (Walker)), Green Leaf Hopper (*Nephotettix virescens* (Distant)), Brown Plant Hopper (BPH) (*Nilaparvata lugens* (Stal)), Gall midge (*Orseolia oryzae* (Wood – Mason)), Leaf folder (*Cnaphalocrocis medinalis* (Guenee)), Rice Hispa (*Dicradaspa armigera* (Oliver)), Rice Case Worm (*Nymphula depunctalis* (Guenee)), Rice Ear head Bug (*Leptocorisa acuta* (Thunberg)), Grasshopper (*Hieroglyphus banian* (Fabricius)) etc., attack the crop. Among these, sucking insect pest, BPH is major factor of lowering the yield to about 10-70%. It was reported that, about 200 ha of paddy was devastated and 3,250 ha was severely infested during dry season in East Godavari district, also stated that, at high population density hopper burn or complete drying of plant would result upto 60% yield losses in paddy.

In this context, one of the studies conducted at field level observed lowest BPH population (7.50 BPH/hill) at 10 days after spraying and highest yields were recorded with Buprofezin 25 SC @ 1 ml/l and it was also reported that, significantly high mirid bug populations were recorded in Buprofezin (all doses) treated plots. It was observed in another study low BPH population (1.40-1.30 BPH/hill) in a treated plot with new molecule UPI-206 (Flonicamid 50 WG) @ 150g a.i ha⁻¹ in summer 2008 over untreated control (13.40 BPH/hill). In another study that Monocrotophos 40 EC @ 0.04% was most effective in reducing the pest population, being 28.26, 24.73, 21.60 and 18.06 BPH/5 sweeps after 24, 48, 72 and 120 hours of application, respectively. Also it was recorded that maximum reduction in BPH population (3.68 BPH/plant) using Buprofezin @ 825 ml ha⁻¹ followed by Endosulfan @ 2000 ml ha⁻¹ and Chlorpyriphos @ 3750 ml ha⁻¹. In another study conducted at field level during *Kharif* 2008-2009 observed that Ethiprole (0.05 kg a.i. ha⁻¹) and Buprofezin (0.20 kg a.i ha⁻¹) are highly effective against BPH. Also in another study it was observed that, Pymetrozine 50 WG @ 350 g a.i ha⁻¹ is quite promising in reducing BPH population (6.75 BPH/hill) at 7 days after spraying without any phytotoxicity symptoms and produced better yield. In a field experiment to know the efficacy of newer insecticides and botanicals on *N. lugens* population, observed that Buprofezin 25 SC @ 1.0 ml/l recorded the lowest BPH population and higher yields with highest net profit of Rs. 66,128.13 ha⁻¹. In some other study conducted on the field efficacy of newer insecticides against *N. lugens*, in which Buprofezin 25 SC @ 875 ml ha⁻¹, at 7 and 10 days after spraying was found to be at par with Imidacloprid 17.8 SL and were significantly effective than Chlorpyriphos 20 EC. In a field experiment, with novel insecticide Triflumezopyrim (DPX-RAB55) 10.6% SC @ 25 and 35g a.i ha⁻¹ against BPH and recorded to be most effective in reducing BPH population, 0.37 and 0.23 BPH/hill at 15 days after spraying, respectively. A study on bio-efficacy of Buprofezin 25% SC against sucking pests in paddy, recorded that Buprofezin 25% SC @ 225 g a.i ha⁻¹ reduced the pest population (8.06 BPH/hill) and also increased the yield without any effect on...
the natural enemies of BPH. In another study conducted at field level with a premixture of Flubendiamide 4% + Buprofezin 20% SC @ 875 ml ha\(^{-1}\) against BPH for two seasons during, Kharif 2012 and Rabi 2013 and recorded lowest BPH population 5.53 and 3.47 BPH/hill at 20 days after spraying, respectively.

03-18

**EFFECT OF ELEVATED CO\(_2\) ON FEEDING PREFERENCE AND PERFORMANCE OF BEET ARMYWORM, *SPODOPTERA EXIGUA* (NOCTUIDAE: LEPIDOPTERA) ON CHICKPEA**

Divya Bharathi, T., Krishnayya, P. V and Srinivasa Rao, M.
Dept. of Entomology, Agricultural college, Bapatla, Guntur.
Corresponding author: divya.telugu007@gmail.com

Concentration of CO\(_2\) in the atmosphere is likely to increase up to 550 \text{mol mol}^{-1} by the middle of 21\textsuperscript{st} century. Such an increase in the atmospheric CO\(_2\) would affect plant growth and as well the productivity of crop plants. Changes in quality of host plants under elevated CO\(_2\) conditions likely in future can affect the survival, growth and its development and population dynamics of insect herbivores. A field experiment was conducted to examine the growth and development of *Spodoptera exigua* (Hubner) (Noctuidae: Lepidoptera) on chickpea grown under elevated CO\(_2\) (550 ± 25 ppm) and ambient CO\(_2\) (380 ± 25 ppm) conditions in open top chambers at CRIDA, Hyderabad. Under elevated CO\(_2\) conditions the concentrations of nitrogen, amino acids and proteins were lower compared to ambient CO\(_2\) conditions. But the concentrations of carbon, relative proportion of carbon to nitrogen, tannins, total soluble sugars (TSS), starch and carbohydrates were higher under elevated CO\(_2\) conditions compared to that of ambient CO\(_2\) conditions. As a result this alteration in food quality significantly affected the growth parameters of *S. exigua* in the form of increased food consumption, more fed leaf area, gain in larval weight and more faecal matter production due to extended larval duration and pupal duration. This resulted in reduced fecundity, particularly in *S. exigua* raised under elevated CO\(_2\) conditions compared to ambient conditions. Further feeding indices were recorded revealed increased approximate digestibility and relative consumption rate of *S. exigua* under elevated CO\(_2\) condition coupled with reduced efficiency of conversion of ingested food and digested food. As a result, the relative growth rate was decreased under elevated CO\(_2\) conditions. In a nutshell, it can be concluded that elevated CO\(_2\) concentrations altered the quality of chickpea foliage and has the negative effect on the growth and development of *S. exigua*.

**Keywords:** CO\(_2\) concentration, climate change, Spodoptera exigua, chickpea, feeding indices

03-19

**STANDARDIZATION OF LETHAL DOSE OF GAMMA RADIATION AND ITS EFFECT ON GROWTH AND FLOWERING OF TUBEROSE VARIETY ‘HYDERABAD SINGLE’**

Sai Ratna Sharavan, Ch., Swarajya Lakshmi, K., Tanuja Priya, B., Usha Bharathi, T. Ruth, Ch and Reddi Sekhar, M.
Department of Floriculture and Landscape Architecture, Dr. Y.S.R. Horticultural University, College of Horticulture, Anantharajupeta.
Corresponding author: chnani11@gmail.com

Mutation breeding appears to be well standardized, efficient and cost-effective breeding techniques that can be exploited for the creation of novel ornamental cultivars. Tuberose (*Polianthes tuberosa* Linn.) is one of the most important bulbous perennial flowering plant of tropical and sub-tropical areas. In India, it
occupies second position after gladiolus in area and production. To avoid excessive loss of actual experimental materials, radio-sensitivity tests were conducted to determine LD 50 doses before massive irradiation of similar material. Bulbs of Tuberose variety ‘Hyderabad Single’ were exposed to six doses of gamma irradiation (5, 10, 15, 20, 25 and 30 Gy) at BARC, Mumbai and 0 as control was maintained. Significant reduction in vegetative characters was observed with increased dose of gamma irradiation. Bulbs treated with doses 5, 10, 15 Gy and control plants has shown flowering. There was an increase in spike and rachis length for bulbs exposed to 15 Gy and 10 Gy respectively, more number of florets was observed in 5 Gy treatment and maximum floret weight, flower stem diameter and width of corolla tube were recorded for bulbs treated with 15 Gy. The probit analysis based on sprouting percentage and mortality of treated bulbs exhibited that LD 50 value of gamma irradiation for Tuberose var. Hyderabad Single was 20 Gy.

03-20

IN-VITRO EVALUATION OF CONFRONTATION ASSAY OF DIFFERENT ISOLATES OF TRICHODERMA SPP. AGAINST SOROSPORIUM PASPALITHUNBERGII CAUSING HEAD SMUT DISEASE OF KODO.

Jahaar Singh, Ashish Kumar, Jain, A. K and Tripathi, S. K.
Department of Plant Pathology, J.N.K.V.V., College of Agriculture, Rewa, M.P.
Corresponding author: singhjahaar4890@gmail.com

Trichoderma is a genus of fungi that is present in all soils, where they are the most prevalent culturable fungi. Several Trichoderma species to form mutualistic endophytic relationship with several plant pathogens. The isolates of Trichoderma were not only able to parasitize the mycelia of the soil borne pathogens but they were also capable of significantly parasitizing and killing the foliar pathogen like head smut disease causing pathogen. All the 40 isolates of Trichoderma significantly inhibited the growth of S. paspalithunbergii. It was observed that all the isolates of Trichoderma spp. inhibited more than 40% of growth of S. paspalithunbergii after 96 hours of incubation period under confrontation assay. The per cent inhibition ranged from 4.76% to 24.60% after 48 hours of incubation period. However, after 96 hours of incubation period, per cent inhibition ranged from 41.67% to 46.93%. The per cent inhibition was less than 25% after 48 hours of incubation period because of highly slow growing nature of the pathogen. The maximum inhibition in growth of S. paspalithunbergii was recorded in case of isolate T6 after both the incubation periods of 48 and 96 hours. After 48 hours of incubation maximum inhibition percentage of 24.60% was recorded by isolate T6 while minimum inhibition of 4.76% was recorded by isolate T1. Maximum inhibition of 46.93% in growth of S. paspalithunbergii was recorded by isolate T6 after 96 hours of incubation while minimum inhibition of 41.67% was recorded by Trichoderma T23.

Key words: Trichoderma, Sorosporium paspalithunbergii, inhibition percent, biocontrol agent, foliar plant pathogenic fungi.

03-21

IMPROVEMENT OF VEGETABLES FOR HEAT TOLERANCE

Vara prasad, N and Pratyusha, P.
College of Horticulture, Dr. Y.S.R.Horticultural University, V.R.Gudem
Corresponding author: varaprasadchows@gmail.com

Vegetables are rich and comparatively cheaper source of vitamins and minerals, they are called protective foods. Each plant species, more particularly each genotype, has an optimum range of temperatures for its normal growth and development, the temperature moves beyond this optimal range, it generates temperature
stress, i.e., temperature interferes with the performance. Temperature stress may be grouped into the following 3 categories: (1) heat stress, (2) chilling stress and (3) freezing stress.

The temperature is the most important climatic factor influencing sink strength consequently photo assimilate partitioning between the plant organs. Most tissues of higher plants are unable to survive extended exposures to high temperatures.

Total water consumption did not differ among entries but, heat tolerant varieties had greater water uptake than heat sensitive ones at the onset of head formation. Heat tolerant varieties also possessed thicker leaves, higher leaf sap electrical conductivity and chlorophyll content, and lower stomatal number. These characteristics appeared to facilitate water transport to the leaves and reduce transpiration, thus enabling the heat tolerant plants to maintain leaf turgidity during the heading stage at high temperature. Vigorous root growth also seems essential to supply adequate water to the leaves so that they can maintain good turgor at high temperature.

Mechanisms of heat tolerance are (1) heat avoidance-transpiration, leaf reflectance due to pubescence and glaucousness, insulation by bark and (2) heat tolerance- membrane stability, stability of Photo system II, Photosynthetic translocation, osmoregulation, stem–reserve mobilization.

Growth under heat stress, yield under heat stress, flower, fruit, seed, etc. formation and pollen fertility, seed germination under heat stress, recovery after heat stress sensitivity of the photosynthetic process, sensitivity of the photosynthetic process, membrane stability following heat shock are the selection criteria for heat tolerance.

Breeding methods such as Selection, Pedigree method, Population improvement, Inter specific hybridization, Back cross breeding and Biotechnological methods are used to develop heat tolerant varieties.

03-22

**BIO-PHYSICAL AND BIO-CHEMICAL RESISTANCE OF CASTOR GENOTYPES TO THE GREEN LEAFHOPPER, *EMPOASCA FLAVESCENS* FABRICIUS.**

*Mounica, B., Venkateswarlu, N. C., Murali Krishna, T and Sudhakar, P.*

Department of Entomology, S. V. Agricultural College, Tirupati

Corresponding author: bmounica2035@gmail.com

Bio-physical, bio-chemical parameters influencing the castor plant resistance to the green leafhopper (GLH), *Empoasca flavescens* (Fabr.) (Homoptera: Jassidae) has been studied. Analysis was conducted to compare the varietal differences of castor in relation to resistance or susceptibility to attack by GLH. Bio-physical parameters included bloom nature of the genotype, leaf trichome density and colour of the leaf and bio-chemical characters included proteins, phenols, total free amino acids, total carbohydrates in the leaves of castor. Bloom of the genotypes played a major role in imparting resistance. Triple and double bloom genotypes were found to have less number of leafhoppers whereas the genotypes with zero and single bloom have more number of leafhoppers. The selected genotypes of castor did not have any trichomes. Castor genotypes with darker leaves sustained low leafhopper population. Among, bio-chemical constituents, phenol content had significant negative correlation with leafhopper population and hopper burn scores. Total carbohydrates content had significant positive correlation with leafhopper population. Total free amino acids content had significant negative correlation with hopper burn scores. Proteins had no significant association with both leafhopper population and hopper burn scores.

**Key words:** Bio-physical, bio-chemical, green leafhopper Emoasca flavescens.
03-23

**OCCURRENCE OF FUNGAL FOLIAR DISEASES OF BLACKGRAM IN GUNTUR DISTRICT OF ANDHRA PRADESH**

*Gunasri, R., Manoj Kumar, V., Prasanna Kumari, V., Sreekanth, B and Sairam Kumar, D.V.*

Department of Plant Pathology, Agricultural College, Bapatla.
Corresponding author: gunasri.reddi@gmail.com

Blackgram [*Vigna mungo* (L.) Hepper] is one of the important pulse crop which is grown as a source of income and nutrition to billions of people of South and South East Asia. The crop is of special significance in A.P. as it fits well in rice – pulse cropping system as a relay crop particularly in Krishna – Godavari and North Coastal zones. However, the yields have not been consistently good and in some seasons showed a marked decline because of its susceptibility to several diseases (fungal and viral) and pests. Of the foliar fungal diseases, leaf spots caused by *Corynespora cassiicola* and *Cercospora canascens*, powdery mildew caused by *Erysiphe polygoni* and rust caused by *Uromyces appendiculatus* are important yield constraints in blackgram cultivation.

A survey was conducted during rabi 2016-17 in two mandals, i.e., Chebrolu and Guntur mandals of Guntur district for the occurrence of fungal foliar diseases. When scored on a 1-9 scale and expressed as PDI, the occurrence of Corynespora leaf spot was 11.11% (30-35 DAS), 31.89% (40-45 DAS) and 67.27% (50-55 DAS), the occurrence of Cercospora leaf spot was 11.11% (30-35 DAS), 28.88% (40-45 DAS) and 53.70% (50-55 DAS). When scored on a 0-5 scale, powdery mildew PDI at 30-35 DAS was 0.00%, 22.85% at 40-45 DAS and 63.22% at 50-55 DAS and no rust severity was recorded among the surveyed villages.

**Keywords:** Blackgram, cercospora leaf spot, corynespora leaf spot, powdery mildew, rust

03-24

**IMPACT OF ELEVATED CARBONDIOXIDE AND TEMPERATURE ON FECUNDITY OF MAIZE APHID, *RHOPALOSIPHUM MAIDIS* (HOMOPTERA: APHIDIDAE)**

*Mounica, D., Krishnayya, P.V., Srinivasa Rao, M., Anil Kumar, P and Srinivasa Rao, V.*

Department of Entomology, Agricultural College, Bapatla

Climate change is any significant long-term change in the expected patterns of average weather of the earth over a significant period of time. It is about the effects of non-normal variations to climate and other parts of the earth. Climate change scenarios include higher temperatures, changes in precipitation and higher atmospheric CO₂ concentrations. Agriculture is one of the most vulnerable sectors to the anticipated climate change with adverse effect on crop yields. The increased levels of atmospheric CO₂ concentrations can have a direct effect on the growth rate of crop plants. However, insect response to elevated CO₂ may depends on both host plant and herbivore species. Both the concentration of atmospheric CO₂ and temperature have been increasing in the last three decades. In this century, the CO₂ concentration has been predicted to be doubled and the temperature may increase by 2°C (IPCC, 2017). Feeding trials were conducted by adopting cut leaf method. *R. maidis* fecundity increased with increased temperatures at 20°C (37.8 nymphs/female) to 27°C (77.12 nymphs/female) and decreased at 33°C (14.36 nymphs/female) & 35°C (3.56 nymphs/female) under eCO₂ conditions over ambient CO₂. The predicted changes in temperature and CO₂ concentration affect the population dynamics and the status of insect pests of various crops.
03-25

BIOEFFECTICITY OF NEW INSECTICIDAL MOLECULES AGAINST
SUCKING PESTS OF OKRA

Hemadri, T and Vijaykumar, L.
Department of Entomology, College of Agriculture, UAS, Bangalore
Corresponding author: hemadri.smily123@gmail.com

The bio-efficacy of new insecticide molecules against sucking pests of okra (Leafhopper, Amrasca biguttula biguttula; aphid, Aphis gossypii; Whitefly, Bemisia tabaci) was conducted during summer 2015 under Randomized Block Design (RBD) at College of Agriculture, V.C. Farm, Mandya with 10 treatments including an untreated control and were replicated thrice using a popular and susceptible okra variety Arka Anamika. Among eight new insecticide molecules evaluated for their bioefficacy under field conditions along with standard check i.e. oxydemeton methyl 25 EC and an untreated control, the foliar sprays of imidacloprid 17.8 SL @ 0.5 ml/l and acetamiprid 20 SP @ 0.5 g/l were found to be most effective against sucking pests. However, both seed coating chemicals viz., imidacloprid 17.8 SL seed coating @ 4:20 ml/kg and thiamethoxam 25 WG seed coating @ 2:20 ml/kg were found least effective against sucking pests compared to standard check and these two chemicals were found superior over untreated control. All the new molecules were found safe to natural enemies. The result on the cost economics of sucking pests management revealed that, among the treatments the highest yield (79.35 q/ha) was recorded in imidacloprid 17.8 SL @ 0.5 ml/l. This was followed by acetamiprid 20 SP @ 0.5 g/l and thiamethoxam 25 WG @ 0.3 g/l, which recorded 69.24, 65.42 quintal/hectare respectively. Among the treatments the highest net profit (Rs. 130300) was recorded in imidacloprid 17.8 SL @ 0.5 ml/l. This was followed by acetamiprid 20 SP @ 0.5 g/l which recorded (Rs. 110980/ha) and thiamethoxam 25 WG @ 0.3 g/l (Rs. 102760). Among the treatments the highest cost benefit ratio (1: 4.59) was recorded in imidacloprid 17.8 SL @ 0.5 ml/l. This was followed by acephate 95 SG @ 0.3 g/l, and acetamiprid 20 SP @ 0.5 g/l which recorded 1: 4.05, 1: 4.04 respectively.

Keywords: New molecules, sucking pests, natural enemies, okra.

03-26

IMPORTANCE OF REFUGE PLANTS FOR NATURAL PEST CONTROL IN MAIZE CROP

Ravi Kumar, V.
Department of Entomology, Agricultural College, Bapatla.
Corresponding author: vanamaravikumar76@gmail.com

The use of carefully selected non-crop plants to provide the resources that herbivorous crop pest’s natural enemies need is being increasingly incorporated into integrated pest management programs. Refuge plant species Foeniculum vulgare and Gossypium barbadense that are planted next to a maize crop favoured natural control of herbivores considered as pests of maize. F. vulgare and G. barbadense are the most effective refuges, showing the highest richness and abundance of both predators and parasitoids, including several insect species that are reported to attack the main insect pests of maize [Spodoptera frugiperda (J.E.Smith) and Rhopalosiphum maidis (Fitch)], as well as other species that serve as alternative hosts of these natural enemies. In these refuge plant species, parasitoid Hymenoptera are found more frequently because of having extrafloral nectaries in their bracts. Adults of many insects, especially Hymenoptera, need nectar to complete their diet and assist with the energy requirements for flight. Additionally, it has been shown that extrafloral nectaries may induce higher longevity and parasitization rates and they are available for longer periods of time than floral nectar. Despite promising results reporting the role of extrafloral nectaries on
herbivore suppression (or, at least, on attracting predators and parasitoids), these refuge plant resources are not widely used. Farmers are still reluctant to incorporate agroecological practices, and very large amounts of pesticides are being applied to maize crops. Hence there is an urgent need to improve the efficiency of different agroecological methodologies to control maize pests.

**Key words:** Maize, refuge plants, pest control, agroecological practices

03-27

**PROVING PATHOGENICITY OF USTILAGINOIDEA VIRENS IN RICE AN INCITANT OF RICE FALSE SMUT AND STUDY OF ITS CULTURAL AND MORPHOLOGICAL CHARACTERS**


Indira Gandhi Krishi Vishwavidyalaya, Raipur.

Corresponding author: ladhasavitha@gmail.com

False smut of rice is caused by *Ustilaginoidea virens* (Cke.) Tak. (teleomorph: *Villosiclava virens* (Nakata) Tanaka & Tanaka) has become an important grain disease causing significant yield losses in major rice producing states of India. *Ustilaginoidea virens* was successfully isolated from smut balls of infected rice grains. To prove the pathogenicity, the pathogen was inoculated in potato sucrose broth and incubated in an incubator shaker at 125 rpm at 28°C for 2 weeks. Conidia were harvested and plants (TN 1) at booting stage were selected for inoculation and injected with 2 ml of conidial suspension (2×10^5 conidia ml^-1). Artificially inoculated plants produced typical smut balls under glass house condition. Thirty isolates of *U. virens* were collected from central, east and north-east states of India and subjected to cultural and morphological studies. All the collected isolates were confirmed with specific *U. virens* ITS primers and the isolates produced an amplicon of 360 and 280 bp. The results revealed that *U. virens* is a slow growing pathogen and the colony diameter ranged from 41.50 mm to 74.25 mm after 30 days of inoculation. Colony colour in most of the isolates was initially white, then changed to yellow and finally green. The isolates varied in the growth pattern. Secting in mycelial growth was observed in twelve isolates and other characters *viz.*, zonation, sector formation, furrow formation and chlamydospore formation were also varied between the isolates. Using cluster analysis, isolates were grouped into two major groups (I, II), in which the first major group (I) included 12 isolates, which are further divided into two subgroups. The first sub group (Ia) included nine isolates and second sub group (Ib) included three isolates. Similarly, the second major group (II) included a total of 18 isolates, which were divided further into two subgroups, subgroup (IIa) included 10 isolates and second subgroup (IIb) included eight isolates. Scanning Electron Microscope study on chlamydospores revealed that the shape of the chlamydospore was varied from globose to irregularly round with prominent spines on the outer surface and conidia were oval to elliptical in shape.

03-28

**DEVELOPMENT OF IN VITRO TECHNIQUE TO SCREEN FOR DROUGHT STRESS TOLERANCE IN (MUSA ACUMINATE AAA, GRAND NAIN) BY PEG INDUCED OSMOTIC STRESS**

Viswanath, M.

College of Horticulture, Dr. YSR Horticultural University, V.R.Gudem.

Corresponding author: vikkywikram513@gmail.com

Bananas are crops of vital importance to hundreds of millions of people in developing countries. The major constraints for banana production are largely dominated by biotic and abiotic stresses. Drought stress
remains an ever-growing environmental problem that severely limits crop production worldwide and causes important agricultural losses particularly in arid and semiarid areas. The successful cultivation of water-loving Cavendish clones, in drought-prone areas with protected irrigation, has provided the sufficient momentum to research on drought in bananas. Tissue culture is a novel technique that enabled the evaluation of tolerance to environmental stresses because it allowed their manipulation in vitro. The study investigated the adverse effects of drought stress on growth, yield and endogenous phytohormones of the Cavendish banana, and focused on the progress towards the development of stress tolerant lines through tissue culturing based on in vitro selection. Drought stress was induced by applying Polyethylene Glycol (PEG) solutions with elevated strengths of (1, 2 & 3%). Tolerance effect was acquired by pre-treating the plantlets with trehalose using different concentrations (20, 60 & 100 mM), to test which concentration provides the most eminent outcome. Results exposed that trehalose has positive significant effects combating drought stress.

03-29

HOST PLANT RESPONSES TO INSECT OVIPOSITION

Neethu Natarajan, Pranyusha, B and Chennarao, P.
Department of Entomology, Agricultural College, Bapatla.
Corresponding author: neethujan4@gmail.com

Plants can respond to insect egg deposition and thus resist attack by herbivorous insect from the beginning of the attack i.e egg deposition. Plants take insect eggs deposited on leaves, as a warning of future herbivory and intensify their defense against feeding larvae by shifting the quantitative nutritional pattern of egg deposited leaves. Egg-induced plant defense strategies directly targeting the eggs laid by insects include plant-mediated desiccation of eggs, egg dropping, egg crushing and egg killing. Formation of Neoplasm and Hypersensitive Response (HR) in plants is caused by egg deposition. Hypersensitive Response-like symptoms induced by a planthopper’s egg deposition (Sogatellafurcifera, Nilaparvatalugens, and Laodelphaxstriatellus) are accompanied by the formation of watery lesions and production of ovicidal compounds like benzyl benzoate in rice. In several insect species, exocrine secretions coating the eggs elicit defensive plant responses.

Indirect plant defense responses towards egg deposition do not affect the eggs or hatching larvae directly, but employ the third trophic level. Changes in plant’s volatile emission induced by insect egg deposition are known to attract parasitoids and thus defend the plant against herbivores. Both jasmonic acid and salicylic acid pathways play a role in induction of defense response in plants, which majorly depend on the oviposition and also gave the complexity of plant-egg interactions in an on-going arms race between herbivores and their host. Plants release volatiles induced by herbivore feeding that may affect the diversity and composition of plant-associated arthropod communities.

Keywords: egg deposition, egg-induced plant defense, plant volatiles.

03-30

EFFECT OF MICRO NUTRIENTS ON URDBEAN LEAF CRINCKLE DISEASE

Usha Rani, L., Manoj Kumar, V., Anil Kumar, P., Prasanna Kumari, V. Bhavani·G and Sandhya Rani, C.
Department of Plant Pathology, Agricultural College, Bapatla.
Corresponding author: usharoolekkala2@gmail.com

Blackgram [Vigna mungo (L.) Hepper] is an important short duration pulse crop grown in Krishna-Godavari and North Coastal zones of A.P as a relay crop in rice–pulse cropping system. However, the yields have not been consistently good and in some seasons showed a marked decline because of biotic stress
associated with fungal, bacterial and viral diseases resulting in heavy yield losses. Of the several viral diseases occurring in this zone, leaf crinkle disease is important. Among the viral diseases, Urdbean Leaf Crinkle (ULCD) is considered to be the most serious causing considerable damage (35-81% yield loss) to the crop depending on season and variety. Urdbean leaf crinkle disease (ULCD) is the most common disease occurring in all seasons and cultivated varieties in all the urdbean growing provinces of India and was reported to be transmitted by important insect pest of blackgram viz., whiteflies and aphids and seed. It is necessary to find alternate means of managing the disease, as no chemical management is possible other than spraying insecticides for vector management. The literature available on using micronutrients for managing the diseases is reviewed and presented herewith.

Spraying of the micronutrients mainly ZnSO₄, MgSO₄ are said to be more effective and showed a good result on urdbean leaf crinkle disease (ULCD). These micronutrients mainly masking the ULCD and allow the plant to metabolize normally. The disease incidence is said to be less in summer crop.

**Keywords:** Blackgram, micronutrients, spraying, ULCD

---

**03-31**

**CURRENT SCENARIO IN GLOBAL CLIMATE CHANGES AND ITS EFFECT ON EFFICACY OF INSECTICIDES**

*Deekshita, K., V.Krishnayya, P., Srinivasa Rao, M., Anil Kumar, P and Shaik Nafeez Umar*

Department of Entomology, Agricultural College, Bapatla.
Corresponding author: deekshitakonchada@gmail.com

Agriculture yields strongly depends on the crop protection measures. Due to reshape in climate not only crop yields but also pesticide use is expected to be affected. Future agriculture will inevitably face challenges caused by climate change, which might lead to both global and local alterations. Intergovernmental Panel on Climate Change IPCC, 2007 predicted that the global average surface temperature will increase by 1.4 – 5.8 °C with the increased atmospheric carbon dioxide (CO₂) from 550 to 970 ppm by 2100. The principal drivers of climate change are increased carbon dioxide and temperature. Higher temperatures and increased CO₂ concentrations, associated with a considerable change in photosynthetic activity, promote plant growth and expansion which results in dilution of the absorbed pesticide concentration in plants and decreases the pesticide residues. Increase in precipitation may lead to rapid dissipation of insecticide residues for which more frequent application is needed. In field, temperature has a prominent effect on insecticide effectiveness. It also plays a critical role to control toxicity of microbial insecticides which are highly sensitive to the environment. The study conducted at ICAR- Central Research Institute for Dryland Agriculture demonstrated the toxicity of spinosad (a microbial insecticide) against Spodoptera litura was decreased by 5.12 fold from 27 to 36æ%C. Similarly increase in carbon dioxide also results in decrease in mortality of S.litura (LC₅₀ – 0.031 and 0.059 at 380 and 550 ppm respectively). In general a warmer climate may necessitate an increased pesticide usage due to voltalisation, degradation and chemical alteration of pesticides. So there is an urgent need to assess the efficacy of various insecticides under diverse environmental conditions, and develop appropriate strategies for pest management to mitigate the adverse effects of climate change.

**Keywords:** Carbon dioxide, climate change, temperature, pesticide, precipitation
Indian pulses account for 20% of the area under food grains and contribute around 7-10% of the total food grains production in the country. Pulses are grown in the semi-arid regions under wide agro-climatic conditions of India. The commonly grown major pulse crops in India are pigeonpea, greengram, blackgram, chickpea, horsegram, and cowpea. The major pulses producing states are Madhya Pradesh (25%), Uttar Pradesh (13%), Maharashtra (12%), Rajasthan (11%), Andhra Pradesh (9%) and other states together (30%). Among major constraints known to limit the yield of grain legumes, insect pests are main factors of which spotted pod borer (*Maruca vitrata*), whiteflies (*Bemisia tabaci*), thrips (*Caliothrips indicus*), aphids (*Aphis craccivora*), and leafhopper (*Empoasca kerri*) were recorded as major pests of pulses.

**SEASONAL INCIDENCE**

Climate change impact on the pests population include change in phenology, distribution, community composition and ecosystem dynamics that finally leads to extinction of species (Walter *et al.*, 2002). Incidence and development of insect-pests are very much dependent upon prevailing environmental factors such as temperature, relative humidity and precipitation. Hence they prefer particular environmental conditions for their survival in a particular host. When some insects prefer cool and humid conditions as optimum for their growth and development there are some others which thrive well under dry and high temperature conditions. In this regard, it is essential to study the pattern of seasonal incidence of major pests infesting the crop and their preferable environmental conditions as this will help in their management, if tackled in the right way.

Larval population of spotted pod borer, *Maruca vitrata* on redgram showed significant positive correlation with minimum temperature and minimum relative humidity (Kuldeep Saxena and Ram Ujagir, 2007). Umbarkar *et al.* (2010) reported that the population of spotted pod borer started appearing from 5th week after sowing and peak pest density was observed during 7th week after sowing in greengram at Junagadh. The larval population of spotted pod borer showed significant negative correlation with minimum temperature (Thejaswi *et al.*, 2008; Shivaraju *et al.*, 2008; Chittibabu *et al.*, 2009; Umbarkar *et al.*, Sonune *et al.*, 2010), significant positive correlation with rainfall (Gopi *et al.*, 2008) and morning relative humidity (Chittibabu *et al.*, 2009) in blackgram. Yadav and Singh (2013) recorded the incidence of spotted pod borer in mungbean from 33rd standard week which attained a peak of 2.4 larvae per plant during 36th standard week. Sujithra and Chander (2014) reported that the 38th and 39th standard weeks were found to be more congenial for the attack of spotted pod borer and recorded 8.10 and 17.77 larvae/plant and 9.7% pod damage. In another filed study, high population of 3.49 whiteflies/leaf was observed during 39th standard week and showed non-significant negative correlation with sunshine hours while rainfall, temperature (minimum and maximum), relative humidity (morning and evening) and wind velocity showed a non significant positive correlation (Yadav *et al.*, 2015). Manoj and Singh (2016) revealed that highest mean population of whiteflies, thrips and leafhoppers were recorded at 37th and 36th standard week and the correlation coefficient of whiteflies and leafhoppers were found significant positive correlation with minimum temperature.
PERCENT DAMAGE

On an average, 2.5 to 3.0 million tonnes of pulses are lost annually due to pest problems in India (Rabindra et al., 2004). Among the sucking pests whitefly is a potential vector of mungbean yellow mosaic virus and cause losses ranging from 30-70% (Swaminathan et al., 2012). Sreekanth (2002) reported that thrips caused at least 40 per cent yield loss in greengram. Among the podborers, spotted pod borer (Maruca vitrata) is a major constraint for the production of pulses at critical flowering and pod formation stages in the Southern Zone of Andhra Pradesh (Chandrayudu et al., 2008). The yield losses caused by M. vitrata have been estimated to be around 30 million dollars annually in India (Saxena et al., 2002). Hence there is a need for the usage of novel insecticides with specific modes of action to combat the major insect pests on grain legumes.

INSECTICIDAL MANAGEMENT

Several reports were available on the insecticidal management of major insect pests on pulses at different locations. Newer insecticides such as Spinosad 45 EC @ 0.4 ml/l and Indoxacarb 14.5 EC @ 0.4 ml/l recorded the lowest pod damage by spotted pod borer in pigeonpea (Rao et al., 2007). Mallikarjuna et al. (2009) recorded the highest larval reduction of pod borers with Flubendiamide 480 SC and Thiacloprid 48 SC followed by Enameectin benzoate 5 SG and Indoxacarb 14.5 SC in dolichos bean. Ashok Kumar and Shivaraju (2009), Mahalakshmi et al. (2012) reported that Thiodicarb and Flubendiamide can be used in controlling the spotted pod borer in blackgram. Sonune et al. (2010) observed that Spinosad 0.009% and Lambda cyhalothrin 0.005% were effective in reducing the larval population of M. vitrata and also reduce the pod damage of blackgram. Chlorantraniliprole 18.5 SC and Flubendiamide 39.5 SC, followed by Spinosad 45 SC (6.21%) showed the lowest percent inflorescence damage due to Maruca (Sreekanth et al., 2015). Gailee et al. (2015) revealed that seed treatment with Thiamethoxam 25 WG @ 3 g/kg of seed + spray with Thiamethoxam 25 WG @ 0.4 g/l were found to be effective against sucking pests and borers of blackgram. Spinosad 45 SC at two concentrations i.e. @ 60g and 70g a.i ha⁻¹ was effective in controlling sucking pests such as thrips, aphids, jassids, whitefly and pod borer at Pantnagar (Lalbalu et al., 2016). Neonicotinoid insecticides like Thiamethoxam 25% WG and Thiacloprid 21.7% SC were found effective in reducing the populations of whitefly, thrips and aphids on urdbean at Madhya Pradesh and Anand (Indrajeet et al., 2017; Sujatha et al., 2017).

CONCLUSION

Studies on seasonal incidence provide information on fluctuation in population density of the pests as well as peak occurrence of pests during the crop growth and hence, the pest population can be effectively managed with minimum cost.
from transplanting till harvest is most significant. The major insect pests viz., diamondback moth (DBM), (*Plutella xylostella* (L.)), cabbage leaf webber, (*Crociodolomia binotalis* (Zell.)), tobacco caterpillar, (*Spodoptera litura* (Fab.)) and mustard aphid, (*Brevicoryne brassicae* (L.)) etc., attack these crops. Among these, DBM has become the most notorious and pernicious pest on cruciferous crops and enjoys worldwide distribution. The damage caused by DBM has been estimated globally to the tune of US$ 1 billion in direct losses and control costs (Grzywacz et al., 2010). It is believed to have originated in the Mediterranean area and is cosmopolitan in distribution infesting cabbage, cauliflower, radish, turnip, mustard and amaranthus etc. Among these, cauliflower and cabbage are the most preferred host plants as their fleshy and succulent leaves provide necessary olfactory and gustatory stimuli for successful selection and colonization.

Population of DBM is influenced by abiotic factors including temperature, rainfall and humidity etc. Alam et al. (2016) reported that the population of DBM commenced from 49th standard week and peak larval density was recorded during second week of January and last week of December. Larval population showed a significant positive correlation with temperature and a significant negative correlation with rainfall and relative humidity. Bashir et al. (2015) have recorded highest mean population of larvae and pupae (4.75±2.14 and 6.7±1.71) per plant in September whereas lowest (0.2±0.41 and 0.4±0.71) in July, during an experiment on population dynamics of DBM from June to November at Peshawar, Pakistan. A negative non-significant correlation and positively non-significant correlation was recorded with maximum and minimum temperatures, respectively; positively significant with relative humidity and negative correlation with rainfall. Vanlaldiki et al. (2013) studied the effect of staggered planting on seasonal incidence of DBM during *Rabi* season in Imphal and reported a peak larval population at the end of March and declined gradually by the end of April. A significant positive correlation was observed between the larval population of DBM and max. and min. temperatures; negative correlation with relative humidity, total rainfall and bright sunshine hours. Experiment by Marchioro and Forester (2011) in Southern Brazil revealed that temperature plays an important role on development and survival of the DBM and temperature differences affect the number of generations resulting differences in the population levels. Ahmad and Ansari (2010) have studied the seasonal incidence of DBM at three localities of Aligarh and recorded an average density of DBM on the last week of August. Rainfall negatively affected the population of DBM. Seasonal incidence of cabbage pests in relation to weather in Pune showed a positive correlation between temperature (*T*<sub>max</sub> and *T*<sub>min</sub>) and DBM populations (Palande et al., 2004).

Different control measures are recommended to manage this pest among which chemical control is also important. Many researchers tested different chemical insecticides for the management of DBM. Yadav et al. (2017), Dotasara et al. (2017), Venugopal et al. (2017), Stanikzi and Thakur (2016) reported that Spinosad 45 SC was found to be the most effective insecticide in reducing the larval populations among different insecticides evaluated. In the studies conducted by Sharma et al. (2017) on the bioefficacy of different insecticides against DBM in Rajasthan revealed that Spinosad 48 SC was found to be the most effective insecticide reducing the pest population to an extent of 94.33 per cent. Selvaraj and Kennedy (2017), Mandal and Mandal (2009) conducted field experiments at Tamil Nadu and Bihar respectively on bio-efficacy of new generation insecticides on DBM and reported that Cartap hydrochloride 50 SP @ 450 g a.i ha<sup>–1</sup> was found effective in reducing the larval populations. Patra et al. (2016) have recorded lowest percentage of DBM damage on cabbage against Chlorfenapyr 10 SC followed by Pyridalyl 10 EC and Indoxacarb 14.5 SC in West Bengal. Among different insecticides evaluated, Profenophos 50 EC was effective in reduction of pest populations followed by Bifenthrin 10 EC (Reddy, 2014). Senguttuvan and Kuttalam (2013) evaluated the biological efficacy of Lufenuron 5.4 EC at 20, 30, 40 and 60 g a.i ha<sup>–1</sup> against DBM at Coimbatore and reported that it was effective @ 60 g a.i ha<sup>–1</sup> in controlling the larval population.

Since the degree of incidence of DBM changes with season, it is desirable to have a thorough understanding of the seasonal incidence of the pest, which will lead to the development of suitable management practices. Among them, chemical control is one of the best management practices for controlling the pest.
populations because of their easy adoption, effectiveness and immediate control. But the general use pattern of insecticides has been widely changing over geographical locations and decades due to loss of usefulness of older insecticides and development of more effective insecticides. This is due to the indiscriminate use of insecticides by the farmers and development of resistance by DBM, which has a long history of eventually becoming resistant to every insecticide used extensively against it.

The judicious use of chemicals with novel mode of action needs to be implemented to manage this insect pest. The novel insecticides in conjunction with other IPM approaches may play a pivotal role in devising effective management strategy against DBM.

03-34

IMPACT OF CLIMATE CHANGE ON INSECT PESTS

Lochala Sangeetha
Department of Entomology, Agricultural College, Naira.

Climate change, especially rise in temperature and atmospheric carbon dioxide (CO₂) concentration, is a major concern today. According to Intergovernmental Panel on Climate Change (IPCC), it is defined as “Change in climate overtime, either due to natural variability or as a result of human activity”. The global average surface temperature will increase by 1.4 – 5.8°C with the increased CO₂ from 550 to 970 ppm by 2100 (IPCC, 2007). Insects are among the groups of organism most likely to be affected by climate change because climate has a strong direct influence on their development, reproduction and survival. Insects have short generations time and high reproductive rates, so they can more like to respond quicker to climate change than long-lived organisms, such as plants and vertebrates (Menendez., 2007). However, improved techniques for managing pests require weather and insect data from thorough monitoring as well as climate information and forecast to determine their suitability. Climate change resulting in increased temperature could impact crop pest insect populations in several ways.

Mainly increase in temperature and atmospheric CO₂ can influence growth and development of herbivore insects either directly or indirectly. Temperature is probably the single most important environmental factor influencing insect behaviour, distribution, development, survival, and reproduction. The effect of temperature on insects largely overwhelms the effects of other environmental factors (Bale et al., 2002). The alternation in food quality under elevated CO₂ i.e., decreased foliar N and increased C: N ratio, affects the herbivores in the form of increased consumption, reduced growth rates and extension of larval durations (Rao et al., 2012). Since CO₂ and temperature have strong and contrasting effects on plant productivity and may alter both the nutritional and defensive composition of plant tissues and thus insects.

Elevated CO₂ levels significantly alter the quality of castor foliage resulting in higher consumption by larvae, longer time to pupate and reducing the fecundity of adults over generations (Srinivasa Rao et al., 2013). Rachappa et al. (2016) observed that there is positively significant correlation with maximum temperature and negatively significant correlation with rainfall and relative humidity. The foliar chemistry of chickpea under elevated CO₂ revealed low nitrogen and high carbon content with increased C: N ratio significantly affected the growth parameters of Helicoverpa armigera (Hub.) in the form of increased consumption, reduced growth rates and extension of larval duration. Further, reduction in fecundity (535 eggs/ female) was also observed in the individuals raised under elevated conditions compared to ambient situations (580 eggs/female) (Khadar et al., 2014). For every 1°C ambient temperature rise there is decrease in winter mortality of about 16.5% in Nezara viridula paving the way for the bug population increase (Kiritani, 2006). The elevated CO₂ level decreases the emission of Jasmonic acid regulated terpene volatiles that reduced the searching efficiency of the parasitoid, Cotesia plutellae (Vuorinen et al., 2004).
Increased precipitation from June to August in some of the gregarization zones of locust in Central Sahara would benefit the desert locust (Hulm et al., 2001). Manikandan et al. (2015) reported that the growth parameters were observed to decrease at 36°C, which reveals that the temperature increases above 34°C is detrimental to the development of BPH. Manikandan et al. (2013) observed the effect of temperature on egg hatching and development time of brown plant hopper and reported that the temperature above 32.7°C was detrimental for the oviposition by BPH females.

Conclusion

Insects evolved 500 million years before and still now the process of co-evolution of insects with the host and abiotic factors is going on. The rapid climate change also influences the insect evolution and makes its adoption to climate change an indispensible thing in its evolution as the insect migration largely depends on the abiotic factors such as temperature, relative humidity, wind currents, direction and rainfall. The insect migration in the pretext of climate change will result in arrival of new insect pest to new geographical region. Thus the insect migration and behavior needs to be studied in an extensive manner in the changing climate scenario.

03-35

**CITRUS TRISTEZA VIRUS AND HAUNGLONGBING (CITRUS GREENING) TWO MAJOR BIOTIC THREATS TO CITRICULTURE.**

Ganesh, T., Sarathbabu, K., Mahendra, K and Lakshmi Narayana, U.
Department of Plant Pathology, N.S. Agricultural College, Markapur.
Corresponding author: ganeshpatho71@gmail.com

Citrus is the important fruit crop belongs to the family Rutaceae. Among many reasons that leading to citrus decline, the diseases (biotic causes) are the major contributors. Among the diseases, *Citrus tristeza virus* (CTV) and Huanglongbing (HLB) are the most lethal, dreadful and important disease of citrus which causes significant yield loss and leading to the death of millions of the citrus trees (Das, 2007; Charith et al., 2010). *Citrus tristeza virus* is the most important viral pathogen under the genus *Closterovirus* in the family *Closteroviridae* and the members of this family are characterized by the long, flexuous and thread like particles with 10-12nm x 2000nm, with single stranded positive sense RNA as genome (monopartite), with 12 ORF’S (Karasev et al., 1995) encoding at least 19 proteins (Bar-Joseph and Dawson, 2008) and about 95% of the genome of CTV is encapsidated 25 kDa major CP (Ahlawat and Pant, 2003) and transmitted by citrus brown aphid (*Toxoptera citricidus*) in a semi-persistent manner (Moreno et al., 2008; Gottwald, 2010; McClean, 1957). The causal agent for HLB is ‘*Candidatus Liberibacter asiaticus*’ (*Ca Las*) which is a heat tolerant form and most destructive pathogen to citrus. *Ca Las* is a fastidious, unculturable, phloem limited gram negative bacterium (Subandiyayah et al., 2000) belongs to the á-subdivision of the phylum Proteobacteria (Jagoueix et al., 1994), transmitted by the vector asian citrus psyllid (*Diaphorina citri*) (Capoor et al., 1967; Halbert and Manjunath, 2004; Das et al., 2007). The different detection methods like ELISA, RT-PCR (for CTV), PCR and LAMP (for HLB) were standardized and used by the earlier researchers for detection. The vector management, using of certified seedling materials and the early detection of these two dreadful pathogens by using the molecular tools like RT-PCR & PCR for CTV and HLB respectively will helpful for planning the efficient management strategy.

**Key words:** Citrus decline, CTV, HLB, RT-PCR, PCR.
GENETICALLY MODIFIED CROPS AND ITS ECONOMIC, NUTRITIONAL, ENVIRONMENTAL IMPORTANCE IN INDIAN PERSPECTIVE

Nayak, B. B., Bharathi, S., Sree Rekha, M and Jayalalitha, K.
Department of Agronomy, Agricultural College, Bapatla.
Corresponding author: nayak.96agri@gmial.com

Genetically modified (GM) crop Technique is a biotechnological tool in this plants one or more genes coding for desirable traits have been inserted. The genes may come from the same or another plant species or from totally unrelated organisms. The traits targeted through genetic engineering are obtained the same as those pursued by conventional breeding. However genetic engineering allows for direct gene transfer across species boundaries, some traits that were previously difficult or impossible to breed can now we developed with relative ease.

At global level, genetic engineering methods were developed over 30 years ago, and since then GM crop have become commercially available and widely adopted. Farmers have widely adopted GM technology although certain coercive groups have acted as catalyzing forces in their respective domains to press hard for legal official sanction. Global area under cultivation of 11 GM crops increased 110 fold from 1996 to 2016 i.e. 1.7 million hectares to 185.1 million hectares in last 21 years, in 30 countries 22 were developing countries and 8 were developed countries. India ranked fourth in the area under global GM crops presently only one GM crop Bt cotton under cultivation it occupies 11.6 million hectare area. (International service for the acquisition of agri-biotech applications (ISAAA, 2016).

The introduction of semi-dwarûng, high-yielding and nutrients-responsive crop varieties in the 1960s and 1970s alleviated the suffering of low crop yield, food shortages and epidemics of famine in India and other parts of the Asian continent. In contrast, the revolutionary new genetics of crop improvement shamble over formidable obstacles of regulatory delays, political interferences and public misconceptions. India beneûted immensely from the green revolution and is now grappling to deal with the nuances of GM crops. The Green Revolution, which brought together improved varieties, increased use of fertilizer, irrigation and synthetic pesticides, is credited with helping to feed the current global population of 6 billion. The ability of pesticides to reduce crop losses, it also discusses their potential negative effects on public health, with particular emphasis in developing countries, and the environment. The response of the agricultural industry in bringing forward new technology such as reduced application rates of targeted pesticides with lower toxicity and persistency is noted.

However, with increasing world population, a slowing of the rate of crop improvement through conventional breeding and a declining area of land available for food production there is a need for new technologies to produce more food of improved nutritional value in an environmentally acceptable and sustainable manner.

India’s policy on GM crops has undergone various shifts. Indian government has set up a regulatory structure to screen GM products and showed interest in agricultural biotechnology as early as the 1980’s. The first application for commercialization of a GM crop was accepted in 1996, but it was 8 eight years later i.e., in 2002 that the first GM crop, Bt cotton was introduced (for control of bollworm complex) the major pest heliothis has developed many fold resistance to the pesticides and at that time total cotton industry was under big stress. In 2005 more applications for Bt cotton were cleared, but no other GM crops has been approved. Approximately, 11.6 million hectares of GM cotton grown in India as of 2016. The future of biotechnology in India is continued to be a source of debate. The government has recently released a draft biotechnology development strategy outlining the agricultural biotechnology as potential for India’s development.
The potential impacts of genetically modified (GM) crops on income, poverty and nutrition in developing countries especially under Indian context continue to be the subject of public controversy. As an example of GM technology at initial period, the effects of insect-resistant \textit{Bt} cotton are analyzed. \textit{Bt} cotton has already been adopted by millions of small-scale farmers, in India, China, and South Africa among others. On an average, farmers benefit from insecticide savings, higher effective yields and sizeable income gains. Insights from India suggest that \textit{Bt} cotton is employment generating and poverty reducing. In addition to insecticide reductions, a major effect of \textit{Bt} cotton in India is a sizeable yield advantage due to lower crop losses (Qaim and Zilberman, 2011). Over the years, average yields were 30–40\% higher on \textit{Bt} than on conventional plots, which is due to more effective pest control and thus a reduction in crop damage. These are large benefits for cotton-producing households in India, many of whom live near or below the poverty line. Extrapolating these profit gains to the total area under \textit{Bt} cotton in India (11.6 million ha, 2016) implies an additional 1.13 billion US$ per year in the hands of smallholder farmers.

On a global basis GM technology has reduced pesticide use, with the size of the reduction varying between crops and the introduced trait. It is estimated that the use of GM soybean, oil seed rape, cotton and maize varieties modified for herbicide tolerance and insect protected GM varieties of cotton reduced pesticide use by a total of 22.3 million kg of formulated product in the year 2000. Insecticides usages in the India in cotton/annum is drastically reduced since 2001 from 46\% (i.e.4470 Mt) market share to 20\% (i.e.222 Mt) in 2011 that equivalent to use of 172 million kg less Pesticide and 14\% reduction of environmental footprint associated with pesticide use and it has also made a significant contribution to reducing the green house gas emission up to 10 billion kg, it has equal to removing five million cars from the roads for a year.

Estimates indicate that if 50\% of the maize, oil seed rape, sugar beet, and cotton grown in the EU were GM varieties, pesticide used in the EU/annum would decrease by 14.5 million kg of formulated product (4.4 million kg active ingredient). In addition there would be a reduction of 7.5 million ha sprayed which would save 20.5 million litres of diesel and result in a reduction of approximately 73,000 t of carbon dioxide being released into the atmosphere.

Genetically modified (GM) crops have been used commercially for more than 21 years. Available impact studies of insect-resistant and herbicide-tolerant crops show that these technologies are beneficial to farmers and consumers, producing large aggregate welfare gains as well as positive effects for the environment and human health. The advantages of future applications could even be much bigger. Given a conducive institutional framework, GM crops can contribute significantly to global food security and poverty reduction. now we are realized the benefits of \textit{Bt} cotton so we can move for further stages of advanced GM crop technology, i.e. improved nutrition, enhanced pest resistance, increased yields and new products for example the likely impacts of beta-carotene rich Golden Rice are analyzed from an extant perspective. Vitamin A deficiency is a serious nutritional problem, causing multiple adverse health outcomes. Simulations for India show that Golden Rice could reduce related health problems significantly, preventing up to 40,000 child deaths every year. These examples clearly demonstrate that GM crops can contribute to poverty reduction and food security in developing countries. To realize such social benefits on a larger scale requires more public support for Research targeted to the poor, as well as more efficient regulatory and technology delivery systems.

In relation to the issue of ‘unnaturalness’ that GM modification did not differ to such an extent from conventional breeding that it is in itself morally objectionable. In making an assessment of possible costs, benefits and risks, it was necessary to proceed on a case-by-case basis. However, the potential to bring about significant benefits in developing countries (improved nutrition, enhanced pest resistance, increased yields and new products) meant that there was an ethical obligation to explore these potential benefits responsibly, to contribute to the reduction of poverty, and improve food security and profitable agriculture in developing countries. (The Nuffield Council on Bioethics (NCOB, 2004)).

The recent controversy regarding the GM-Mustard variety-MVH12 which is placed at the door step of GOI i.e. Genetic Engineering Appraisal Committee’s (GEAC) to be released for commercial cultivation tells the gamut of problems surrounding these crops in India.
It is time to accept other GM crops in the benefit of farming and downward society and at the same time proper evaluation of their negative impacts can change the government policies and address all the ethical, social and moral concerns of public and develop awareness among the people about GM crops and also increase the public sector shareholding in R&D of GM crops to avoid monopoly of corporate MNC’s to protect farmers interest and also to keep in the mind impacts of terminator gene technology and biodiversity for sustainable growth and development.

03-37

BIOLOGY OF Cryptolaemus montrouzieri ON PAPAYA MEALYBUG (Paracoccus marginatus)

Maneesha, A., Koteswara Rao, S. R., Murali Krishna, T and Sudhakar, P.
Department of Entomology, S.V. Agricultural College, Tirupati.
Corresponding author: addankimaneesha@gmail.com

A lab experiment was conducted during 2017 at Insectary, Department of Entomology, S.V. Agricultural College, Tirupati to study the biology of C. montrouzieri on different life stages of papaya mealybug, P. marginatus. The results revealed that the developmental period of C. montrouzieri was significantly maximum (40.80 days) when reared on ovisacs of papaya mealybug followed by I instar nymph (36.20 days), II instar nymph (33.80) and was minimum when fed on III instar nymphs (28.20 days) of papaya mealybug. The total developmental period of C. montrouzieri was significantly highest when reared on ovisacs of papaya mealybug, when compared to that of I, II and III instar nymphs of P. marginatus.

Keywords: C. montrouzieri, P. marginatus, total developmental period.

03-38

ESTIMATION OF GENETIC DIVERSITY IN RICE (Oryza sativa L.) USING SSR MARKERS

Dasari Vanisri, A., Lakshminarayana, S., Vemireddy, R., Neeraja, C.N and Jyothi Badri
Institute of Biotechnology, Hyderabad.
Corresponding Author: dasari.aleena@gmail.com

Rice (Oryza sativa L.) is the main staple food crop of Asia and for more than half of the humanity “rice is life”. Diversity is prerequisite for any crop improvement program as it helps in the development of superior recombinants. Genetic diversity among 112 rice genotypes was estimated based on the Jaccard’s pair wise similarity co-efficient using 12 polymorphic yield related gene specific SSR markers. According to UPGMA cluster analysis all accessions were clustered into three groups. The PIC values ranged from 0.51 (s9) to 0.83 (s3204 and RM18600) with a mean of 0.70. The number of alleles detected varied from 2 to 3. Average number of alleles per primer pair was 2.25. The allele size ranged from 110 to 630bp. Comparison of genetic diversity assessments based on morphological and molecular data by Mantel test indicated significant correlation between them.

Keywords: Genetic diversity, SSR markers
PHYSIOLOGICAL GENETICAL AND MOLECULAR BASIS FOR SALT TOLERANCE IN RICE (Oryza sativa L.)

Somla Naik, R., Umamahesh, V., Lora Anusha, P and Mrudula, G.
Department of Crop Physiology, S.V. Agricultural College, Tirupati.
Corresponding author: rsnayak975@gmail.com

Salinity is one of the major obstacles to increase crop production worldwide. Nearly 20 per cent of the world’s cultivated area (800 M ha) and nearly half of the world’s irrigated lands are affected by salinity. In India the salt affected area is 6.73 million ha (5.5%) out of total irrigated crop area 82.6 million ha (Maser et al., 2002). Salinity tolerance is a complex trait, involving numerous mechanisms early seedling vigour, salt exclusion, salt compartmentation, tissue tolerance, salt translocation, osmoprotectants and efficient active oxygen-scavenging system. The strategies for mitigating salinity problems in crop production include both development of management options (Shannon, 1997) and genetic improvement of salinity tolerance in current cultivars (Epstein et al., 1980) for which the knowledge about physiological, genetical and molecular basis for salt tolerance is essential. Both conventional breeding approaches and innovative approaches are being employed for breeding varieties tolerant to salt stress. Salinity can be altered by different approaches such as physiological (Traits of Na⁺ and Cl⁻ exclusion, trait of ion selectivity (Ca²⁺ and K⁺), traits of photosynthetic parameters and SPAD value and traits of leaf water relations), genetical approaches (marker assisted selection, transgenic rice for salt tolerance, salt tolerant mutants, genome modification through mutation breeding—the ‘forward-genetics’ approach) and molecular approaches (molecular marker resources and QTL mapping for rice salinity tolerance, introduction of desired gene/genes into the rice genome for salinity tolerance—the ‘reverse-genetics’ approach, transcriptomics approach, proteomics approach, phenomics approach, integration of ‘Omics’ approach). A major quantitative trait locus (QTL) for salt tolerance named Saltol was mapped on chromosome 1 using F8 recombinant inbred lines (RILs) of Pokkali/IR29 cross, which is responsible for low Na⁺, high K⁺ uptake and maintaining Na⁺/K⁺ homeostasis in the rice shoots (Nejad et al., 2008). Naresh Babu et al. (2014) investigated that SSR based analysis on a set of salt tolerant landraces from kaipad, other salt tolerant varieties, wild rice lines and salt susceptible lines showed marked variation within the genomic region encompassing Saltol QTL. The results showed that the kaipad genotypes possess Saltol locus similar to Pokkali. The genotypes such as Kuthiru and Ezhome 1 which have normal pericarp colour and high degree of salinity tolerance can be used as new donors for Saltol. Saltol gene and other QTLs associated with salt tolerance have been mapped and are being used for breeding salt tolerant lines eg., BRRI dhan 28 and BR11. Salt tolerant and susceptible pairs such as Chettivirippu-2-Swarna and Pokkali-Swarna were identified as genetically distant based on polymorphism of microsatellite markers as well as diversity in yield and yield attributing traits under both stress and non-stress conditions (Chattopadhyay et al., 2013). In conclusion, understanding genetical physiological and molecular basis may lead to the understanding of stress response and aid in development of new varieties with stress tolerance.

COMPATIBILITY OF PESTICIDE MIXTURES- AN EFFECTIVE WAY OF MANAGEMENT OF CROP PESTS

Anil Kumar, K., Madhumathi, T., Sarma, A. S. R.
Sai Ram Kumar, D.V., Chiranjeevi Ch and Prasanna Kumari, V.
Department of Entomology, Agricultural College, Bapatla.
Corresponding Author: anilento3@gmail.com

‘Compatibility’ is the ability of two or more components of a pesticide mixture to be used in combination without impairment of toxicity, physical properties or plant safety of either of the components. Insect pests and diseases occur simultaneously and damage crops under farmer’s field conditions and estimated to cause
yield losses to the tune of 30 to 40 per cent. Pesticide mixtures saves time, labour, energy, equipment cost to
the farmers and prevents ecological problems like enhanced phytotoxicity, resurgence etc.

An experiment was conducted to test the physical compatibility of the insecticide and fungicide
combinations using emulsion stability test and specific gravity test under lab conditions at Department of
entomology, Agricultural College, Bapatla. The results of emulsion stability test and specific gravity test obtained
indicated that all the insecticides, fungicides alone and in combination were compatible irrespective of the
type of water used (normal tap water, distilled water and standard hard water) as there was no sedimentation
at the bottom and creamy layer at the top of the measuring cylinder with no much variation in their specific
gravity values ranging from 1.001 g (chlorantraniliprole + tricyclazole and phosphamidon + isoprothiolane) to
1.011 g (chlorantraniliprole + carbendazim).

The pH values of insecticide and fungicide combinations in tap water ranged from 6.9 (cartap
hydrochloride + tricyclazole, chlorpyriphos + tricyclazole and chlorpyriphos + isoprothiolane) to 7.8
(chlorpyriphos + carbendazim and chlorantraniliprole + tricyclazole). Similarly EC values ranged from 2.64
dSm⁻¹ (chlorantraniliprole + carbendazim and phosphamidon + tricyclazole) to 3.77 dSm⁻¹ (cartap
hydrochloride + tricyclazole). As there was no much difference in the values of pH, EC compared with alone
chemicals, it indicates that the insecticides and fungicides in combination are compatible chemically.

**Key words:** Compatibility, Tank Mixtures, Emulsion stability, pH, EC

03-41

**GENETIC IMPROVEMENT OF BIO-CONTROL AGENTS AND THEIR USE IN INTEGRATED PEST MANAGEMENT**

*Anil Kumar, K and Prashanthi, P.*

Department of Entomology, Agricultural College, Bapatla.

Corresponding author: anilento3@gmail.com

Indiscriminate use of pesticides has led to serious concerns relating to their adverse effects on non
target organisms, pesticide residues in food and food products, pest resurgence, development of resistance to
insecticides, toxic effects on human beings, and environmental pollution. Therefore, it is important to adopt
pest control strategies that are ecologically sound, economically practical, and socially acceptable. In this
context, deployment of natural enemies that are adapted to extremes of climatic conditions or capable of
tolerating sub lethal doses of pesticides can play an important role in pest management. Release of genetically
improved arthropods for suppression of pest populations has been undertaken in the past and the possible
applications of genetically modified arthropods have expanded considerably. Genetic transformation can be
used to improve the efficacy of natural enemies and their adaptation to the environment, resistance to insecticides,
control of disease vectors, cryopreservation, and improve the rearing systems.

Genetic alteration includes stability and characteristics of the DNA added, nature of alteration (addition,
deletion, etc.), the vector, and the RNA or DNA, which remains in the altered genome. Genetic engineering
helps to transfer the desired gene of interest in direct and indirect ways. Direct methods include microinjection
into eggs, maternal microinjection, electroporation and indirect methods of gene transfer includes sperm-
mediated transfer, through transposons and through viral vectors. Transmission of certain diseases can also be
managed by genetically modifying the endosymbionts like Wolbachia, Sodalis, Wigglesworthia, for instance,
 genetic engineering of endosymbionts in tsetse fly to express anti-trypanosome agents could prevent transmission
of sleeping sickness.

Entomopathogenic bacteria, viruses, fungi, nematodes, and protozoa have a great potential as a
component of integrated pest management. Biopesticides account for 3% of the total pesticide market, and in
which, Bacillus thuringiensis account for 80% to 90%. This low usage of biopesticides may be attributed to
low quality and effectiveness, unstable formulations and delivery systems, sensitivity to light, short shelf-life,
especially in hot and humid conditions, limited host range and specificity to a particular stage of the insect. Hence genetically engineered bioagents are the next level biological weapons that can be effectively used in integrated pest management programmes in the coming future to combat these limitations.

**Key words:** Bio-control agents, Bacillus thuringiensis, Wolbachia, genetically engineered.

03-42

**HETEROsis AND COMBINING ABILITY STUDIES FOR YIELD AND YIELD COMPONENTS IN RICE**

_Sudeepthi, K., Jyothula, D.P.B and Suneetha, Y._

Department of Genetics and Plant Breeding, Agricultural College, Bapatla.

An experiment was carried out during _kharif_ 2015 to assess the heterosis for yield and yield contributing traits of rice. Twenty one (21) cross combinations were obtained by crossing 3 Cytoplasmic male sterile (CMS) lines with 7 testers in Line x tester mating design. This parental material is evaluated along with two standard checks for different yield and attributing traits during _kharif_, 2015 in a randomized block design with two replications to identify suitable general and specific combiners for breeding program and to determine the nature of gene action governing yield and its component traits. Combining ability analysis is one of the useful tools to estimate the combining ability effects and aids in selection of desirable parents and crosses for exploitation of heterosis. The component of variance due to _sca_ was higher than _gca_ for most of the characters except for test weight which indicate the prevalence of non additive gene action and the ratio of _gca_ to _sca_ was low for all the characters studied except for test weight. The line IR 58025A and testers NLR 33654, NLR 3083 were found to be promising general combiners for grain yield per plant and other contributing traits. The cross IR 58025A × NLR 33057 recorded significant _sca_ effects for majority of the characters which could be exploited in future rice breeding program by adopting heterosis breeding strategy. The high magnitude of heterosis for grain yield per plant is evident by significant superiority of crosses over standard hybrid check (DRRH 2). Results indicated that the highest positive significant heterosis was exhibited by the cross IR 68897A x NLR 33654 (59.44%) for standard heterosis for grain yield per plant. None of the hybrids showed positive significant heterobeltiosis for grain yield per plant. It was concluded that superior heterosis for grain yield was due to increased productive tillers per plant, number of filled grains per panicle and test weight.

03-43

**EFFECT OF CLIMATIC EXTREMES ON POLYPHAGOUS CATERPILLARS IN COTTON**

_Sravan Kumar, D. V and Krishnayya, P. V._

Department of Entomology, Agricultural College, Bapatla.

Insects have short generation times and high reproductive rates, and are more likely to respond to climate change than plants and vertebrates. Global warming may lead to ecological consequences such as introduction of new insect pests and non- insect pests attaining pest status.

Temperature is a key factor of the environment affecting various biological traits of insects such as fertility, fecundity, survival and adult life-span. It has been estimated that with a 2°C increase in temperature, insects might experience five additional life cycles per season. Increased temperatures may render synthetic and biopesticides to be less effective. Insects may also pass through vulnerable life stages more quickly, reducing the window of opportunity for parasitism. The effect of CO₂ on insects is also potentially important in a global climate change setting. It affects the insects indirectly by altering the host crop. Cotton (*Gossypium hirsutum*) being a C3 plant may experience 95 per cent yield increase at elevated CO₂ condition. Also, increased CO₂ may cause increased herbivore feeding, due to less nutrition of foliage.
The cotton cultivation is affected by various insect pests like bollworms, tobacco caterpillar and sucking pests that have the potential to reduce yields by 20–80%. Among them *Helicoverpa armigera* and *Spodoptera litura* are the polyphagous caterpillars that have abundant supply of host plants in off season. There are reports of increased foliage consumption and increased population outbreak of such pests due to climatic extremes. The fate of these pests on transgenic crops under elevated temperature and CO$_2$ is not clearly understood. In this context, more investigations into the effects of elevated CO$_2$ and temperature, on the biochemical characteristics of cotton and also on the growth and development of these polyphagous pests are necessary.

**Keywords:** Elevated CO$_2$, climate change, polyphagous, cotton, *Helicoverpa armigera*, *Spodoptera litura*

---

**03-44**

**IMPROVED HUMAN NUTRITION BY BIOFORTIFIED CROPS**

**Govada Venkateswara Rao and Deepak Sharma**  
Department of Genetics and Plant Breeding, IGKV, Raipur.  
Corresponding author: venkateswararogovada13@gmail.com

Many people in the world are suffering due to deficiency of nutrients. In order to reduce this effect a new idea came into existence called biofortification. It is the idea of breeding crops to increase their nutritional value. As a consequence of the predominance of food staples in the diets of the poor, this strategy implicitly targets low-income households. Biofortification provides a truly feasible means of reaching malnourished populations in relatively remote rural areas. Biofortification may have important spin off effects for increasing farm productivity in developing countries in an environmentally beneficial way. This can be done either through conventional selective breeding or through genetic engineering. It differs from ordinary fortification by increasing the nutritional value as the plant grows.

Biofortified crops can be developed by traditional breeding methods, provided there is sufficient genetic variation in crop populations for the desired trait. In case of iron, WHO estimated that biofortification could help curing the 2 billion people suffering from iron deficiency-induced anemia. Folic acid deficiency is a global health problem that affects mainly, though not exclusively, women over the age of 30, and it is the main cause of anemia in at least 10 million pregnant women in developing countries. In food, most of the folic acid occurs as folate and in order to engineer tomatoes with higher level of folate. Biofortified pro-vitamin A maize is an efficacious source of vitamin A when consumed as a staple crop.

Golden rice is an example of a GM crop developed for its nutritional value. Biofortification of crops is a feasible and most economical approach. It could provide a sustainable and genetically simple solution to mineral deficiency disorder affecting billions of people throughout world. Attempt to enhance the pro-vitamin A content in hexaploid wheat through the genetic engineering will not only strengthen our knowledge of carotenoid biosynthetic regulation in wheat endosperm but will also supply predictable and sustainable metabolic engineering strategies for improving wheat nutritional quality and food utilization in the future.

**Keywords:** Biofortification, conventional breeding, genetic engineering, golden rice, vitamin-A.
BIOTIN BINDING PROTEINS – AN ECO-FRIENDLY METHOD OF CROP IMPROVEMENT BY MANAGEMENT OF BIOTIC STRESS

Pranyusha, B., Madhumathi, T., Krishnayya P.V and Manoj Kumar, V.
Department of Entomology, Agricultural College, Bapatla.
Corresponding author: pranyusha3@gmail.com

To sustain the green revolution and feed the ever increasing population, agriculture growth rate and productivity have to improve enormously in an eco-friendly manner. Pests of crops when handled improperly can explode into unmanageable proportion and contribute to economic crop losses. Indiscriminate and unwise use of chemical insecticides can result in control failure, besides polluting the environment and upsetting the ecological balance. In order to minimize the harmful effects of chemical pesticides, integrated pest management including various eco-friendly tactics and one among them is biotin binding proteins.

Biotin is a water-soluble B-vitamin, an essential nutrient for all organisms. It is a co-factor of major carboxylases involved in lipogenesis, gluconeogenesis, fatty acid and amino acid catabolism. As a result, it is required for normal cellular metabolism and growth of insects. But its synthesis occurs only in plants, bacteria and certain fungi. Biotin binding proteins (BBPs) like avidin and streptavidin binds to dietary biotin, making it unavailable to the insects, which then die from a deficiency of this vitamin. The insecticidal activities of Avidin were first discovered in 1959, when it was added to the artificial diet of the housefly. Due to its extreme stability and resistance to proteolysis, these BBPs are used as transgenic crop plant protection.

BBPs are found insecticidal to a wide range of insects causing death and severe growth reduction to about 40 species of insects across five insect orders (Lepidoptera, Coleoptera, Orthoptera, Diptera and leaf-eating Hymenoptera) and mites. In addition, due to its rapid dilution in ecosystem, no adverse impacts on non-target microorganisms or invertebrates have been recorded. However, both avidin and streptavidin function is greatly reduced by cooking, rendering the avidin harmless to humans following cooking, in the same way that cooked eggs are not harmful to humans.

Keywords: Avidin, streptavidin, eco-friendly, BBPs

DIVERSITY FOR YIELD AND BIOCHEMICAL TRAITS IN ITALIAN MILLET (Setaria italica) ELITE GERMLASM

Kavya, P., Sujatha, M., Pandravada, S.R and Hymavathi, T.V.
Department of Genetics and Plant Breeding, College of Agriculture, Hyderabad.
Corresponding author: kavya.pati@gmail.com

Mahalonobis D² statistics was applied to assess the divergence among 40 elite germplasm collections in Kharif season 2015. The analysis of variance revealed significant differences among the genotypes for all the traits studied. The 40 genotypes were grouped into 5 clusters where, Cluster I was the largest comprising of 32 genotypes followed by Cluster II with 5 genotypes, Cluster III,IV,V were monogenotypic clusters. The inter cluster distance was maximum between cluster II and III and minimum between cluster I and III. Hence, crosses can be made between the genotypes of these clusters during hybridization programme for obtaining heterotic recombinants. Among the characters studied Protein content, carbohydrate content, days to 50% flowering, seed yield/plant, no. of basal tillers contributed maximum towards divergence. Higher Carbohydrate, yield have higher means in cluster IV, protein content in cluster III, days to 50% flowering in cluster V, no. of basal tillers in cluster V. No. of basal tillers, ear length, straw yield/plant had positive association with seed
yield/plant. So, improvement in seed/yield/plant is possible by taking above characters in selection scheme. Protein and carbohydrate content was negatively contributed to seed yield/plant while estimating the correlation.

**Keywords:** Italian millet, genetic divergence, $D^2$ statistics

**03-47**

**RNA INTERFERENCE TECHNOLOGY FOR CROP IMPROVEMENT**

Swarajya Lakshmi, B., Padma, V., Ramana, J.V., Satish, Y and Lal Ahamed Mohammed
Department of Molecular Biology and Biotechnology, APGC, Guntur.
Corresponding author: bollineniswarajyalakshmi@gmail.com

The discovery of RNA interference (RNAi) in mid ninety’s added a new dimension in the regulation of gene expression by different types of RNA. It is a phenomenon in which double standard RNA (dsRNA) inhibits the gene expression, typically by causing the destruction of specific mRNA molecules. Historically, it was known by other names, including co-suppression, post transcriptional gene silencing (PGTS), and quelling. Two types of small RNAs (miRNA and siRNA) can bind to other specific mRNA molecules and either increase or decrease their activity. But dsRNA requires the assistance of two enzymes namely Dicer and RNA induced silencing complex (RISC).

Thakur *et al.* (2014) developed transgenic tobacco lines by expression of long ds RNA precursor to make siRNA and knock down the v-ATPase mRNA in white fly. There are several opportunities for the application of RNAi in crop science for its improvement such as stress tolerance (biotic and abiotic) and also enhanced nutritional level. RNAi has also been used to generate male sterility, which is valuable in the hybrid seed industry. Tehseen *et al.* (2010) developed male sterile lines by inhibiting the expression of Bcp1 gene of Arabidopsis through RNAi which is necessary for pollen development. RNAi used in petunia to regulate the pigment-producing gene under control of a powerful promoter to produce variegated coloured flowers. This knock down technology may be useful inducing early flowering, modification of flower colour, delayed ripening, delayed senescence, breaking dormancy, stress free plants.

It is a novel technology to obtain parthenocarpic tomatoes by down regulation of flavonoid biosynthesis pathway through suppression of chalcone synthase (CHS), the first gene in the flavonoid pathway.

RNAi is an important gene regulation pathway and small world with mighty biological functions. Careful consideration of the interplay factors is expected to deliver a competent technology in insect/pest resistance in the near future.
In India, the yellow stem borer caused 1% to 19% yield loss in early planted rice crops and 38% to 80% in late planted rice (Catinding and Heong, 2003, Pasulu et al. 2002 and Mahar et al. 1985). Therefore, the time has now come to control the pests in an ecofriendly and more amicable manner. Hence, attempts were made to know the efficacy of some traditional insecticides and some novel insecticides formulations.

The investigations on “Evaluation of phenylpyrazole group insecticides against Scirpophaga incertulas (Walker) in rice” were carried out at the Research Farm Department of Entomology, B.H.U., Varanasi (UP) during Kharif, 2012. The experiment carried out with eight treatments viz. Fipronil 200 SC @ 30g a.i./ha, Fipronil 200 SC @ 40g a.i./ha, Fipronil 200 SC @ 50g a.i./ha, Fipronil 80 WG @ 50g a.i./ha, Fipronil 5 SC @ 50g a.i./ha, Chloropyriphos 20 EC @ 250g a.i./ha and LambdaCyhalothrin 4.9% CS @ 12.5g a.i./ha.

In terms of efficacy against stem borer, overall performance of various spraying insecticidal treatments were based on the mean indicated that treatment with Fipronil 200 SC @ 50g a.i./ha was the most effective and significantly superior over all other treatments in reducing the dead hearts to minimum level of 2.04 percent (Table-1) with highest yield of rice (64.15 q/ha) was obtained in this treatment 80.50 per cent increase in yield over control. The untreated control recorded 6.75 per cent dead hearts with low. Effective use of the newer insecticides like fipronil coupled with intensive scouting to obtain accurate estimates of populations of pest species present in a field will lead to sustainable management of yellow stem borer in rice.

**Key words:** Fipronil, phenylpyrazole, Scirpophaga incertulas and rice
Table No. 1: Evaluation of phenylpyrazole group insecticides against *Scirpophaga incertulas* (Walker)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Dose</th>
<th>Per cent dead hearts</th>
<th>Mean</th>
<th>Per cent dead hearts</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ADBS 5 DAS 10 DAS</td>
<td></td>
<td>ADBS 5 DAS 10 DAS</td>
<td></td>
</tr>
<tr>
<td>Fipronil 30</td>
<td>6.90*</td>
<td>5.59 5.53 5.56</td>
<td>5.620</td>
<td>3.890 3.850 3.87</td>
<td></td>
</tr>
<tr>
<td>Fipronil 40</td>
<td>6.89</td>
<td>5.03 4.98 5.00</td>
<td>5.413</td>
<td>3.440 3.400 3.42</td>
<td></td>
</tr>
<tr>
<td>200 SC</td>
<td>(15.22)</td>
<td>(12.96) (12.89)</td>
<td>(13.45)</td>
<td>(10.68) (10.62) (10.65)</td>
<td></td>
</tr>
<tr>
<td>Fipronil 50</td>
<td>6.97</td>
<td>4.02 3.91 3.96</td>
<td>5.303</td>
<td>2.100 1.990 2.04</td>
<td></td>
</tr>
<tr>
<td>200 SC</td>
<td>(15.21)</td>
<td>(11.56) (11.40)</td>
<td>(13.30)</td>
<td>(8.30) (8.11) (8.21)</td>
<td></td>
</tr>
<tr>
<td>Fipronil 50 80 WG</td>
<td>6.73</td>
<td>6.02 5.87 5.94</td>
<td>4.967</td>
<td>3.990 3.580 3.785</td>
<td></td>
</tr>
<tr>
<td>5 SC</td>
<td>(15.11)</td>
<td>(14.20) (14.02)</td>
<td>(12.84)</td>
<td>(11.52) (10.90) (11.21)</td>
<td></td>
</tr>
<tr>
<td>Chloropyriphos 250</td>
<td>6.78</td>
<td>5.95 5.73 5.84</td>
<td>5.200</td>
<td>5.700 5.117 5.40</td>
<td></td>
</tr>
<tr>
<td>Lambda Cyhalothrin</td>
<td>6.87</td>
<td>5.98 5.85 5.910</td>
<td>5.860</td>
<td>5.580 5.557 5.56</td>
<td></td>
</tr>
<tr>
<td>Untreated Control</td>
<td>6.80</td>
<td>6.09(14.28) 6.34</td>
<td>6.21</td>
<td>6.233 6.500 7.010</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(15.11)</td>
<td>(15.05) (14.52)</td>
<td>(14.43)</td>
<td>(14.44) (14.77) (15.35)</td>
<td></td>
</tr>
<tr>
<td>SEM±</td>
<td>0.07</td>
<td>0.02 0.01 0.02</td>
<td>0.345</td>
<td>0.266 0.378 0.03</td>
<td></td>
</tr>
<tr>
<td>CD (P&gt;0.05)</td>
<td>NS</td>
<td>0.05 0.03 0.08</td>
<td>NS</td>
<td>0.806 0.812 0.091</td>
<td></td>
</tr>
</tbody>
</table>

**Figures in parenthesis are arsine transformed values.  *Mean of three replications.**

DAS Days after spraying, ADBS A day before spraying.
03-49

STRATEGIES FOR DEVELOPMENT OF BIOTIC AND ABIOTIC STRESS RESISTANT/TOLERANT GENOTYPES FOR PROFITABLE AGRICULTURE

Manorama, K., Pavani, K, Ramana, J.V and Ramana, M. V.
Department of Molecular Biology & Biotechnology, APGC, Guntur.
Corresponding author: kesinenimanorama@gmail.com

Plants have evolved to live in environments where they are often exposed to different stress factors in combination. Most crop plants grow in environments that are suboptimal, which prevents the plants from attaining their full genetic potential for growth and reproduction. They have developed specific mechanisms that allow them to detect precise environmental changes and respond to complex stress conditions, minimizing damage while conserving valuable resources for growth and reproduction. The biotic and abiotic stresses not only affect the yield but also quality; a number of chemicals are available to control the biotic stresses but it increases the cost of cultivation and also exerts hazardous impact on environment. Thus, developing resistant varieties is the best strategy to overcome the biotic and abiotic stresses.

It is very difficult to isolate the resistant lines through conventional breeding because of co-occurrence of different stresses and the involvement of more number of genes in the expression of the traits. High levels of resistance have been transferred to different cultivars from wild species but that poses linkage drag of undesirable agronomic traits. Before actual breeding programme is taken up to accomplish the objective of identifying tolerant genotypes, it is desirable to elicit information on the extent of genetic variability present in the material for the traits of interest are important (Swarup and Chaugle, 1962). The extent of heritability of the selected traits and the magnitude of genetic advance are equally important in identifying the gene action. Knowledge on the association of traits with yield is of paramount importance while aiming for improvement in yield and quality simultaneously in stress environments.

These identification and development of new cultivars is carried out at different levels i.e., Molecular level: Gene, protein, metabolites and signalization pathway studies, Cellular level: Microscopic characterization of the resistance mechanisms, Plant level: Morphological, biochemical and physiological studies and Crop level: Population variations and study the field assays for effective screening.

These studies will provide a platform for the effective identification and utilization of the sources in the breeding programmes for the development of cultivars with durable resistance to biotic stresses and tolerance against abiotic stresses to increase yield.

03-50

MOLECULAR MARKERS: A TOOL FOR DIVERSITY STUDIES IN SESAME

Pavani, K., Manorama, K., Lal Ahamed M., Ramana, J. V and Sireesha, A.B.M.
Department of Molecular Biology and Biotechnology, APGC, Guntur.
Corresponding author: pavanirodur3@gmail.com

Sesame (2n=26) is a member of the Pedaliaceae family and is one of the most ancient oil seed crops. Sesame is cultivated in tropical, subtropical, and southern temperate regions of the world, but mainly in Asia, Africa, and South America. Myanmar leads in sesame production with 890,000 tons, followed by India (636,000 tons), China (588,000 tons), Sudan (562,000 tons), and Tanzania (420,000 tons) (FAOSTAT, 2014). Sesame is mainly cultivated for its seeds. Sesame seeds are very nutritious with almost 50% oil and up to 25% protein content. The species deserves its reputation as “queen of the oil seeds” because of its oil’s
resistance to oxidative deterioration and a high unsaturated fatty acid content of nearly 85%. In addition, polyunsaturated fatty acids constitute more than half of the unsaturated fatty acid fraction in seeds. The excellent stability of sesame oil is attributed to the presence of antioxidant lignans such as sesamin, sesamolin, and sesaminol. The health benefits of these compounds, including antioxidant, antiaging, antihypertensive, anticancer, cholesterol lowering, and antimutagenic properties are reported by several authors (Anilakumar et al., 2010).

Sesame can set seed without significant yield loss under high temperature and drought, its cultivation is feasible and relatively easy in regions with such climatic conditions. However, sesame productivity is constrained by growth-habit traits such as seed shattering, nonsynchronous ripening, and indeterminate growth, and by biotic stresses particularly diseases caused by the bacterium Pseudomonas syringae pv. and the fungi Cerocospura sesame and Alternaria sesame. Wild relatives are proposed as a potential source of pest and microbe resistance alleles (Kawase, 2000). Thus, inclusion of wild accessions with reproductive compatibility into sesame breeding programs will be an effective strategy to improve biotic stress tolerance characters and broaden the breeding potential of sesame.

Access to a wide range of genetic diversity is critical to the success of breeding programs and the ability to identify genetic variation is indispensable for effective management and use of genetic resources. It depends on characterization which involves description of variation for morphological traits. Phenotypic characterization is performed to know the agronomic value of specific accessions.

The integration of molecular marker technologies has significantly improved the speed and precision of modern plant breeding, molecular genetic research in sesame which is lagged behind other crops, restricting the use of molecular breeding in the crop. The onset of DNA-based research in sesame is relatively recent with the first report describing the use of the random amplified polymorphic DNA technique for sesame germplasm characterization (Bhat et al., 1999). Simple sequence repeats are widely used in plant molecular genetic studies because they are hypervariable, reproducible, relatively abundant, and provide extensive genome coverage (Powell et al., 1996). Due to their highly polymorphic nature, genomic SSRs allow distinguishing among closely related genotypes and extremely useful to establish core collections. Further, they are useful to know the extent of allelic diversity. The SSR markers are also used to analyze the molecular genetic diversity and population structure of a sesame collection.

In sesame, the first specific SSR markers were reported by Dixit et al. (2005) and the reports on these markers in sesame are limited (Wei et al., 2008; Yepuri et al., 2013 and Surapaneni et al., 2014). Singh et al. (2015) used three types of molecular markers, RAPD, ISSR and SSR, to study patterns of genetic variation among the 44 commercially cultivated sesame accessions representing different regions of the India. A high level of polymorphism was found with both RAPD and ISSR markers and the mean polymorphism information (PICs) content values were 0.130 and 0.675 for RAPD and ISSR markers, respectively.

Park et al. (2014) used 14 SSR markers to differentiate 70 sesamum accessions (43 Korean accessions and 27 Chinese accessions) and demonstrated the potential of SSR markers for differentiation between Korean and Chinese accessions. Wu et al. (2014) developed 349 simple sequence repeat (SSR) and 79 insertion-deletion (InDel) markers from cDNA library and reduced-representation sequencing of a sesame cultivar Zhongzhii 14 and the results are useful for Marker assisted breeding. Zhang et al. (2012) studied complete analysis of sesame genetic resources (Core collection) of China using phenotypic and molecular data (SSR) and by extracting a sesame mini-core collection (MC) of 184 accessions.

Thus, the use of molecular markers is useful for in depth analysis of diversity at genic level and also to know the allelic variations for the desired traits. They are basis for the exploitation in marker assisted breeding programmes.
03-51

DETECTION OF SEEDBORNE MYCOFLORA OF GROUNDNUT

(Arachis hypogaeae L.)

Srinivas, A., Pushpavathi, B., Lakshmi, B.K.M and Shashibhushan, V.
Department of Plant Pathology, College of Agriculture, Hyderabad.
Corresponding author: sunny.srinivas76@gmail.com

The groundnut seeds were subjected to standard blotter and agar plate methods as recommended by ISTA, for detection of seedborne mycoflora. Fourteen fungi belonging to eleven genera viz., Macrophomina phaseolina, Rhizoctonia sp., Aspergillus flavus, Aspergillus niger, Aspergillus ochraceus, Aspergillus ustus, Fusarium sp., Rhizopus sp., Alternaria sp., Mucor sp., Penicillium sp., Trichoderma sp., Chaetomium sp.and Cladosporium sp.were recorded through standard blotter method, whereas twelve fungi belonging to ten genera Macrophomina phaseolina, Rhizoctonia sp., Aspergillus flavus, Aspergillus niger, Aspergillus ochraceus, Fusarium sp., Rhizopus sp., Alternaria sp., Mucor sp., Penicillium sp.,Trichoderma sp.and Cladosporium sp.were recorded through agar plate method. Several pathogenic and storage fungi were observed in both the methods. Among the fungi detected, frequency of Aspergillus niger was found significantly highest in both the methods (standard blotter method - 40.00% and agar plate method - 33.00%). Of the two methods tested for detection of seed mycoflora, standard blotter method was found superior over agar plate method.

03-52

BACTERIOPHAGES IN PLANT DISEASE CONTROL

Siva Bharathi, B and Lakshmipathy, R.
Department of Agricultural Microbiology, APGC, Lam, Guntur.
Corresponding author: sivabharathi1107@gmail.com

Losses in crop yields due to diseases need to be reduced in order to meet increasing global food demands associated with growth in the human population. There is a well-recognized need to develop new eco-friendly strategies to combat bacterial diseases in crop plants. Current control measures involving the use of traditional chemicals or antibiotics are losing their efficacy due to the natural development of bacterial resistance to these agents. In addition, there is an increasing awareness that their use is not environmentally unfriendly. Development of various eco-friendly strategies are in progress to control the diseases in plants. One among them is use of phages for disease control, a fast expanding area of plant protection with great potential to replace the chemical control measures prevalent at present. Phages can be used effectively as part of integrated disease management strategies. The relative ease of preparing phages and low cost of production make them good candidates for widespread use in developing countries as well. However, the efficacy of phages, as is true of many biological control agents, depends greatly on prevailing environmental factors as well as on susceptibility of the target organism.

Bacteriophages, the viruses which infects bacteria, have received increased research interest in recent years as a realistic environmentally friendly means of controlling bacterial diseases. Their use presents a viable control measure for a number of destructive bacterial crop diseases, with some phage-based products already becoming available on the market. Phage biocontrol possesses advantages over chemical controls in that tailor-made phage cocktails can be adapted to target specific disease-causing bacteria. Unlike chemical control measures, phage mixtures can be easily adapted for bacterial resistance develops over a time.
Unlike chemical biocides, phages occur naturally in the environment and humans are thus exposed to them on a daily basis without any harm. After application, their numbers increase if their target bacterial host species are accessible to them. However, they tend to persist in high numbers in any environment as long as suitable comes. Phages generally have a narrow host range, typically being limited to stains within a particular species of bacteria. This can allow the creation of phage mixtures which can target bacterial species within a given genus of bacteria only. This could be a specific bacterial phytopathogen or it could be a particular bacterium in a microbial community whose suppression could help to improve crop growth without harming other beneficial bacteria. Since bacteriophages are very effective, specific in their mode of action and not harming other organisms can be better utilized to control bacterial diseases without affecting environment.

03-53

MORPHOLOGICAL CHARACTERIZATION OF COTTON GENOTYPES USING DUS CHARACTERS

Anjani, A., Padma, V., Ramana, J.V and Satish, Y.
Department of Molecular Biology and Biotechnology, APGC, Guntur.
Corresponding author: anjanialluri9@gmail.com

Constant evaluation and characterization of the existent, yet uncharacterized germplasm is useful, and it many times forms the cornerstone for the development of new and better varieties. In the present study, the data were collected on stem, leaf, flower and boll parameters as per DUS characteristics from forty cotton genotypes collected from different parts of the country. Variability was observed for eight parameters out of twenty descriptors studied. No plant of any genotype studied showed a deviation to characteristics from the mentioned descriptors. No variation was observed for leaf colour, hairiness, leaf appearance, leaf nectarines, leaf shape, stem hairiness, bract type, flower petal spot, flower anther colour filamentation, boll bearing habit, boll colour and boll opening. Among leaf characteristics, petiole pigmentation was present most of the genotypes while pigmentation was absent in seven genotypes indicating the usefulness of this character as a tool for identification of specific genotypes. No variation was observed for leaf colour. Leaf shape was palmate in all the lines which is conducive for the egg laying by bollworms. Stem pigmentation was absent in 15 genotypes while remaining genotypes showed pigmentation. The cream colour is a common petal characteristic of upland cotton and petal colour was cream in 38 lines and yellow in 2 lines (CNH 1118 and L 1008). Stigma position was exerted in 28 lines and embedded in 12 lines. Pollen colour was cream in 32 lines and yellow in eight lines. Boll bearing habit and boll colour in all the lines was solitary and green, respectively and most of the cases these are normal characteristics. Boll shape was round in 14 lines, ovate in 22 lines and elliptic in 4 lines. Boll surface was smooth in all the lines except in one line (SCS 1061). Boll tip was blunt in 32 lines and eight lines had pointed one. Boll opening was semi-open in all the lines. Thus, the characterization of the germplasm using DUS descriptors is helpful for varietal identification and protection and these forty lines are reservoirs for different parameters which can be exploited in breeding programmes.

Key words: Cotton, DUS descriptors, germplasm,
COMPARATIVE EVALUATION OF DIFFERENT INDIGENOUS AND EXOGENOUS BARLEY (*HORDEUM VULGARE* L.) GENOTYPES FOR TERMINAL HEAT TOLERANCE.

**Banoth Vinesh and Prasad, L.C.**

Department of Genetics and Plant Breeding, Institution of Agricultural Sciences, BHU, Varanasi.
Corresponding author: vinesh.banoth511@gmail.com

Barley is a member of a member of the grass family, subfamily of *Poaceae (Gramineae)* family. Among the abiotic stress, heat stress (terminal high temperature) is one of the major causes of low productivity of crops. The present investigation comprising of 101 barley genotypes was conducted at Genetics and Plant Breeding, Banaras Hindu University, during *rabi* of 2016-17. Treatments were two sowing dates viz., early sowing sown on 22nd November 2016 and late sown on 18 December 2017 at Agriculture Farm, BHU. In the grain filling stage, temperature was 20-22 °C under late sown condition it was 28-35 °C in early sown condition. In late sown condition highest yield per plant and grains per ear were recorded. Path coefficient analysis revealed high positive direct effect of spike length with awn, spike length without awn, plant height and grains per ear on seed yield per plant, in early condition. In the late condition, effective tillers per plant and spike length without awn showed high positive direct effect on seed yield per plant. It is noticeable from the analysis of variance that all the 101 genotypes studied in early and late conditions were differed significantly for all the thirteen and fourteen characters, respectively. In the early condition, HBSN-175 recorded the highest yield per plant and MOROC-9-75 recorded the highest number of grains per ear. The trait, 1000 grain weight, was morot in INBON-05-50. The terminal heat stress varieties, HBSN-7 (7.58 g) had highest grain yield per plant; BH-976 (49.76) recorded the highest 1000 grain weight; PL-751(29.66) recorded the highest number of grains per ear; highest leaf rolling was observed in the line, RD-2552 (2.216) and the highest proline concentration was observed in HMBSN-1-2-1-1(39.53).

03-55

PHYSIOLOGICAL AND MOLECULAR ANALYSES OF DROUGHT TOLERANCE RESPONSES IN AMARANTHUS (*AMARANTHUS TRICOLOR* L.) UNDER ELEVATED CARBON DIOXIDE ENVIRONMENTS.

**Dheeraj Chatti and Manju R. V.**

Department of Plant Physiology, College of Agriculture, Vellayani, Kerala Agricultural University, Thiruvananthapuram. Kerala.
Corresponding author: chattidheeraj@gmail.com

The level of Carbon dioxide in the atmosphere is rising at an unprecedented rate. According to NOAA, 2014 global concentration of CO₂ has reached 400 ppm for the first time in recorded history and its concentration is expected to increase about 550 ppm within next 50-100 years. Carbon dioxide is the key substrate for plant growth as it represents the sole source for carbon, which is limited by present-day CO₂ concentrations. Increased CO₂ concentration has been found to increase water use efficiency in the majority of species studied. To understand the physiological and biochemical basis of varietal responses of amaranthus to water stress conditions and to study their modifications under CO₂ enriched environment, a pot culture experiment was conducted with three varieties of amaranthus i.e, Arun (V₁), CO -1 (V₂) and Renusree (V₃) in the Open Top Chambers (OTC) system. Two OTCs, one with CO₂ concentration of 600 ppm (T1), other with an ambient CO₂ concentration (T2) and an open control (T3) were maintained. Plants were subjected to water stress during their critical stages of development and then were allowed to recover. Various biochemical and growth parameters like free amino acids, reducing sugar content, total dry matter content and antioxidants like...
ascorbic acid content were analysed to understand the effect of CO$_2$ enrichment on drought tolerance. Electrophoresis analysis of proteins was analysed using SDS PAGE. Elevated CO$_2$ was found to increase total dry matter production (0.99 g), reducing sugars (15.98 mg/g), free amino acids (1.19 mg/g) and ascorbic acid (116.31 mg/100g ) content. Agriculture and allied sectors being the most vulnerable to climate change; it is an urgent imperative that adaptive strategies need to be developed for sustaining an enhancing agricultural production for achieving food security to an ever increasing population and to design improved production technologies with suitable varieties for a changing climatic scenario.

**Key words:** Climate change, global warming, elevated CO$_2$, drought tolerance, antioxidants, reducing sugars, free amino acid.

---

03-56

**SEED PROTECTION WITH NATURAL PESTICIDES AGAINST STORAGE PESTS**

*Kavitha, G, SeshaMahalakshmi, M., Radhika, K and Bayyapu Reddy, K.*

Department of Seed Science and Technology, APGC, Guntur.

Corresponding author: kavitha038ag@gmail.com

Losses due to insect infestation is a major problem during seed storage which cause economic damage and deteriorates the quality of seed, besides loss in quantity, especially in the developing countries. There are a number of insect pests that infest seed, food grains in stores and public ware houses. Few major storage pests are *Sitophilus oryzae* Linn (rice weevil), *Sitophilus granarius* Linn. (granary weevil), *Rhyzoperthadominica* (Fabr.), (lesser grain borer), *Trogodermagranarium* (khapsa beetle), *Callosobruchuschinensis* (L.) (pulse beetle), *Tribolium castaneum* (red ûour beetle), *Cryptolestes ferrugineus* (L.)(rusty grain beetle), *Oryzaephilus surinamensis* (L.)(sawtoothed grain beetle).

The overall damage caused by these insect pests worldwide is estimated to be 10-43% annually.

The use of synthetic pesticides has undoubtedly contributed to green revolution in different countries through increased crop protection. Pesticides, which are intended for preventing, destroying or controlling any pest. Therefore they pose severe adverse effects. In stored-product protection, the development of insecticide resistance is a growing problem in storage. The development of resistant strains and accumulation of toxic residues due to uninterrupted and indiscriminate use of chemical insecticides led to the danger of seed deterioration. Hence an awareness was created world-wide to use newer insecticides that are pest-specific, non-toxic to plants and mammals, ecofriendly, less prone to pesticide resistance, relatively less expensive and locally available.

A natural pesticide is a chemical/ extracted compound produced by plants to control of insects, fungi and other predators. Natural pesticides are much safer in comparison to synthetic pesticides. The natural pesticides are produced from locally available raw materials, have no side effects, eco-friendly, easily biodegradable and non-toxic to non-target organisms. Indian farmers use neem leaves and seed for the control of stored grain pests. The use of oils in stored-products pest control is also an ancient practice. Botanical insecticides such as pyrethrum, derris, nicotine, oil of citronella, and other plant extracts have been used for centuries. Turmeric, garlic, glicridia, castor, ginger, custard apple, coriander, *Agave, Datura, Calotropsis* and *Ipomeoa* are some of the other widely used botanicals to control and repel crop pests.
03-57

MANAGEMENT OF SEED BORNE DISEASES USING BIO-CONTROL AGENTS

Lakshmi Pravallika, P., Bhattiprolu, S.L and Radhika, K.
Department of Seed Science and Technology, APGC, Guntur.
Corresponding author: pravallika.palusani@gmail.com

Food and livelihood security is jeopardized by different biotic constraints of which diseases hold the centre stage. Plant diseases are among the main constraints affecting the production and productivity of crops both in terms of quality and quantity. Seeds are known to carry a considerable amount of microorganisms. These organisms become active under favourable conditions and affect the seed germination which results in lower plant population and abnormal seedlings in field, thereby causing considerable reduction in yield.

To ensure a healthy crop, use of seeds devoid of any pathogens is a mandate. To make the seeds disease-free, seed treatment should be an integral part of crop husbandry. Seed treatment can be done either by using chemicals or bio-control agents or botanicals.

Use of chemicals continues to be the major tactic to mitigate the menace of crop diseases. However, because of the environmental concerns, health conscious attitude of human beings and other hazards associated with the use of chemicals, use of bio agents to suppress the disease causing activity of plant pathogens is gaining importance.

Biological control involves the use of beneficial organisms, their genes and/or products, such as metabolites, that reduce the negative effects of plant pathogens and promote positive responses by the plant. Biological control can achieve the objective of disease suppression through a number of ways such as antibiosis, competition, mycoparasitism and induced resistance, plant growth promotion and rhizosphere colonization capability.

Majority of bio-control products can be applied against seed borne and soil borne pathogens, including the causal agents of seed rot, damping-off, wilts, seedling blight and root rot diseases. These products are mostly used for seed treatment and have been effective in protecting several major crops such as rice, wheat, maize, cotton, pulses, oilseeds and vegetables against pathogens like Fusarium, Alternaria, Cercospora, Macrophomina, Aspergillus, Penicillium, Pyricularia, Curvularia, Helminthosporium, Pythium, Phytophthora etc.

One of the major limiting factors in the wide use of microbial bio-control agents is their high cost of production (initial investment), low temperature requirement, very short shelf life, quality maintenance and difficulty in registration of the products.

03-58

ISOLATION OF CELLULASE-PRODUCING BACTERIA AND CHARACTERIZATION OF THE CELLULASE FROM THE ISOLATED BACTERIUM

Prasanna Kumar, B., Triveni, S., Subhash Reddy, R and Vijaya Gopal, A.
Department of Agricultural Microbiology, APGC, Guntur.
Corresponding author: badde.prasannakumaragrico@gmail.com

Cellulose, a 1,4-α-linked glucan, which constitutes between 20 and 30% of the litter mass, provides a significant carbon source to the soil microbial community. As the main component of plant fiber structures, cellulose is arranged in crystalline to amorphous forms and is substrate to numerous species of both fungi and bacteria relying on extracellular enzymes. Up until now, the most studied group of cellulose-degrading
microorganisms which are characterized by multicomponent, synergistic cellulolytic enzyme systems. Although cellulose-decomposing bacteria are ubiquitous in soils, systematic studies on the structure and activities of cellulolytic communities are rare. Studies of a few groups of cellulolytic soil bacteria provided evidence for the existence of different cellulase systems, which are clustered or bound to the cell walls. Cellulolytic enzymes play an important role in natural biodegradation processes in which plant lignocellulosic materials are efficiently degraded by cellulolytic fungi, bacteria, actinomycetes and protozoa. In industry, these enzymes have found novel applications in the production of fermentable sugars and ethanol, organic acids, detergents and other chemicals. Several studies were carried out to produce cellulolytic enzymes in organic waste degradation process by several microorganisms. Many cellulases produced by bacteria appear to be bound to the cell wall and are unable to hydrolyze native lignocellulose preparations to any significant extent. A wide variety of Gram-positive and Gram-negative species are reported to produce cellulose, including Clostridium thermocellum, Streptomyces spp., Ruminococcus spp., Pseudomonas spp., Cellulomonas spp., Bacillus spp., Serratia, Proteus, Staphylococcus spp., and Bacillus subtilis. The cellulase is released into the substrate and the free enzymes start hydrolyzing the cellulose. The glucose to a length of maximum four glucose molecules are taken up by the microorganism and either used directly or cleaved further via intracellular hydrolyses. Most of the facultative anaerobic bacteria that produce noncomplexed cellulase systems are most often used in the industrial production of cellulolytic enzymes, because the secreted enzymes can easily be harvested. The isolates were identified based on gram reaction and colony morphology on different media. The clearing zone size and colony diameter of these isolates were measured when incubated aerobically at 37°C. The result showed that maximum clearing zone ranged from 1.38 and 1.25 mm demonstrating that the isolates have the ability to degrade the carboxymethyl cellulose and indicating high ability of cellulase production. Among bacterial isolates, the isolates CDB-30 and CDB-34 as evidenced by its maximum clearing zone value of 1.38 mm, followed by CDB-43 (1.32 mm), CDB-36 (1.30 mm), CDB-10 (1.25 mm), CDB-64 (1.25 mm), CDB-11, CDB-26, CDB-41, CDB-31 (1.18 mm), CDB-15 (1.13 mm). Similarly quantitative estimation of cellulose activity results revealed that same manner (CDB-30: 0.149 mg ml-1, CDB-34: 0.148 mg ml-1, CDB-10: 0.136 mg ml-1, CDB-36: 0.135 mg ml-1, CDB-43: 0.129 mg ml-1). Some isolates showed high cellulase specific activity at low temperature (30°C) and some showed higher activity at high temperature (50°C). Moreover, bacteria isolates tended to produce more cellulose enzymes hydrolyzing than carboxymethyl cellulose hydrolyzing enzymes (CMC).

**Key words:** Crystalline, lignocellulosic, hydrolyze, Pseudomonas spp., Cellulomonas spp.

03-59

**GENOTYPING PLATFORMS AND HIGH THROUGHPUT SNP CHIPS FOR CROP IMPROVEMENT**

_Sri Vidya, G. K., Amaravathi, Y., Eswara Reddy, N.P and Vasanthi, R. P._

Department of Plant Molecular Biology and Biotechnology, S V Agricultural College, Tirupati.

Corresponding author: srividya1296@gmail.com

There is a rapidly rising trend in the development and application of the molecular markers assays for gene mapping and discovery in the field crops and trees. Thus far, recent advances in the Next Generation Sequences (NGS) and Single Nucleotide Polymorphism (SNPs) genotyping greatly accelerate the crop improvement if properly deployed. High throughput SNP genotyping offers a number of advantages over the previous marker systems, including an abundance of markers, rapid processing of large populations, a variety of genotyping systems to meet different needs and database storage due to the bi-allelic nature of SNP markers. NGS technologies have enabled rapid whole genome sequencing, providing extensive SNP discovery pools to select informative markers for different sets of germplasm. Highly multiplexed fixed array platforms have enabled powerful approaches such as genome–wide association studies. The routine type of trait–
specific SNP markers requires flexible, low-cost systems for genotyping smaller numbers of SNPs across large breeding populations, using platforms such as Fluidigm’s Dynamic Arrays, Douglas Scientific Array Tape etc. Also genotyping by sequencing (GBS) is rapidly becoming popular for low-cost high density genome-wide scans through multiplexed sequencing. The development of such platforms faces serious challenges at phenotypic gaps in crop plants. It is expected that such genotyping platforms will be achieved in major crops in consideration of (i) rapid development in gene discovery of important traits, (ii) deepened understanding of quantitative traits through new analytical models and population designs, (iii) improvement in cost effectiveness of large scale genotyping. Genotyping platforms and high throughput chips (SNP) will provide unprecedented opportunities to accelerate the development of the cultivars with desired yield potential, quality, and enhanced adaptation to mitigate the effects of climate change.

03-60

**STRATEGIES FOR THE DEVELOPMENT OF BIOTIC AND ABIOTIC STRESS RESISTANT CROPS IN CHANGING CLIMATIC CONDITIONS**

**Ajitha, V., Mamatha, P and Usha, G.**

Advanced Post Graduate Centre, Lam, Guntur.
Corresponding author: ajithajasmolini@gmail.com

In today’s climate change scenarios, crops are exposed more frequently to episodes of abiotic stresses such as drought, salinity, elevated temperature, submergence and nutrient deficiencies, these stresses limit crop production. Loss due to diseases range from 20 to 30%, in case of severe infection, total crop may be lost. It has become traditional for ecologists, physiologists, and agronomists to divide stresses experienced by plants into two major categories: biotic and abiotic. Biotic stresses originate through interactions between organisms, while abiotic stresses are those that depend on the interaction between organisms and the physical environment.

Stress resistant crops are a dire need as human population continues to increase and a population of nine billion expected by 2050. In recent years, advances in physiology, molecular biology and genetics have greatly improved our understanding of crops response to these stresses and the basis of varietal differences in tolerance. Elements of an enhanced breeding strategy are wide hybridization, marker assisted selection and transgenics.

Genes for brown plant hopper has also been identified in wild rice germplasm and are being mobilized to cultivated rice. Widening of the genetic base through identification of novel resistance genes from wild relatives of rice, their deployment in breeding programs, and pyramiding two or more effective resistance genes are some of the approaches envisioned for developing rice cultivars with durable resistance to Xanthomonas oryzae pv. oryzae. Many of the wild species of Oryza such as O. longistaminata, O. rufipogon, O. minuta, and O. nivara have been reported to be resistant to BB. Five BB resistance genes—Xa21, Xa23, Xa27, Xa29t, and Xa30t—have so far has been identified from O. longistaminata, O. rufipogon, O. minuta, O. officinalis, and O. nivara, respectively (Kumar et al., 2012). So far, 40 R genes and 17 QTLs conferring host resistance against various strains of Xoo have been identified.

The breeding strategies for which MAS is used most frequently, are selection of simple traits or QTLs from breeding lines/populations, introgression of genes from breeding lines or wild relatives, MABC, marker-assisted recurrent selection (MARS), and pyramiding of genes. e.g. hybrid breeding or pyramiding of resistances. Development of improved Basmati386 through MAS by pyramiding of bacterial blight resistance genes xa13 and Xa21, semi dwarfing gene sd1 and monitoring the retention of genes conferring aroma, amylase content and grain elongation genes and release of Punjab Basmati 3 are some of the examples of marker assisted selection.
To date, successes in genetic improvement of environmental stress resistance have involved manipulation of a single or a few genes involved in signaling/regulatory pathways or that encode enzymes involved in these pathways (Jewell et al., 2010). Transgenic plants overexpressing the genes involved in ABA synthesis showed increased tolerance to drought and salinity stress (Ji et al., 2011). A variety of insects, mites and nematodes significantly reduce the yield and quality of the crop plants. The success of the transgenic approach led to the development of Bt crops, transgenic crops are used worldwide to control major pests of cotton, corn and soybean (Toenniessen et al., 2003.)

Environmental stresses which include both abiotic and biotic stresses are the major force that governs the food production in tropics. To achieve sustainable crop production to feed growing human population, strategic measures should be taken in management of these environmental stresses. Scientists are able to visualize in individual experiments hundreds of genes involved in the complex phenomenon of plant response to stress.

03-61

BIOCHEMICAL CHANGES IN OKRA DUE TO INFECTION WITH Cercospora abelmoschii

Amulya, G., Prasanna Kumari, V., Anil Kumar, P and Manoj Kumar, V.
Department of Plant Pathology, Agricultural College, Bapatla.
Corresponding author: amulya3gummalla@gmail.com

Okra (Abelmoschus esculentus (L.) Moench) is an important warm season vegetable crop extensively used globally for its nutritional and health benefits. Okra is cultivated for a variety of uses but mainly for its edible leaves and immature green seed pods or fruits. Diseases play a vital role in yield losses of the crop. In India, two species of Cercospora viz., C. malayensis Stev. and Solh. and C. abelmoschi Ell. and Ev. were found to cause leaf spots in okra. The common biochemical constituents like phenols, proteins, sugars and chlorophyll, peroxidase etc., are important in imparting resistance to the crop plants. But almost all living animals and plants show biochemical changes after infected by infectious agent. Sometimes, host plant is induced to synthesize these compounds upon infection. So, present study was carried out to evaluate the changes occurring in biochemical’s (viz., total phenols, total proteins) in Cercospora infected okra leaves from different plots, two weeks after complete execution of fungicide treatments. Results revealed that phenol content in lower leaves (1.58 mg g-1) and upper leaves (1.52 mg g-1), total protein content in lower (9.32 mg g-1) and upper leaves (9.23 mg g-1) were significantly higher in trifloxystrobin + tebuconazole @ 0.1% applied plants. Significant negative correlation existed between disease severity and total phenols (-0.903), total proteins (-0.903).

Key words: Cercospora leaf spot, okra, trifloxystrobin + tebuconazole, phenol, proteins.

03-62

SEED DRYING USING SILICA GEL AND ALUMINIUM SILICATE (ZEOLITE) BEADS

Aiswarya, N., Bhattiprolu, S.L and Bayyapu Reddy, K.
Department of Seed Science & Technology, APGC, Lam, Guntur.
Corresponding author: aiswaryanavani@gmail.com

Seed drying is one of the most important post harvest operation in seed processing. Drying protects the seed from internal heat development and mold growth there by increases the viability, vigour and storage potential of the seed. Seed drying is defined as the process of reducing the moisture content of the seed to
safer limits. Elimination of moisture from the seed depends on the relative humidity and temperature of the environment surrounding the seed.

Drying can be done by various methods like sun drying, mechanical drying, etc.,. But during drying process care should be taken that the temperature does not exceed safe limits as high temperatures causes damage to seed. So, inorder to prevent this dessicators like Silica gel and Aluminium silicate beads are used in drying process. They absorb the moisture present in the surrounding environment there by causing the seed to lose its moisture content without raising the surrounding temperature.

Usually dessicators are use to dry small quantity of seeds in laboratories, gene banks and for drying low volume high density seeds. Recently various technologies are being developed to use these dessicators for bulk drying operations. Another advantage of dessicators is that they are having indicators and they can be regenerated and reused after every drying.

03-63

**BIOEFFICACY OF NEW MOLECULES AGAINST APHIDS ON OKRA**

*Sravan Kumar, D. V and Meena, R. S.*

Dept. of Entomology, Agricultural College, Bapatla.

Corresponding author: venkat.9006@gmail.com

Among the vegetable crops grown in India, okra (*Abelmoschusesculentus* L. Moench), also known as lady’s finger or bhendi, belonging to family Malvaceae is an important crop grown throughout the year. Besides India, it is grown in many tropical and subtropical parts of the world. Tender fruits are used as vegetables or in culinary preparations as sliced and dried pieces. It is also used for thickening gravies and soups, because of its high mucilage content. The roots and stems of okra are used for cleaning cane juice. Matured fruits and stems containing crude fibre are used in paper industry. Okra is ravaged by many insect pests right from germination of seeds to harvest of fruits. Okra attracts various insect pests of which aphid causes major damage by sucking the sap and excreting honey dew. Field studies were conducted to manage okra aphid with certain neonicotinoidinsecticides in comparision with spinosad, novaluron and cartap hydrochloride. Among them, thiacloprid and imidacloprid were effective in reducing the aphid population by 74.66 and 61.16 percent respectively. These were followed by acetamiprid and thiamethoxam that recorded 57.53 and 57.48 per cent reduction in population. Cartap hydrochloride effectively contained 45.13 percent aphid population. Spinosad achieved about 10 % reduction in population and novaluron, the growth regulator was very slow in attaining aphid mortality.

**Keywords:** Biotic, neonicotinoid, Malvaceae

03-64

**STUDY OF PARENTAL POLYMORPHISM IN OIL PALM (*ELAEIS GUINEENSIS* JACQ.) USING SSR MARKERS.**

*Ramaraju, B.R.V., Ramana, J.V and Kalyana Babu, B.*

Department of Molecular Biology and Biotechnology, APGC, Lam, Guntur.

Oil palm (*Elaeis guineensis* Jacq.) is a perennial monocotyledonous tree belonging to the family Palmae, with a diploid chromosome number, 2n=32. It is recognized as the high yielding edible oil crop. In India, Andhra Pradesh (1.51 lakh ha area and 7.99 lakh tons production), Karnataka (0.38 lakh ha area and 1.01 lakh tons production), Tamil Nadu (0.28 lakh ha area and 0.05 lakh tons production), Mizoram (0.23
lakh ha and 0.09 lakh tons production) and Kerala are the principal oil palm growing states. In the present study, SSR markers were used as they are currently the most preferred molecular marker system owing to their highly desirable properties viz., abundance, hyper-variability, and suitability for high throughput Analysis. For studying the parental polymorphism two Dura oil palm genotypes 240D and 281 were selected. The variation among these parents was characterized using 400 SSR markers. Nineteen SSR markers were polymorphic between 240D and 281 (4.75%). So these identified Nineteen markers between these two parents can be used for further studies such as linkage map construction and mapping QTL’s for various morphological traits and improve their yields.

03-65

**A REVIEW ON BIOLOGICAL CONTROL OF POSTHARVEST DISEASES**

*Eden Georgia, K., Anil Kumar, P. and Manoj Kumar, V*

Department of Plant Pathology, Agricultural College, Bapatla.

Corresponding author: karedi.eden@gmail.com

Postharvest diseases of fruits and vegetables are major expense in food production. Upto 50-60% of fresh produce discarded because of postharvest spoilage. Because of poor storage and food handling technologies losses in under developed countries run even higher. Pathogenic microorganisms, such as fungi, mainly belonging to genera *Alternaria, Aspergillus, Botrytis, Fusarium, Monilinia, Pencillium, Rhizopus* are the main causal agent of postharvest deterioration. Some of the pathogenic fungi such as *Alternaria alternata, Aspergillus spp, Fusarium spp* and *Pencillium expansum* also produce toxic metabolites known as mycotoxins. The use of synthetic fungicides is the primary means for controlling postharvest diseases. However, increasing global concern about environmental and human health risks due to pesticide residues has consequently reduced their use in the field near harvest and or in postharvest situations. The use of synthetic fungicides is also discouraged by the increase of fungicide-resistant pathogen-strains, the very low or even “zero” chemical residues required by fruit retailers and consumers. These have encouraged the rapid development of alternative approaches. Biological control of postharvest diseases (BCPD) has emerged as an effective alternative. Biological control is economically viable and environmentally safe.

**Keywords:** Postharvest diseases, biological control

03-66

**CHARACTERIZATION OF Sclerotium rolfsii ISOLATES CAUSING COLLAR ROT IN CHICKPEA**

*Srividya, P.V., Lal Ahamed M., Ramana, J.V and Khayyum Ahammed, Sk.*

Dept. of Molecular Biology and Biotechnology, APGC, Lam, Guntur.

Corresponding author: pvr0708@gmail.com

Chickpea crop is prone to many diseases among these, collar rot caused by *Sclerotium rolfsii* Sacc. is gaining importance as this has been observed in different parts of the country. With the drastic reduction of chickpea area in Northern India and its quantum increase in hot, drier rainfed Central and Southern India, the collar rot is emerging as the most destructive constraint to chickpea production and productivity. Cultivation of resistant varieties is the ideal and feasible management of the disease and resistant sources against this disease have been identified in various countries but stable resistance could not be achieved due to the prevalence of virulent isolates of *S. rolfsii*. Keeping this in view, the present study was carried out during rabi 2017-18 by collecting the soil samples for the isolation of 20 isolates from different parts of chickpea growing areas of Andhra Pradesh. The isolates were studied for the mycelia growth on different media, temperature and pH requirements for the multiplication and mycelial characteristics for easy identification.
Growth of the mycelia was observed on two different media PDA (Potato Dextrose Agar) and CDA (Czapek Dox Agar) along with the requirements of temperature and pH. The growth of the mycelia was faster on Potato Dextrose Agar medium than Czapek Dox Agar medium for all the isolates. But few isolates (CSR-18 & CSR-20) showed similar fast growth pattern in both media while most of the genotypes showed slower growth on CDA compared to PDA. The growth of the mycelia was fast at 27°C and 30°C while slow at 15°C, 20°C and marginal at 25°C. The mycelium growth was absent at 35°C. The growth of the mycelia was faster at slight acidic to neutral pH (6-7) at 27°C. Based on morphological mycelial characters CSR-18 & CSR-20 isolates were dark brown in colour after maturity among 20 isolates and were very fast in growth and formation of sclerotia on two media compared with other isolates. The isolate, CSR-14, showed light orange coloured mycelia. The isolates, CSR-18 & 20, recorded small sized dark brown sclerotial bodies and the isolate, CSR -14, produced irregular orange colour sclerotial bodies. The remaining isolates produced brown and light brown sclerotial bodies.

03-67
AN ESSENTIAL BIOTECHNOLOGICAL PROCEDURE- TRANSGENIC BREEDING

Archana, R.S and Sudha Rani, M.
Dept. of Genetics and Plant Breeding, Agricultural College, Mahanandi

It is essential to improve food production and distribution in order to feed the growing world population. Continuous practice of old methods in agriculture cannot reduce the food scarcity, as the over use of chemicals, drought and infertile soil are a severe issues where the investment is more and the yielding is less, these all due to unpredictable climatic changes and uncontrolled pesticides. To overcome these issues scientists have concentrated on the new technologies by combining the specific genes in-vivo for the crops which is called transgenic crops/plants. Transgenic crops can address these issues as they are biotic and abiotic resistant and high yielding along with improved nutritional traits. The plant biotechnology era began in the early 1980s with the landmark reports of producing transgenic plants using agrobacterium. There are various methods available for introducing desirable genes into plant cells among which agrobacterium and biolistic gene gun methods are more efficient. Using this procedures thousands of transgenic crops have been developed experimentally or field tested, while few of them are currently cultivated world wide.

However, the rapid growth of the GM crop-based industry has also created controversies in many regions. The effective detection and regulation of GM crops are necessary to reduce the impact of these controversies. Genetic engineering is the inevitable wave of the future and that we cannot afford to ignore a technology that has such enormous potential benefits. However, we must proceed with caution by improving our knowledge on establishing precise methods to insert and place the transgenes at specific locations in the recipient chromosomes and potential side effects of foreign DNA to avoid causing unintended harm to human health and the environment as a result of our enthusiasm for this powerful technology.

03-68
TRANSMISSION AND CONTROL OF PLANT VIRUS THROUGH INTERFERING WITH VECTOR TRANSMISSION

Sayiprathap, B.R., Saratbabu, K., Ambarish, K.V., Girish, B.R and Ramachandra, V.
Department of Plant Pathology, Agriculture College, Bapatla.

Viruses are the obligatory parasite, rely on vectors(insects, mites, fungus, nematodes, phanerogamic parasites etc.) for transmission from infected to healthy plants. There is a specific interaction exists between vector-receptors and virus-proteins for retention and successful transmission of viruses. Viruses are mainly
transmitted as coat proteins (CP) and intact virion particles inside the vector system. In addition with CP, some of the viruses depend on additional non-virion proteins, like Helper Component protein (HC-pro) helps in transmission of Potyviruses, Read-Through (RT) protein in Luteoviruses and minor Coat Protein (CPm) in Closterovirus. In nature, among plant viral vectors, aphids are efficient vectors present in large numbers and are known to transmit some of the viral members viz., Potyvirus, Luteovirus, Closterovirus, Rhabdovirus etc. Thrips also important vectors, transmit Tospoviruses in which 1st instar nympal acquisition only transmit virus particles in persistance-propogative manner. Mites are known to transmit Rymoviruses, Tritimoviruses and Emaroviruses in a semi-persistent manner with the help of HC-pro. Some of the nematodes belong to Longidoridea known to transmit Nepoviruses and Tritichordoridae transmit Tobravirus. Among the fungi, Plasmodiphoroides and the genus Olpidium known to transmit plant viruses, both in-vitro and in-vivo.

Host resistance plays a major role to defend plant viruses, but only a few plant resistance genes have been described that operate against viruses, vectors or vector-transmission process. Viruses are often difficult to control once infected with cell, so it is more advisable to interfere with vector transmission of plant viruses. The vectors mainly controlled by spraying chemicals like insecticides, nematicides, acaricides and fungicides, along with quick control, cause adverse environmental effects and even sometimes may cause outbreaks of disease by pest resistance, so it is advised to go for safer methods like vector/ virus resistance, biological and integrated methods. Use of microorganisms like Pseudomonas putid, P. fluorescencne, Trichoderma sps., etc., effectively controls soil borne zoosporic vectors. Resistance to wheat curl mite, a vector of WSMV, has been obtained by introgression of a resistance genes from Aegilops tauschii into wheat, at least 5 resistance genes to mite colonization may occur suggesting that this species useful for wheat improvement. The Mi-1, 2 genes identified in tomato plants confer resistance to whiteflies. More leaf trichomes have been investigated as possible source of resistance to whiteflies, as they interfere in feeding. Recent genetic engineering techniques like RNA interference (RNAi) technology and coat-protein mediated resistance (CPMR) are available for the control of viruses even inside the host cell by interfering different stages of virus cycle. Many promising results have shown that engineered resistance against plant viruses through RNAi could help to achieve sustainable and integrated control of viruses.

03-69
MODERNIZATION IN PLANT BREEDING APPROACHES FOR IMPROVING BIOTIC STRESS RESISTANCE IN CROP PLANTS

Deepika Sahu
Department of Genetics & Plant Breeding, College of Agriculture, JNKVV, Jabalpur.
Corresponding author: deepikasahu611@gmail.com

The main aim of plant breeding is to ensure quantity/quality of crops to respond to the Continuous increase of world population. However, the genetic potential of crop productions are constantly threatened by environmental stresses, including biotic and abiotic factors that reduce crop yield and quality. Biotic stresses are a potential threat to global food security. The origin of new pathogens and insect races due to climatic and genetic factors is a major challenge for plant breeders in breeding biotic stress resistant crops. Yield losses due to biotic stresses have resulted in 800 million people underfed in the world. Reduced yield due to biotic stresses and increasing food demand put international food security at risk. Biotic stress remains a broadly defined term and those who study it face many challenges, such as the greater difficulty in controlling biotic stresses. In the past, classical breeding approaches like introduction, hybridization, composite crossing, multline and backcross breeding were utilized for this purpose. These methods were expensive, slow and hectic for developing resistance in crops. Furthermore, coping with fast evolving pathogens with using these time-consuming methods is not possible. Therefore, molecular genetic approaches like mutation, Marker Assisted Selection (MAS), genomics, recombinant DNA technology, Targeted Induced Local Lesions in Genome
(TILLING) and Virus Induced Gene Silencing (VIGS) were adapted by breeders to develop effective resistance in crop plants in a shorter time. Modern Plant breeding has made a profound impact on food production and will continue to play a vital role in world food security.

**Key Words:** MAS, TILLING, VIGS, genomics

---

**03-70**

**GENOME EDITING FOR CROP IMPROVEMENT**

*Amarnath, K and Durga Prasad, A.V.S.*

Department of Genetics and Plant Breeding, Agricultural College, Mahanandi.

The potential genome editing techniques i.e. Meganucleases, TALENs (transcription activator-like effector nucleases), ZFNs (zinc finger nucleases), and CRISPR-Cas9 (Clustered Regularly Interspaced Short Palindromic Repeats) are gaining much importance after the decreased popularity of Genetic modification technology. CRISPR (A site specific mutagenesis technique targeting DNA) gained popularity within five years and became a highly utilized research tool across the world because of its precision and negligible side effects on environment as compared to GMOs. Though, the existing genome editing technologies such as EMN, ZFN, and TALENs have been the major useful tools. But, their wide spread application has been hampered by many limitations such as temporary inhibition of gene function, unpredictable off-target binding, costly, difficult to handle and time-consuming to engineer. However, the recent discovery of Clustered Regularly Interspaced Short Palindromic Repeat (CRISPR)/CRIPSR associated (CRISPR/Cas system) immune system in bacteria has changed the pace and fate of plant genome editing for crop improvement.

CRISPR/Cas is an unique Genome Editing tool, specialized adaptive immune mechanism used by bacteria to protect against foreign invading Phage DNA molecules. A coordinated effort of all these molecules result in the site-specific double-stranded DNA breaks in the targeted foreign DNA molecule. For precise and efficient genome editing in crop plants, a chimeric single guide RNA (sgRNA) in place of crRNA and tracrRNA has been incorporated.

 Genome editing has wider applications in biomedical research, human therapies and agriculture, which all have potential benefits for human health. There is on-going debate about the extent to which current regulations on genetically modified organism should apply to use of genome edited organisms.

---

**03-71**

**PHYSIOLOGICAL INTERVENTIONS TO ENHANCE DROUGHT TOLERANCE IN BLACK GRAM**

*Mikhina, M. S and Sandhya Rani, P.*

Department of Crop Physiology, S.V Agriculture College, Tirupathi.

Corresponding author: mikhinams@gmail.com

Terminal drought stress is one of the most serious constraints in blackgram production. Physiological studies have indicated that root traits, water use efficiency, specific leaf area, relative water content, transpiration rates, stomatal conductance plays major role in conferring drought tolerance. Root traits such as root depth, root length density, root to shoot ratio and root biomass are being targeted for increase water uptake and nutrient acquisition. Shallow roots helps in increased phosphorous uptake under stress condition. Quantification of water use efficiency at canopy and single leaf level helps to screen large number of black gram genotypes for drought tolerance. Specific leaf area negatively correlated with water use efficiency and can be used surrogate
method to measure. Relative water content is the sensitive index under cellular water deficit condition. Maintenance of lower stomatal conductance helps in lesser transpiration and photosynthetic rates. Among all the physiological traits, water use efficiency has gained major importance.

03-72

**ISOLATION AND SCREENING OF BACTERIAL ANTAGONISTS AGAINST Sclerotium sp. INCITING COLLAR ROT IN BRINJAL**

_Shiva, B., Deepa Khulbe and Srinivas, P._
Department of Plant Pathology, College of Agriculture, OUAT, Bhubaneswar.

Alternate disease management strategies are imperative for sustainable ecofriendly agriculture in future. Bacterial biocontrol agents have proven to be highly effective for plant disease management, especially soil borne plant pathogens. A number of such isolates also have plant promoting attribute too. In the present study several rhizospheric bacteria were evaluated against their antagonistic property against the soil borne _Sclerotium rolfsii_ causing collar rot in brinjal. About 42 bacterial isolates were isolated from the rhizosphere of solanaceous vegetables and were screened for their phosphate solubilising and antagonistic activities. Among all the selected isolates one isolate putatively identified as _Bacillus_ sp. was found to be having a dual property of phosphate solubilisation and _in vitro_ antagonistic activity against the soil borne pathogen _Sclerotium rolfsii_.

**Keywords**: biocontrol agents, antagonism, soil borne pathogen, _Sclerotium rolfsii_.

A variety of fungi are known to cause important plant diseases, resulting in a significant loss in agricultural crops. The plant diseases need to be controlled to maintain the level of yield both quantitatively and qualitatively. Farmers often depend heavily on the use of synthetic fungicides to control the plant diseases. However, the environmental problems caused by excessive use and misuse of synthetic fungicides have led to considerable.

Table 1: Inhibition of soil borne _Sclerotium_ sp. by different native bacterial isolates.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Bacterial isolates</th>
<th>Growth in mm</th>
<th>Inhibition%</th>
<th>Growth in mm</th>
<th>Inhibition%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ISO-23</td>
<td>12.7</td>
<td>68%</td>
<td>14.7</td>
<td>68%</td>
</tr>
<tr>
<td>2</td>
<td>ISO-16</td>
<td>21.7</td>
<td>46%</td>
<td>26.5</td>
<td>44%</td>
</tr>
<tr>
<td>3</td>
<td>ISO-19</td>
<td>17.5</td>
<td>56%</td>
<td>26.0</td>
<td>55%</td>
</tr>
<tr>
<td>4</td>
<td>ISO-12</td>
<td>26.2</td>
<td>35%</td>
<td>32.0</td>
<td>32%</td>
</tr>
<tr>
<td>5</td>
<td>ISO-17</td>
<td>20.7</td>
<td>48%</td>
<td>24.0</td>
<td>49%</td>
</tr>
<tr>
<td>6</td>
<td>AN-15</td>
<td>14.0</td>
<td>65%</td>
<td>15.5</td>
<td>67%</td>
</tr>
<tr>
<td>7</td>
<td>CONTROL</td>
<td>40.2</td>
<td>-</td>
<td>47.2</td>
<td>-</td>
</tr>
</tbody>
</table>
Results

Bacterial strains were isolated from different solanaceous crops and were screened by the dual plating against *Sclerotium* sp. infecting brinjal. In all 42 isolates were isolated and among them seven were found to be have Phosphate-solubilizing property, they have been further tested antagonism against *Sclerotium* sps. It was found that among all isolates, isolate 23 showed highest antagonism as evident from an high inhibition zone with highest inhibition of 68% (Table 1). Bacterial antagonism may be due to production of toxic metabolites (enzymes, antibiotics and volatile organic compounds), competition for nutrients and space, prevention of pathogen colonization of host tissues and induction of resistance in plants to crop diseases. The bacterial species included in the genera *Pseudomonas, Bacillus, Burkholderia, Lysobacter, Serratia and Pantoea* have been reported to be effective against several plant pathogens by acting through one or more mechanisms. The isolate 23 has been tentatively identified as *Bacillus* sp. based on its growth characteristics. The rhizobacterial species are potent biocontrol agents and also efficient promoters of plant growth, thus providing double benefits to the treated plants. Factors that influence the efficiency of the biocontrol agents have been studied. These studies are useful to select the suitable bacterial strain(s) that could provide higher level of protection to the plants under a particular set of environmental conditions existing in different agro ecosystem.

Changes in people’s attitudes towards the use of synthetic fungicides in agriculture. Today, there is an increase in the awareness of the healthy food and healthy environment. In response to this need, some researchers have focused their effort to develop alternative measures to synthetic chemicals for controlling plant diseases. Among these, is that people about referred to as biological control using microbial antagonists. Many microbial antagonists have been reported to possess antagonistic activities against plant fungal pathogens, such as *Pseudomonas fluorescens, Agrobacterium radiobacter, Bacillus subtilis, B. cereus, B. amyloliquefaciens, Trichoderma viride, Burkholderia cepacia, Saccharomyces spp., Gliocadium spp.* *Sclerotium rolfsii* Sacc. is a devastating soil-borne fungus and it infects more than 500 plant species in tropical and subtropical countries of the world (Aycock, 1966; Punja, 1985). It is presently known as a serious pathogen on many crops of economic importance in most of tropical and sub-tropical regions of the world. It causes blight, root rot, stem rot, foot rot, collar rot, rhizome rot etc. of many crop plants. Management of the plant diseases caused by soil borne pathogens i.e. *Sclerotium rolfsii* Sacc. is very difficult with fungicides alone as this fungus displays strong ability to survive in soil through the formation of dark brown spherical sclerotia that have strong resistance to both chemical and biological degradation (Chet & Henis, 1972; Punjor, 1985). In recent years, the biological controls of soil-borne pathogens such as *S. rolfsii* have also been investigated (Baker, 1987; Lockwood, 1988; Jadon, 2009).

Materials and methods

Infected plant part was washed in running tap water and cut into small bits (2-3 mm). These bits were surface sterilized with Sodium hypochlorite (20 %) solution for 60 sec. Subsequently they were washed in sterile distilled water to remove traces of Sodium hypochlorite. The bits were picked up and placed using a sterilized needle and forceps in the centre of the petriplates containing potato dextrose agar. Bacterial strains were isolated from rhizosphere soil and root of soil serial dilution method at the concentration of 10^-4-10^-6 employing Pikovskaya Agar media. Rhizoplane bacteria were isolated by cutting the root portion in pieces of 5-6 mm length inoculated in 3-different media Pikovaskya, Kings- B media, and pseudomonas specific media. The pathogenicity of isolated *S. rolfsii* strain on the brinjal was confirmed by collar inoculation method under greenhouse condition. The typical symptoms were produced within a week of the inoculation, which were identical to those produced in the field.

The antagonistic activity of all bacteria isolates was studied on *Sclerotium* sps by dual culture technique (Francisco et al., 2011). On Petri dishes with PDA a bacterial streak was made adjacent to a disk of 5mm mycelium of the same diameter of *Sclerotium* sps. The effect of bacteria on pathogen was determined by mycelia growth inhibition (Saeideh et al., 2008).
Genetically modified (GM) crop Technique is a biotechnological tool where in the plants, one or more genes coding for desirable traits have been inserted. The genes may come from the same or another plant species or from totally unrelated organisms. The traits targeted through genetic engineering are obtained the same as those pursued by conventional breeding. However genetic engineering allows for direct gene transfer across species boundaries, some traits that were previously difficult or impossible to breed can now be developed with relative ease.

At global level, genetic engineering methods were developed over 30 years ago, and since then GM crops have become commercially available and widely adopted. Farmers have widely adopted GM technology although certain coercive groups have acted as catalyzing forces in their respective domains to press hard for legal official sanction. Global area under cultivation of 11 GM crops increased 110 fold from 1996 to 2016 i.e. 1.7 million hectares to 185.1 million hectares in last 21 years, in 30 countries 22 were developing countries and 8 were developed countries. India ranked fourth in the area under global GM crops presently only one GM crop Bt cotton under cultivation and it occupies 11.6 million hectare area. (International service for the acquisition of agri-biotech applications (ISAAA, 2016).

The introduction of semi-dwarﬁng, high-yielding and nutrients-responsive crop varieties in the 1960s and 1970s alleviated the suffering of low crop yield, food shortages and famines in India and other parts of the Asian continent. In contrast, the revolutionary new genetics of crop improvement shamble over formidable obstacles of regulatory delays, political interferences and public misconceptions. India beneﬁted immensely from the green revolution and is now grappling to deal with the nuances of GM crops. The Green Revolution, which brought together improved varieties, increased use of fertilizer, irrigation and synthetic pesticides, is credited with helping to feed the current global population of 6 billion. The ability of pesticides to reduce crop losses, it also discusses their potential negative effects on public health, with particular emphasis in developing countries, and the environment. The response of the agricultural industry in bringing forward new technology such as reduced application rates of targeted pesticides with lower toxicity and persistency is noted. However, with increasing world population, a slowing of the rate of crop improvement through conventional breeding and a declining area of land available for food production there is a need for new technologies to produce more food of improved nutritional value in an environmentally acceptable and sustainable manner.

India’s policy on GM crops has undergone various shifts. Indian government has set up a regulatory structure to screen GM products and showed interest in agricultural biotechnology as early as the 1980’s. The first application for commercialization of a GM crop was accepted in 1996, but it was 8 eight years later i.e., in 2002 that the first GM crop, Bt cotton was introduced (for control of bollworm complex) the major pest heliothis has developed many fold resistance to the pesticides and at that time total cotton industry was under big stress. In 2005 more applications for Bt cotton were cleared, but no other GM crops has been approved. Approximately, 11.6 million hectares of GM cotton grown in India as of 2016. The future of biotechnology in India is continued to be a source of debate. The government has recently released a draft biotechnology development strategy outlining the agricultural biotechnology as potential for India’s development.
The potential impacts of genetically modified (GM) crops on income, poverty and nutrition in developing countries especially under Indian context continue to be the subject of public controversy. As an example of GM technology at initial period, the effects of insect-resistant Bt cotton are analyzed. Bt cotton has already been adopted by millions of small-scale farmers, in India, China, and South Africa among others. On average, farmers benefit from insecticide savings, higher effective yields and sizeable income gains. Insights from India suggest that Bt cotton is employment generating and poverty reducing. In addition to insecticide reductions, a major effect of Bt cotton in India is a sizeable yield advantage due to lower crop losses (Qaim and Zilberman,2011). Over the years, average yields were 30–40% higher on Bt than on conventional plots, which is due to more effective pest control and thus a reduction in crop damage. These are large benefits for cotton-producing households in India, many of whom live near or below the poverty line. Extrapolating these profit gains to the total area under Bt cotton in India (11.6 million ha, 2016) implies an additional 1.13 billion US$ per year in the hands of smallholder farmers.

On a global basis GM technology has reduced pesticide use, with the size of the reduction varying between crops and the introduced trait. It is estimated that the use of GM soybean, oil seed rape, cotton and maize varieties modified for herbicide tolerance and insect protected GM varieties of cotton reduced pesticide use by a total of 22.3 million kg of formulated product in the year 2000. Insecticides usages in the India in cotton/annum is drastically reduced since 2001 from 46% (i.e.4470 Mt) market share to 20% (i.e.222 Mt) in 2011 that equivalent to use of 172 million kg less Pesticide and 14% reduction of environmental footprint associated with pesticide use and it has also made a significant contribution to reducing the green house gas emission up to 10 billion kg, it has equal to removing five million cars from the roads for a year.

Estimates indicate that if 50% of the maize, oil seed rape, sugar beet, and cotton grown in the EU were GM varieties, pesticide used in the EU/annum would decrease by 14.5 million kg of formulated product (4.4 million kg active ingredient). In addition, there would be a reduction of 7.5 million ha spray which would save 20.5 million litres of diesel and result in a reduction of approximately 73,000 t of carbon dioxide being released into the atmosphere.

Genetically modified (GM) crops have been used commercially for more than 21 years. Available impact studies of insect-resistant and herbicide-tolerant crops show that these technologies are beneficial to farmers and consumers, producing large aggregate welfare gains as well as positive effects for the environment and human health. The advantages of future applications could even be much bigger. Given a conducive institutional framework, GM crops can contribute significantly to global food security and poverty reduction. now we are realized the benefits of Bt cotton so we can move for further stages of advanced GM crop technology, i.e. improved nutrition, enhanced pest resistance, increased yields and new products for example the likely impacts of beta-carotene rich Golden Rice are analyzed from an extant perspective. Vitamin A deficiency is a serious nutritional problem, causing multiple adverse health outcomes. Simulations for India show that Golden Rice could reduce related health problems significantly, preventing up to 40,000 child deaths every year. These examples clearly demonstrate that GM crops can contribute to poverty reduction and food security in developing countries. To realize such social benefits on a larger scale requires more public support for research targeted to the poor, as well as more efficient regulatory and technology delivery systems.

In relation to the issue of ‘unnaturalness’ that GM modification did not differ to such an extent from conventional breeding that it is in itself morally objectionable. In making an assessment of possible costs, benefits and risks, it was necessary to proceed on a case-by-case basis. However, the potential to bring about significant benefits in developing countries (improved nutrition, enhanced pest resistance, increased yields and new products) meant that there was an ethical obligation to explore these potential benefits responsibly, to contribute to the reduction of poverty, and improve food security and profitable agriculture in developing countries. (The Nuffield Council on Bioethics (NCOB,2004)).

The recent controversy regarding the GM-Mustard variety-MVH12 which is placed at the door step of Genetic Engineering Approval Committee’s (GEAC) to be released for commercial cultivation tells the gamut of problems surrounding these crops in India.
It is a fact from all above benefits it is time to accept other GM crops in the benefit of farming and downward society and at the same time proper evaluation of their negative impacts can lead to change in the government policies. It has to be addressed on all the ethical, social and moral concerns of public and develop awareness among the people about GM crops and also increase the public sector shareholding in R&D of GM crops to avoid monopoly of corporate MNC’s to protect farmer interest and also keep in the mind impacts of terminator gene technology and biodiversity for sustainable growth and development.

03-74

ECO-FRIENDLY MANAGEMENT OF BANDED LEAF AND SHEATH BLIGHT OF LITTLE MILLET (PANICUM SUMATRENSE) CAUSED BY RHIZOCTONIA SOLANI KUHN

Bharat Kumar, Jain, A.K., Tripathi, S.K., Sharma, S and Prajapati, S.
Department of Plant Pathology
JNKVV, College of Agriculture, Rewa, M.P.
Corresponding author: bharat00dubey@gmail.com

Among small millets, little millet (Panicum sumatrense) belonging to family Poaceae is one of the hardiest low water demanding small seeded crop grown by tribal and poor farmers in marginal lands for food and feed. It has an excellent rejuvenating capacity compared to other cereal crops. In India, area of little millet is about 291 thousand hectares with annual production of 102 thousand tones and productivity of 349 kg ha⁻¹. The area of little millet in Madhya Pradesh is about 51.54 thousand hectares with productivity of 525 kg ha⁻¹. Banded leaf and sheath blight caused by Rhizoctonia solani is becoming an important constraint for little millet cultivation and affect the crop at all the stages of crop growth. Formation of irregular lesions with straw colour centre and a wide reddish brown margin are the important symptoms produced by the fungus in host plant. In the present study, three biocontrol agents namely Trichoderma viride (T.v.), Pseudomonas fluorescens(P.f.) and Bacillus subtilis (B.s.) were evaluated as seed treatment and soil application for the management of BLSB. All the biocontrol agents were found to minimize the severity (relative lesion height) of BLSB from 43.9 to 69.1%. Lowest RLH and maximum reduction was recorded in soil application of value added P.f. + T.v. + B.s. @ 335 g each of formulation mixed in 25 kg FYM, incubated for 15 days and applied over an area of 1 acre at the time of sowing and results were at par with soil application of value added T.v. or P.f. @ 1 kg formulation mixed in 25 kg FYM, incubated for 15 days and applied over an area of 1 acre at the time of sowing. An increase in grain yield of little millet varied from 10.5 to 23.4% in the different treatments. The highest grain yield of little millet was also obtained in the same treatments.

03-75

SCREENING OF PGPR MICROORGANISMS FROM THE SOIL

Hari Priya, V and Jayanthi Abraham
Microbial Biotechnology Laboratory, School of Bio-Sciences and Technology,
VIT University, Vellore.
Corresponding author: haripriya.vattikuti@gmail.com

Plant growth promoting rhizobacteria posses vital role in increasing fertility of the soil, promoting plant growth and protection from phytopathogens for sustainable agriculture. The primary motive of this research was to check for any microbial species with the ability to produce PGPR activity from the soil. Seven different bacterial isolates and four fungal isolates, morphologically distinct, were screened for PGPR activity. The isolates were tested for antimicrobial activity against E.coli, Salmonella, Klebshiella, Pseudomonas, Staphylococcus aerus, Serratia, Proteus mirabilis. Enzyme assays such as laccase, cellulose, chitin, lignin and protease were performed. Isolates were tested for heavy metal degradation using zinc. Isolates were
tested for ammonium production and HCN production. Through this study, isolated bacterial and fungal strains from the agricultural soil in Andhra Pradesh. From these seven bacterial isolates obtained from the soil, three isolates showed good activity for nitrogen fixation and potash solubilization. They also had capability of cell wall degrading enzyme activity such as protease, cellulase and chitin activity. Fungal isolates showed good IAA, HCN and ammonia production. There by these isolates can be used for lateral root and shoot growth. They serve as a good promoting factor. Isolated strains were also checked for zinc utilization capacity and two of the bacterial isolate showed very good activity. Hence it can be concluded that these isolates can be used for agricultural purpose that is can be used as an excellent biofertilizer.

**Keywords:** PGPR, enzyme assay, antimicrobial activity, Salmonella, Serratia, E.coli.

03-76

**INDICES FOR SCREENING OF DROUGHT TOLERANCE IN MAIZE (Zea mays L.)**

*Dinesh Rahul, V., Rama Rao, G., Jayalalitha, K., Ashoka Rani, Y and Hareesh Babu, P.*

Department of Crop Physiology, Agricultural College, Bapatla.

Corresponding author: dineshrahuly@gmail.com

Maize -The crop of future, as mentioned by Dr. Norman E. Borlaug is one of the third most important crop next to wheat and rice in the world. Maize is an important cereal food crop mostly used as a fodder for poultry and livestock which accounts for 66% of its production. In India with the growth in-demand of poultry feed increased the interest for maize. However, an estimated 15% to 20% of maize grain yield is lost every year due to drought and such losses may further increase with the severity of drought due to climate change. The genotypes which withstand and overcome the drought can be evaluated for drought tolerance which serves the need of high production even under changing climate. Drought tolerance is a complex trait whose expression includes changes in morphology, physiology, and biochemistry. Development of drought tolerance in maize serves the most effective way of sustaining maize production in drought prone areas. Drought tolerance in maize is contributed by many different characters, the Improvement of drought tolerance in high yielding genotypes could be brought about only through the incorporation of those morphological and physiological mechanisms of drought tolerance. Indexing yield to some quantifiable measure of stress severity is the only means of quantitatively evaluating relative drought tolerance in a larger collection of cultivars. There are different indices used for the screening of drought tolerance in maize which may be grouped under five different categories as follows Morphological, Phenological, Physiological, Biochemical, and Agronomic indices. The morphological indices include Plant Height, Cob Height from the ground, Leaf angle, Leaf rolling, Leaf senescence, Tassel Branching, silk length, Root length and Root branching. The genotypes which show less reduction in plant height and less cob height, narrow leaf angle, less leaf rolling and senescence, more tassel branching, reduced silk length, more root length and branching are considered to be more tolerant to drought. Phenological indices include Anthesis silking interval, days to 50% anthesis and days to 50% silking. Drought induces reduction in the anthesis to silking interval the genotypes with less number of days between the anthesis and silking are considerd to be more drought tolerant. Physiological indices include Relative leaf water content, Leaf water potential, Chlorophyll stability index, Cell membrane stability index, Membrane injury index and Chlorophyll florescence index. Maize crop subjected to drought stress undergo many physiological changes the genotypes which show less reduction in the Relative leaf water content are considered to be more tolerant, the genotypes with more chlorophyll stability index, Chlorophyll florescence index, Cell membrane stability and less membrane injury index are considered to be more drought tolerant. Biochemical indices include Proline content, ABA, Peroxidase, Catalase, Lipid peroxidase, Super oxide dismutase and Leaf epicuticular waxes. Drought induces the accumulation of different polyamines of low molecular weight and proline is one among them the genotypes with higher proline content are considered to be more drought tolerant. The drought stress also induces the accumulation of oxygen radicals, H₂O₂ and other reactive oxygen
species, plant to protect itself from these oxidative damage increases its antioxidant activity of different enzymes
the genotypes with high antioxidant activity are considered to be more drought tolerant. Agronomic indices
include Yield stability index, Drought stability index and Drought tolerance index. Reduced water supply definitely
reduces the yield the genotypes which show less reduction in yield are considered to be more drought tolerant
gronomically. The genotypes with best performing to the above indices may be considered for selection.

**Keywords:** Maize, drought, climate change, screening

03-77

**COMPARATIVE EFFICACY OF NEWER INSECTICIDE MOLECULES AGAINST BROWN PLANTHOPPER, Nilaparvata lugens STAL.**

Deekshita, K., Rama Rao, C.V., Sandhya Rani, C and Prasanna Kumari, V.
Department of Entomology, Agricultural College.
Corresponding author: deekshitakonchada@gmail.com

Comparative bioefficacy of few newer insecticides were tested against brown planthopper of rice under field conditions during kharif 2015 at Agricultural College Farm, Bapatla. The data on planthoppers
inferred that pymetrozine 50 WG @ 0.5 g l\(^{-1}\) proved to be the most effective insecticide in reducing population
by recording highest per cent population reduction (62.98%) over untreated control. The insecticide dinotefuran
20 SG @ 0.4 g l\(^{-1}\) (59.60 %) was on par with pymetrozine in suppressing the pest population and also these
three chemicals recorded with the highest grain yields 5266 and 5228 kg ha\(^{-1}\).

About 100 insects were recorded as pests on rice crop, of them 20 are designated as major pests.
Among them, brown planthoppers constitute one of the most important pest causing substantial yield losses.
Use of insecticides forms one of the most effective management tools and an important component of Integrated
Pest Management (IPM) besides biological and cultural means. Insecticide proves to be the only option
where we can rely for emergency management of insect pest reaching on or beyond ETL. The indiscriminate
use of broad spectrum chemicals reduces the biodiversity of natural enemies, reduce the natural control and
induce outbreak of secondary pests and contaminate eco-system result in resurgence of brown planthopper.
As, the resistance to existing insecticides is an on-going problem that requires the development of new insect
control tools so there is a need to evaluate the new groups, new formulations of insecticides and their
combinations for their target and non target effects.

**Material and Methods**

Field experiment was conducted during kharif 2015 in Randomised Block Design (RBD) with nine
treatments including untreated control replicated thrice. The insecticide treatments includes imidacloprid 17.8
SL, thiamethoxam 25 WG, acetamiprid 20 SP, sulfoxaflor 25 SC, dinotefuran 20 SG, pymetrozine 50 WG,
buprofezin 25 SC and monocrotophos + dichlorvos 36 SL + 76 EC along with untreated control. The
planthopper susceptible variety Sambha mashuri (BPT 5204) was grown in plot of size 20 m\(^{2}\) at spacing of 20
x 15 cm with recommended package of practices excluding plant protection. The treatments are imposed as
and when the pest reaches ETL. The data on population of BPH on 10 randomly selected hills from each plot
were recorded at one day before the application of treatments, three days after spray and five days after
spray.

**Results and Discussion**

The data regarding the efficacy of treatments after first spray revealed that five days after first spray
pymetrozine 50 WG @ 0.5 g l\(^{-1}\) proved superior (7.03/hill) followed by dinotefuran 20 SG @ 0.4 g l\(^{-1}\) (7.60/
hill) and sulfoxaflor 25 SC @ 0.75 ml l⁻¹ (7.90/hill) by recording 66.14, 63.38 and 60.85 per cent population reduction over untreated control respectively. The data after second spray showed that after five days after second spray pymetrozine 50 WG @ 0.5 g l⁻¹ was found to be superior with lowest mean population of BPH (5.03/hill) followed by dinotefuran 20 SG @ 0.4 g l⁻¹ (6.33/hill) and sulfoxaflor 25 SC @ 0.75 ml l⁻¹ (6.33/hill) and on par with each other and recorded 74.43, 68.91 and 65.53 per cent reduction of BPH over untreated control respectively. The results after two sprays indicated that pymetrozine 50 WG @ 0.5 g l⁻¹, dinotefuran 20 SG @ 0.4 g l⁻¹ and sulfoxaflor 25 SC @ 0.75 ml l⁻¹ provided superior control of BPH as compared to other traditional neo nicotinoids like imidacloprid, acetamiprid and thiamethoxam. Present findings are also experimentally corroborated by earlier workers. In former studies dinotefuran 25 g a.i. ha⁻¹ performed very good spectrum of action throughout the seasons against brown planthopper (Ghosh et al., 2014) Pymetrozine 50 WG @ 400, 350, 300, 250 and 200 g a.i ha⁻¹ was superior in minimizing the population of BPH in rice (Murali et al., 2009). Similarly the efficacy of pymetrozine (24 g a.i. ha⁻¹) against BPH after three and seven days after application was 73.69 % and 64.92 % respectively over control (Gui et al., 2009)

03-78

DETECTION OF SEED BORNE MYCOFLORA OF GROUNDNUT
(Arachis hypogaeae L.)

Srinivas, A., Pushpavathi, B., Lakshmi, B.K.M and Shashibhushan, V.
Department of Plant Pathology, College of Agriculture, Hyderabad.
Corresponding author: sunny.srinivas76@gmail.com

The groundnut seeds were subjected to standard blotter and agar plate methods as recommended by ISTA, for detection of seedborne mycoflora. Fourteen fungi belonging to eleven genera viz., Macrophomina phaseolina, Rhizoctonia sp., Aspergillus flavus, Aspergillus niger, Aspergillus ochraceus, Aspergillus ustus, Fusarium sp., Rhizopus sp., Alternaria sp., Mucor sp., Penicillium sp., Trichoderma sp., Chaetomium sp.and Cladosporium sp. were recorded through standard blotter method, whereas twelve fungi belonging to ten genera Macrophomina phaseolina, Rhizoctonia sp., Aspergillus flavus, Aspergillus niger, Aspergillus ochraceus, Fusarium sp., Rhizopus sp., Alternaria sp., Mucor sp., Penicillium sp., Trichoderma sp.and Cladosporium sp. were recorded through agar plate method. Several pathogenic and storage fungi were observed in both the methods. Among the fungi detected, frequency of Aspergillus niger was found significantly highest in both the methods (standard blotter method - 40.00% and agar plate method - 33.00%). Of the two methods tested for detection of seed mycoflora, standard blotter method was found superior over agar plate method.

03-79

CORRELATION AND PATH ANALYSIS STUDIES OF GRAIN YIELD, YIELD ATTRIBUTES AND QUALITY TRAITS OF RATOONING IN RICE
(Oryza sativa L.).

Hari Ram Kumar, B., Satyanarayana, P.V., Ratna Babu, D., Srinivasa Rao, V.
Chamundeswari, N and Krishnam Raju, S.
Department of Genetics & Plant Breeding, Agricultural College, Bapatla.
Corresponding author: hrk.bandiazu@gmail.com

Twenty varieties were used for correlation and path analysis studies of ratoon rice for twenty seven traits (yield, yield attributing and grain quality traits), revealed that the genotypic correlations were, in general are higher than phenotypic correlations indicating that the apparent associations are largely due to genetic
reasons. The traits, days to 50% flowering, days to maturity, plant height, total number of tillers per plant, total number of tillers as percentage of main crop total number of tillers, number of vegetative buds after harvest of main crop, number of ear bearing tillers, number of ear bearing tillers as percentage of main crop ear bearing tillers, panicle length per plant, number of grains per panicle, test weight, milling percentage, head rice recovery, kernel length, kernel length after cooking, kernel linear elongation ratio, gel consistency and alkali spreading value were found to possess significant association in desirable direction with grain yield per plant. Path analysis revealed the true relationship of days to 50% flowering, days to maturity, number of vegetative buds after harvest of main crop, number of ear bearing tillers as percentage of main crop ear bearing tillers, hulling percentage, kernel length, kernel length after cooking, volume expansion ratio, water uptake and gel consistency by establishing significant positive association and positive direct effect with grain yield per plant. The residual effect permits precise explanation about the pattern of interaction of other possible components of yield i.e., residual effect measures the role of the possible independent variables which were not included in the study on the dependent variable. The residual effect of 0.142 was observed in the present study, indicated that the characters included were contributed more than 86.80 per cent of variability pertaining the dependent variable i.e., yield. However, closer scrutiny of correlation and path coefficient analysis revealed that, simultaneous improvement of ratoon crop grain yield per plant with good quality may possible through manifestation of days to 50% flowering, days to maturity, number of vegetative buds after harvest of main crop, number of ear bearing tillers as percentage main crop ear bearing tillers, kernel length, kernel length after cooking and gel consistency.

Key Words: Association, path analysis, ratoon rice and Oryza sativa L.

EFFECT OF MILK AND MILK PRODUCTS ON BLACKGRAM POWDERY MILDEW

Manasa, P and Anil Kumar, P.
Department of Plant Pathology, Agricultural College, Bapatla.
Corresponding author: manasa.mahi68@gmail.com

Black gram is one of the important pulse crop grown in all the 3 seasons such as kharif, rabi and summer and throughout India. It is consumed in the form of dal (whole or split, husked and unhusked or parched). Urd grain contains 24% protein, 60% CHO, 1.3% fat and is the richest source of phosphoric acid among pulses (5-6% richer than others). It is used as a nutritive fodder specially for milch cattle. It is also used as green manuring crop. Being deep rooted crop, helps in binding soil particles and thus prevents soil erosion.

Milk has become the latest secret weapon in fighting powdery mildew. Actually it’s not so secret and it’s been used in treating diseases for decades. It’s been tried as an additive to improve the spreading and sticking of other pesticides.

More than fifty years ago, researchers in Canada discovered that milk sprays could help prevent powdery mildew on tomato and barley. More recently, a spray made of 40% milk and 60% water as effective as chemical fungicides in managing powdery mildews on several plants.

Milk diluted with water helps to prevent some types of fungus from endangering plants, as well as giving plants added nutrients. Diluted milk can be poured directly into the soil or sprayed on to leaves. The proteins present in the milk offer an antiseptic-like effect, when exposed to sunlight, to be effective, the solution should be applied in bright sun.

Black gram is affected by several diseases of which powdery mildew is an important disease capable of causing huge losses in yield. Keeping in view of the hazardous nature of chemical fungicides, management through natural products such as milk is envisaged.
03-81

SCREENING OF GERMPLASAM AGAINST ALTERNARIA LEAF SPOT OF BLACKGAM

Ambarish, K.V., Adhinarayana, M and Anil kumar, P.
Department of Plant Pathology, Agricultural College, Bapatla.
Corresponding author: ambarishkv111@gmail.com

Blackgram or Urdbean (Vigna mungo (L.) Hepper) belongs to family leguminaseae and is one of the important pulse crop in Andhra Pradesh especially under rice fallows considered to be one of the important disease. Of late, in Andhra Pradesh Alternaria leaf spot is causing drastic impact on the growth and development of the crop resulting in severe yield losses. Hence, there is an immediate need to identify the resistance/tolerance sources for Alternaria leaf spot in order to strengthen the breeding programmes aiming to improve the yield coupled with resistance to Alternaria leaf spot. In order to assess the resistance existing in available blackgram genotypes, 55 blackgram genotypes were screened under natural conditions at Regional Agricultural Research Station (RARS), Lam farm, Guntur during kharif 2017-18. Of these 55, only eight genotypes are moderately susceptible (14.55%), three genotypes showed susceptible reaction (5.45%) and remaining 44 genotypes were highly susceptible (80%). None of the genotypes showed resistant or highly resistant reaction.

03-82

NANOTECHNOLOGY AND ITS APPLICATIONS IN AGRICULTURE

Deekshitha, D.K.D., Raj Rushi, V.S.L and Gouthami, N.
Department of Soil Science and Agricultural Chemistry, Agricultural College, Bapatla.

Agriculture is the backbone of most developing countries, with more than 60% of the population reliant on it for their livelihood. Agricultural scientists are facing a wide spectrum of challenges which can be dealt with by exploring one of the frontier technologies such as ‘Nanotechnology’. Nanoscience is the study of phenomena and manipulation of materials at atomic, molecular and macromolecular scales, where properties differ significantly from those at a larger scale (The Royal Society and the Royal Academy of Engineering, 2004). Several nanotechnology applications for agricultural production are Nanoforms zeolites for slow release and efficient dosage of water and fertilizers for plants, Nanosensors for soil quality, plant health monitoring; and pest detection, Nanomagnets for removal of soil contaminants, Nanoparticles for new pesticides, insecticides and insect repellents (Salamanca et al., 2005).

Simonian et al. (2005) described a novel strategy for the direct detection of OP neurotoxins based on the change in fluorescence of a competitive inhibitor of the OPH enzyme produced by the presence of gold nanoparticle attached to the enzyme. the genes of plants or animals can be manipulated using nanoparticles, nanofibres and nanocapsules. (Vassaux et al., 2006; Torney et al., 2007). According to Satapanajaru et al. (2008) nano ZVI can be successfully used to remediate atrazine in water and soil. Khodakovskaya et al. (2009) have reported the use of carbon nanotube for improving the germination of tomato seeds.

Foliar application of nanoliquid fertilizer, Ferbanat improved the growth and yield of cucumbers. (Ekinci et al., 2014). nano-P application enhanced P use efficiency from 15% (P fertilizer) to 58%. Nanoparticles Zn (10 ppm) and Fe (30 ppm) increase polysaccharide release by microorganisms which help in reducing erodibility of soil. (Tarafdar and Indira, 2016)
EFFECT OF GAMMA RADIATION ON SEED MYCOFLORA AND SEED QUALITY PARAMETERS OF GROUNDNUT AT DIFFERENT STORAGE PERIODS

Srinivas, A., Pushpavathi, B., Lakshmi, B.K.M and Shashibushan, V.
Department of Plant Pathology, College of Agriculture, Hyderabad.
Corresponding author: sunny.srinivas76@gmail.com

Groundnut seeds were treated with gamma radiation @ 0.1, 0.3, 0.5, 1.0, 1.5 and 2.0 kGy and the radiation effect on seed mycoflora at different storage periods (upto 3 months) was studied using standard blotter method. A total of 13 seedborne fungi belonging to 10 genera viz., Macrophomina phaseolina, Rhizoctonia sp., Rhizopus sp., Aspergillus flavus, Aspergillus niger, Aspergillus ochraceus, Aspergillus ustus, Alternaria sp., Fusarium sp., Penicillium sp., Trichoderma sp., Chaetomium sp. and Cladosporium sp. were recovered from untreated and treated seeds at different storage periods. Of the treatments tested, gamma radiation at 2.0 kGy (31.34%) was found significantly superior followed by 1.5 kGy (35.16%), 1.0 kGy (70.84%) and the least (77.56%) with 0.1 kGy. It was also observed that, Aspergillus niger was found to be predominant in all the dosages tested followed by Aspergillus flavus, Rhizopus sp. and Fusarium sp. Field mycoflora viz., Macrophomina phaseolina and Rhizoctonia sp. were recorded in all the treatments tested except Rhizoctonia sp. which was completely inhibited at 2.0 kGy treatment. Other fungi viz., Alternaria sp., Penicillium sp., Trichoderma sp., Aspergillus ochraceus, Aspergillus ustus, Chaetomium sp. and Cladosporium sp. were rarely recorded from the treatments tried and further reduced with the increase in dosage. Effect of gamma radiation on seed quality parameters was also tested and results indicated that gamma radiation can’t be used as seed treatment in groundnut due to reduced germination and vigour.

NANO TECHNOLOGY – A BOON FOR PLANT DISEASE MANAGEMENT

Sumanth Kumar, M., Prasanna Kumari, V and Anil Kumar, P.
Department of Plant Pathology, Agricultural College, Bapatla.
Corresponding author: sumanthmangalapuri@gmail.com

Crop diseases have an enormous impact on farming productivity and profits. Continuous usage of chemicals to manage plant diseases, result in residual toxicity in crop and their produce, in soil and water resources resulting in tremendous impact on nature and life. Nano molecules would be an ecofriendly alternative to chemicals in disease management. When macromolecules are manipulated to the size of nano particles (1-100 nm) they behave in unique way gaining properties such as increased surface to volume ratio, improved surface catalytic activity, higher reactivity and mobility in the body of the organism including cellular entry. The nano particles act upon pathogens in a way similar to chemical pesticides and the nano particles can be used as carrier of active ingredients of the pesticides (pesticide nano formulations) to target pathogens. They can cover wide area with limited usage preventing residual toxicity. Nano-based anti microbes like Cu, Fe, Si, Ag, Au are produced with ease using certain fungi, bacteria and viruses which fight against fungal and bacterial pathogens to a greater extent of 100% besides fortifying the plant. The nano particles also aid to make their usage as diagnostic probes in pathogen detection and residue analysis. Thus nanoparticles have wide potential in plant disease diagnosis and an ecofriendly mode of disease management.
NEXT GENERATION TECHNIQUES IN PLANT BREEDING. 
PRINCIPLES AND PROSPECTS.

Ayesha, Md., Ratna Babu, D., Satyanarayana Rao, V and Dayal Prasad Babu, J.
Department of Genetics and Plant Breeding, Agricultural College, Bapatla.
Corresponding author: smilesofaisha@gmail.com

Plant breeding until the year 2000 was primarily an intentional selection process in which seeds of most suitable crops were kept for following growing season. Upon rediscovery of laws of Mendelian inheritance, plant breeding was given a theoretical basis. To make our food production system more efficient, sustainable & flexible continued efforts must be made in plant breeding & cultivation techniques.

Although traditional breeding is based is based on the steps of crossing and selection remains an ongoing activity for crop improvement, it faces limitations as many crops have complex genetics (Ex: because not all crosses produce fertile offspring) or a long generation time (Ex: fruit trees). Novel plant breeding techniques are focussed on accelerating the breeding cycle by indirectly using genetic modification techniques. Compared to traditional breeding these techniques reduce the time and effort needed to produce new crop varieties.

Cis-genesis is the production of GM plants using donor DNA from species itself or from a cross compatible species. Intra genesis is similar to cis-genesis but the difference is that they are introduced as a new combination of functional elements of different genes. Grafting on a GM rootstock is a technique wherein a non-GM scion is grafted onto a GM rootstock, the resulting combined plant will be regarded as genetically modified, but products (flowers/fruits) harvested from scion do not carry genetic modification.

A heterozygous offspring plant that is selected from a breeding programme cannot be reproduced from seeds as the unique combination of genetic variance will be lost upon further seed multiplication. A strategy called ‘Reverse breeding’ was designed by the company ‘Rijk zwaan’ to create parental lines, to produce selected heterozygous offspring plant from seed. Another technique to develop a GM plant is through Agro-infiltration where in it uses soil bacteria that transfers DNA to plant cells. This is primarily used as a selection method during breeding programmes for obtaining disease resistance plants. Accelerated breeding following the induction of early flowering is a breeding strategy where in the juvenile phase of the plants is shortened for precocious flowering.

RNA dependent DNA methylation uses plants RISC system for silencing the expression of specific plant genes. It results in epigenetic variation & this phenomenon is mediated by small interfering RNA (siRNA). Oligonucleotide directed mutagenesis is a technique wherein small synthetic DNA molecules are introduced in plant cells thereby the plants target DNA sequence is altered as desired. This technique has been successfully applied in several plant crops (Ex: to generate herbicide tolerance. Sequence specific nucleases (SSN) are the synthetic proteins designed in the lab which at any location in DNA can be stably knocked out, mutated or replaced. Different variants of SSN include ZFN, TALEN’s, CRISPER/CAS9 etc.

Nanotechnology refers to- controlling, building and restructuring materials and devices on the scale of atoms and molecules. A nanometer (nm) is one-billionth of a meter. Nanoscale carriers can be utilized for the efficient delivery of fertilizers, pesticides, herbicides, plant growth regulators etc. The mechanisms involved in the efficient delivery, include: Encapsulation and Entrapment, surface ionic and weak bond attachments among others & improve stability against degradation in the environment and ultimately reduce the amount to be applied, which reduces chemical runoff and alleviates environmental problems.

One of the processes using nanoparticles is ‘photocatalysis’. It is a combination of two words ‘photo’ means ‘light’ and ‘catalysis’ means ‘reaction caused by a catalyst’. So, it involves the reaction of catalyst (nanoparticles) with chemical compounds in the presence of light. Nanoparticles can be used for the
bioremediation of resistant or slowly degradable compounds like pesticides. These harmful compounds tend to join the positive holes, are degraded and converted into non-toxic compounds. Photocatalysis can be used for purification, decontamination and deodorization of air. It has been found that semiconductor sensitized photosynthetic and photocatalytic processes can be used for the removal of organics, destruction of cancer cells, bacteria and viruses.

Quantum dots (QDs) for staining bacteria - There are numerous bacteria which are responsible for many diseases in humans like tetanus, typhoid fever, diphtheria, syphilis caused by different species. To stain bacteria, the most commonly used BIOLABELS are organic dyes, but these are expensive and their fluorescence degrades with time. Fluorescent labeling by quantum dots (QDs) with bio-recognition molecules has been discovered through the recent developments in the field of luminescent nano.

03-86

SPLAT- AN EFFECTIVE METHOD OF PHEROMONE DISPERSION FOR THE MANAGEMENT OF PESTS.

Prashanthi, P., Anil Kumar, K and Debjyoti Chakraborty
Department of Entomology, Agricultural College, Bapatla.
Corresponding author: prashanthi0617@gmail.com

Pheromones are important component in Integrated Pest Management in agriculture. Artificial introduction of these semiochemicals into field, elicits a specific response to a specific insect pest, leaving desirable non-target organisms, like natural enemies and pollinators, often unaffected. It is proven difficult to develop and commercialize effective, economically-viable semiochemical based pest control technologies. SPLAT (Specialized Pheromone and Lure Application Technology) emulsion is a unique controlled-release technology that can be adapted to dispense and protect a wide variety of compounds from degradation, including semiochemicals, pesticides and phagostimulants, in diverse environments.

SPLAT emulsions releases the optimal rate of semiochemical for the desired amount of time, while protecting active ingredients from degradation. SPLAT products are formulated to release semiochemicals for 2 weeks to 6 months and the longevity depends on its composition, how it was applied, as well as the environmental conditions. SPLAT is a “matrix-type” or “monolithic” diffusion-controlled release device that compresses the active ingredients with the slowly releasing carrier materials. Because of its controlled-release capacity, SPLAT formulations typically use smaller amounts of active ingredients than other semiochemical products, reducing application costs and environmental impact.

Several SPLAT formulations are available for mating disruption, repellent and attract-and-kill. Furthermore, the biodegradability and low manufacturing cost of SPLAT significantly decrease environmental impacts and enable commercialization of more affordable semiochemical-based control products. Thus the results on SPLAT will encourage the farmers to adopt this technology in crop pest management.

Keywords: Splat, semiochemicals.
EFFICACY OF FUNGICIDE ON SHEATH BLIGHT SEVERITY (LESION LENGTH) OF RICE

Ashok Kumar, K., Indra Kumar, Anil, Kotasthane, S and Toshy Agrawal
Department of Plant Pathology, CoA, IGKV Raipur.
Correspondence: ashokkoshariya@gmail.com

Sheath blight caused by *Rhizoctonia solani* Kühn (teleomorph: *Thanatephorus cucumeris* (A.B. Frank) Donk) is a major constraint (second only to rice blast) to rice production (Teng, Torres, Nuque, & Calvero, 1990), causing 5-10% yield losses in low land tropical Asia (Willocquet *et al.*, 2004). Nine fungicides (Taqat, Captaf, Contaf Plus, Pulsor, Propiconazole, Ill-Hexacarb, Hexaconazole, Bavistin, and Folicur) were used to evaluate the efficacy against sheath blight disease. The different fungicides at recommended concentration (detailed elsewhere in result and discussion) in water (Taqat, Captaf, Contaf Plus, pulsor, Propiconazole, Hexacarb, Hexaconazole, and bavistin, Hexaconazole, Folicur) was sprayed with the help of hand sprayer. Plant of variety swarna was inoculated first and a day after the inoculated plants were sprayed with fungicides.

Growth of runner hyphae originating from inoculum induced lesions at the surface of rice tissue, established penetration structures to produce primary lesion. Growth of runner hyphae originating from this lesion at the surface of rice tissues, establishes penetration structures to produce a new (daughter) lesion (Ou 1985), (T W Mew 1991) and typical symptoms of sheath blight which were observed 96 hrs after inoculation. This refers to the progress of infection along a tiller, from its base to its upper leaves (‘vertical spread’ termed by Kozaka 1961) by means of expanding lesions or by means of short-range progress of, and infection by, mycelial structures of the fungus. Quantitative data was generated for the expanding lesion by measuring the total lesion length and width and individual lesion length and width. Sheath blight severity was calculated in reference to lesion length and sheath length (Table 4.3 and Fig 4.1). No differences were observed for the lesion width (data not presented). It was observed that plots sprayed with Thifluzamide (Pulsor S) (31µl/l), Thifluzamide (Pulsor S) (52µl/l), Thifluzamide (Pulsor S) (42µl/l), Thifluzamide (Pulsor S) 62µl/l, and Hexacarb 2400µl/l affected the sheath blight development by reducing the total lesion length (minimum and maximum % sheath area infected ranged from min 2.73 to 6.00 and 13.64 to 12.50 respectively) affecting the vertical spread of the disease (Table 4.3). Rest of the other fungicides in different concentrations sprayed on the crop was not effective in reducing the vertical spread of the disease by reducing the lesion length.

**Key words:** Sheath blight, disease incidence, Fungicide
Theme - 4
Farm Mechanization and Post Harvest Technologies to Enhance Farm Profitability
ADVANCES IN FARM MECHANIZATION AND POST HARVEST MANAGEMENT FOR IMPROVING PRODUCTIVITY OF INDIAN AGRICULTURE

Venkata S.P. Bitra
Professor, Department of Processing and Food Engineering
College of Agricultural Engineering, Bapatla.
Corresponding author: prasad_bvss@yahoo.co.in

Agriculture is the oldest industry, dating back to the nomadic age. It initially depended solely on human labor, then captured animal power, and followed next by reliance on mechanical developments such as steam/diesel-engine tractors and mechanical implements with hydrostatic power where control was needed for attached implements. To date, most mechanization problems have been solved from the mechanical point of view. The solution of unsolved problems depends on further improvements that require the replacement of human intelligence to meet the needs for greater autonomy in more unstructured and uncertain environments. Human intelligence entails sensing, perception, prediction, planning, proactive response, and feedback. Promising fields in this context include mechatronics, complex system automation, and large-scale optimization. Necessity is driving the absorption of information technologies into agricultural technologies, whether in the guise of a machine, a process controller, or a planning and management system.

Farmers who are blessed with large landholdings and other capital, good market access and support systems, and the capacity to use farm inputs like irrigation, purchased fertilizer and other agricultural inputs can produce the large surplus yields that keep food prices low. Such farmers, like their counterparts with smaller farms, may be vulnerable to rising energy costs insofar as irrigation, fertilizer and transport to market are dependent on fossil fuels. Technologies that allow them to increase yields and the efficiency of cost-intensive inputs (or substitute them partially) will increase their profitability and reduce the potential damage done to the environment. Large farms are suitable for using heavy agricultural machinery and economize farm operations and increase farm income.

Globally, there are over 500 million small family farms, most of which are mixed farms producing crops and livestock. Half of the world’s cereals are produced in these small-scale mixed farms. Smallholding farmers are often at a disadvantage position in terms of available resources and accessing markets. They rely substantially on self-provisioning. It is difficult for a farming family to make a better living from growing crops or raising a few animals on a half-hectare plot with few inputs and unsophisticated technologies, unable to reach the market. Not all small-scale farmers can become large scale farmers, but some form of aggregation of primary production and support services will be required in order to take advantage of new markets and technologies, and to transform farming into an attractive local business and job opportunity. In many developing and emerging economies where youth make up 20% of the population and youth and women’s unemployment is a serious issue, new visions of smallholder farming with enhanced societal value and respect would provide a deliberate platform for generating employment opportunities and reducing migration from rural areas to urban centers. Custom hiring of control-based sophisticated agricultural machinery is one of the directions to take care of the migration.

Modern agriculture in developed countries including the United States involves far more than farms and farmers – it depends on enormous, highly sophisticated systems that move, store and processes producers’ output throughout an extensive value chain that extends to food products and final consumers. Agri-engineering
can help to increase productivity through the wider adoption of best practices, for example advanced nozzle design and GPS guidance.

Productivity improvement in agriculture has been brought by enlargement of size and horse power of agricultural machines. However, productivity in India cannot be increased in the same way as in the Western countries because of the differences in weather condition, land condition and social constraints.

A. Early engineering practices in agriculture vs. present scenario

Although systematic farm mechanization started in nineteenth century in a vigorous manner in the USA, a notable event involving early OilPull tractors occurred on October 2, 1911. A special plowing demonstration was held at Purdue University (Fig. 1). Three tractors were connected to a specially built, fifty-bottom plow that cut a 60-foot-wide furrowed path. A record was set for plowing fourteen acres per hour on that day.

The tractors and ploughs were mechanically controlled earlier with governor (Fig. 2) to manage steam inlet valve of steam engine (now for fuel regulation) and servo mechanism (Fig. 3) to operate hydraulic mechanism of tractor to regulate hydraulic pump to achieve constant ploughing quality. This era has now changed with electronic controls (Fig. 4) (these days, we are observing health of car engine and transmission systems monitored with electronic controls).

![Fig. 1 Three OilPull tractors pulling special fifty-bottom plow at Purdue University (October 2, 1911)](image)

![Fig. 2 Governor](image)

![Fig. 3 Servo mechanism](image)
Information and communication technologies along with controls have improved gradually over the years. Similarly, style of farming also gone into evolution to increase the farm productivity due to inventions in science and technology (Fig. 5). Here, it is discussed the recent trends of modernization/automation of farm equipment operations, namely spraying, combining, baling, forage harvesting, etc.
1. Combines

The Advance Rumely Company, USA began producing combines in 1925 in great numbers. In a combine, both reaping and separation are combined and performed on a platform while moving through the field. The undercarriage has to withstand continuous movement often on uneven terrain. A three-wheel undercarriage was selected for the separating unit. The single, front wheel also served as the tow bar for the tractor or a sizable team of horses or mules. The conventional separator had to be reconfigured to adapt to the three-wheel undercarriage. Since the tractor (more common than horses) could not drive the separator with the flat belt while under tow, a separate four-cylinder internal combustion engine was adapted to the combine frame to provide power.

1.1 Mass flow sensor for combines

1.1.1 Sensor requirements

Till the year 2000, research on yield sensors has focused mainly on the development of reliable grain flow sensors on combine harvesters (Fig. 6) for measuring the grain yield during harvesting. Although many sensors have been proposed, only a few proved to be suitable for commercial application due to the severe performance criteria imposed on the sensors, the most important of which are:

- The sensor should be able to measure the grain flow with sufficient accuracy such that measurement errors are less than 5%.
- Machine motion and vibration should not disturb the accuracy of the sensor.
- Analysis of the measurement signal before it becomes suitable for deriving yield maps should be simple and straightforward.
- Accuracy of the sensor must remain independent of variations in bulk properties.
- Requirements for recalibration and maintenance of the sensor should be limited.
- The sensor should have an appropriate design for easy integration in combines.

A yield sensor has been developed that amply meets the above-mentioned performance requirements.
1.1.2 Grain yield sensor

The proposed grain flow sensor is mounted at the outlet of the grain elevator, as shown in Figure 7. The sensor consists of a 90-deg curved plate or chute, supported at the elevator housing by two pendulum rods that can rotate around a pivot point. A beam spring keeps the sensor in its initial position when the machine is at rest. A counterweight is fixed to the opposite tips of both rods such that the pivot point coincides with the center of gravity of the whole assembly so as to render the sensor insensitive to translational vibrations of the combine. In addition, this suspension drastically reduces the influence of driving uphill or downhill on the zero reading of the sensor. Normally, the threshed grain kernels are thrown by the pin parcels into the storage tank. To lead the grain flow smoothly into the sensor, a deflection plate and a rotor are installed at the head of the elevator.

![Fig. 7 Grain flow sensor of combine elevator](image)

The grain mass flow entering the sensor exerts a force on the curved plate, causing the assembly to start rotating around its pivot point against the spring force. This final force is the result of the gravity force $F_g$, the centrifugal force $F_c$, and the friction force $F_f$ between the grain mass and the curved plate body and thus is a function of the total grain mass $m$ on the plate. Consequently, the registered instantaneous deflection of the beam spring by a linear inductive distance sensor is a measure of the mass flow variations in the curved plate.

2. Sprayers

Fortunately, most weed populations develop in patches in the field, with large areas of the field remaining free of weeds or having a very low weed density in the early stage of infestation. As a consequence, herbicides would be used more efficiently if they were applied in the appropriate dose, where they are needed, and not to areas with insignificant weed densities. Thus, weeds have been suggested as the primary target for spatially selective pest control and done using reflection measurements (Fig. 8).
Fig. 8 Weed activated spraying

3. Round baler

Crop after combine operation left in the field is of immense economic importance and it has got several industrial applications in chemical industry, pharmaceutical, etc. Bales are made to protect this biomass. Square and round balers are used to pack it with twine or net. Round balers (Fig. 9) are doing good densification of bale with control systems. Round baler automation controller is made possible by BaleTrak Pro™ (Fig. 10). It provides the following monitoring functions:

- On/off key—turns monitor on or off
- Twine/net key—selects between twine or net wrap
- Baler symbol—gate closed, ready to bale
- 24-bar graph - bale-shape indicators
- Small bale symbol—near-full bale

Fig. 9 Round baler
- Bale with twine/net wrap symbol—stop forward travel, wrapping started, maintain PTO speed
- Baler with bale ejecting symbol—open gate and eject bale
- Numerical display—shows bale diameter increasing in inches
- Variable core symbol—ON, if selected (variable core kit optional)
- Battery symbol—low-voltage indication
- Stop sign symbol alarm—stop baling immediately, investigate/correct
- Bale with net wrap symbol—net wrap did not feed or knife did not cut material
- Baler with gate open symbol—gate open, ejecting bale
- Numerical display—bale counter, daily/lifetime totals
- Error code display—displays the error code number for diagnosing the electrical system
- Slip clutch alert kit (optional)

Fig. 10 BaleTrak Pro controller of round baler

BaleTrak Pro provides the following controlling functions:
- Set bale size
- Set twine spacing/net wrap
- Set the number of twine end wraps
- Manually extend twine arms
- Manually retract twine arms
- Adjust starting time of net wrap application
- Set the number of net wraps
- Set the distance of twine from bale ends
- Manual twine actuator movement with electronic bypass
- Onboard diagnostics

4. Forage Harvester

Ensiling of forage for feeding the animals is a major activity in developed countries. Forage harvester (Figs. 11 and 12) is a promising machine to perform this activity. The flail orientation is controlled hydraulically with fluid pump in order to load the wagon with size reduced forage/biomass. A small metal piece entering into the machine can damage the tooth of cutter head knives (Fig. 13). Cutterhead, which is heart of the machine, is a costly item and protection is our concern. IntelliGuard™ metal detector (Fig. 14) protects cutter head.
The available IntelliGuard™ metal detector protects the cutter head and livestock from ingestion of iron-based metal objects. When stray metal is detected, a sensor in the lower feed roll sends a signal to a solenoid, which causes a pair of locking pawls to stop the feed rolls. The sensor then alerts the operator to the metal location in the feed rolls by LED lights on the monitor. A red light and alarm on the control (shown) alert the operator when metal has been detected. Diagnosis and calibration of the control system is most important to identify unwanted material to enter into the machine.

The self-diagnostic system allows the operator to test the metal detector to ensure it is operating correctly. IntelliGuard™ can be calibrated and adjusted for maximum sensitivity under various crop, field, and machine conditions. If feed roll damage occurs, IntelliGuard™ can be recalibrated to account for the damage and still maintain the ability to sense ferrous metal.

B. Control systems and automation

In early days, the automatic control equipment was a simple one connecting sensors and actuators through a relay. Today higher performance, multiple functions and easier service are required, which make microcomputer indispensable. Major control items for a combine are:
1. Automatic cutting height control which controls the knife height above the ground level during cutting crops.
2. Automatic ground speed control to control traveling speed during operation to maximize the operation efficiency without decreasing threshing performance of combine.
3. Automatic direction control of steering for combine traveling along plant lines.
4. Automatic feeding control for plant feeding depth to thresher.
5. Automatic alarm device and voice alarm for informing engine speed down by work load, grain level in tank and straw clogging by lamps, buzzer and voice.

Currently, there are significant challenges faced by the farming industry, not least of which are a reduction in the available labour workforce, and a more ‘corporate’ style of farming. Such factors demand an increase in farming efficiency and productivity. The autonomous farm is seen as a complex system-of-systems, where there is necessarily a seamless integration of requirements, bringing together the areas of robotics for autonomous farming, and Precision Agriculture (PA), which deals with issues of agronomy. In essence, agricultural robotics uses on-farm sensing and control to actuate autonomous farm machinery with the aim of satisfying agronomy-based objectives. These data sets include a Precision Farming Data Set (PFDS) formed off-line before crop cultivation, containing spatially precise navigation data for any and all autonomous machinery, and a Precision Agriculture Data Set (PADS), which is a continually evolving entity consisting more of agronomy data in relation to the crop. Secondly, research undertaken in autonomous farm machinery is highlighted, where we present a foundation for the autonomous and robust control of articulated farm vehicles for real-time trajectory tracking in the presence of uncertain conditions.

The agricultural sector is rapidly being transformed into an industry of major importance that must rely heavily on computer-integrated management and advanced control systems. These technologies are becoming essential components of the next generation of plant and animal “factories” in the new millennium. Efforts are being undertaken to survey the technological landscape and recognize trends shaping this upcoming application field. Recent research has resulted in advances in all technologies bound to the closed loop as well as to the outer loops necessary to meet higher autonomy and precision (Fig. 15).

![Fig. 15 Advances in control loop components](image-url)
machines have been progressing rapidly in recent years. Some of them are already put into actual use. They deal with automatic control of the working equipment of agricultural machines. The productivity of agricultural machines is expected to be improved tremendously when the technology of automatic vehicle guidance is put into practical use. As automatic guidance technology, an autonomous guidance system using simple input signals, an autonomous guidance system using input signals required for control extracted from multiple video information signals, and an externally assisted guidance system using a fixed laser oscillation source have been studied with respect to their properties. As a result, it has been found that selective use of these three systems according to the job requirements of agricultural machines will attain the above purpose.

Agricultural machine automation is showing progress in putting the work equipment adjustment mechanism control into practical use. Examples are feeding rate and cutting height control for combines and cultivation depth control and lift control for tractors. Along with the development of these technologies, radio control for unmanned operation and combine direction control were already developed. Automatic operation technologies are now basically on the level of practical application as far as the grain farming is concerned.

Various systems have been proposed for vehicle guidance. Among them said three systems are considered to be appropriate in view of the agricultural machine characteristics and required guidance accuracy.

1. **Agricultural machine condition monitoring solution**

   Machine health monitoring apart from regular maintenance is very important for uninterrupted operation throughout the year. In this context, B&R, Austria developed a condition monitoring solution for mobile automation based on a comprehensive hardware portfolio, ready-made software components and a powerful engineering tool.

1.1 **Predictive maintenance**

   The X90 controller with integrated condition monitoring of B&R (Fig. 16) allows operators of agricultural machinery to continuously monitor the health of their equipment. The results help determine exactly which components require maintenance and when. Problems can be detected in their early stages and corrected before they result in unplanned downtime. Repairs can instead be timed to coincide with regular scheduled service.

---

Fig. 16 X90 controller of B&R
1.2 Develop 3 times faster

The ready-made software components of mapp Technology make it easier and faster to perform frequently recurring programming tasks. With the software for new machinery and equipment completed in a third of the time, this brings a dramatic reduction in time to market. Since the components are maintained entirely by B&R, the resulting application software is also of higher quality.

2. Sensor technology

Sensors are appliances that can sense e.g. sound, light and weight without direct contact with the object. Sensor technology is also useful for the determination of the composition and/or the quality of food. The agro and food sector uses sensor technology to collect data on the soil, crops and animals through sensors that are integrated in all kinds of agricultural equipment and machines, aircraft and drones or even satellites. Sensors provide farmers with real-time information on their crops and livestock, enabling them to respond more effectively, e.g. by taking (corrective) measures. Sensor technology can be used to establish product quality and safety, but e.g. also the origin. Examples of sensor technology in agriculture include aerial photographs, thermal images and near-infrared data (NIR data) (Fig. 17).

Sensor technology allows multiple applications, including:

- Smart packaging that is able to tell if a product is still fresh.
- Millimeter wave sensors that enable contact free measurements in the core of a food product. The specific interaction between these waves and water allows manufacturers to optimize drying and freezing processes in the food industry.
- Lab-on-a-chip technology integrating various laboratory functionalities on a single chip of several cm². This technology greatly facilitates the diagnosing of sick animals, the detection of specific gases and the determination of the freshness of a product.
- Hyper spectral camera that is able to detect strange objects, latent defects or food moulds, by inspecting the product surface or analyzing and visualizing the composition (e.g. liquid, sugar, fat and protein content).
- Optic fiber biosensor to detect (hidden) allergens, genetically modified organisms and DNA of micro-organisms and viruses.
C. Towards precision agriculture

Severe global competition with sharp price increases for raw agricultural products and heightened concern about the environment force farmers toward more appropriate use of resources for field crop production. In this respect, manufacturers, in close cooperation with leading research groups, began developing intelligent agricultural machines for precise and site-specific field operations, integrating mechanical, electronic, computer, and information systems.

It needs advanced mechatronic designs for three different mobile agricultural machines. A yield-mapping system for a combine harvester requires the design of the necessary sensors and processing of the acquired data. The latter includes aspects of filtering, elimination of unusable data, and compensation for machine dynamics. To reduce chemical inputs for plant protection, field sprayers are equipped with an intelligent selective spraying system. Optical sensors, detecting weeds among field crops, activate the appropriate pulse-width-modulated nozzles, mounted on the spray boom. The nozzles are correctly positioned in the field by stabilizing the spray boom with an active suspension. To improve and ease field operations, especially in row crops where the distance between rows and between plants within a row must be extremely precisely regulated, the steering mechanism of the agricultural machine is controlled by a reliable navigation system. The latter fuses data from several dead-reckoning sensors and in combination with global positioning systems. The communication system is the backbone for the tractor-implement as well as for the tractor-farm computer transfer of the large amount of data needed for precision agriculture. Control problems in the high-precision spreading of liquid manure are also addressed. The system developed for this purpose makes use of an extended Kalman filter and a Smith predictor.

D. Wireless control through smart phones in agricultural applications

Wireless control in agriculture technology applications is evolving rapidly, largely due to the fast adoption of smart phones and tablets into all parts of everyday life. Devices such as smart phones and tablets are a disruptive technology that will force change to almost every industry, and agriculture is not an exception. There are countless Machine-to-Machine (M2M) communication applications where iPhone and Android devices bring real value to the control and monitoring of agriculture equipment.

A few years ago, wireless controls in agriculture technology applications were relegated to special applications, with dedicated remotes controlling specific functions. As the cost for a wireless interface was relatively large, the wireless control – a control interface that was not directly wired to the machine that it was controlling – was adopted only where the benefits were clear and the costs could be justified.

The world has changed, and today, most farmers have very powerful control and monitoring devices in their pocket: smart phones. The introduction of these devices has significantly changed the cost/benefit analysis of adding wireless control capabilities to an agriculture control system, as the costs have significantly gone down while the capabilities have increased exponentially.

M2M communications in the area of agriculture technology allow devices, both wired and wireless, to connect. M2M solutions allow a device (such as a smart phone) to capture an event (i.e. the weather) that is transmitted through a network (like the cellular network) to an application (app) that converts the event into relevant data (alerting, in this example, that the equipment needs adjustment because of a particular weather situation).

Today’s typical iPhone or Android device is a powerful processing tool containing built-in M2M communication functionalities that can be very useful in agriculture control applications: GPS, internet connectivity, wireless control capabilities and a high definition display with touch-screen controls are just a few examples.

Another great benefit for using iPhone or Android devices for agriculture technology applications is that remote-specific issues (such as battery life, and replacement of lost/damaged special function remotes) are no longer the responsibility of the manufacturer of the agriculture equipment.
but tied into a cell phone that the farmer already owns, is familiar with, and regularly upgrades.

With these changes to the technology landscape, a wide range of new potential applications for interfacing tablets and smart phones to agriculture technology applications is opening up. Innovative engineers designing agriculture equipment will quickly recognize how this M2M communication technology can be applied to their systems to bring new control and monitoring capabilities – providing them with a significant competitive advantage – while other companies that are reluctant to change may quickly get left behind.

When all pieces of the agriculture technology control system are integrated, mechanical/ electronic devices and software communicate with each other and evolve through the endless range of possibilities that OEMs have today in the agriculture sector. Designers of agriculture equipment should begin considering how M2M communication and these new technologies can add value to their systems and applications. Some agriculture technology control applications may have been difficult or costly in the past; today, with the addition of mobile smart devices, innovations can be straightforward and economical. The following are some examples:

- **Telematics and remote diagnostics** – A Wi-Fi or Bluetooth-enabled implement controller can connect to Cloud-based services through the cellular network of a mobile device. This would allow service and support people to see live machine diagnostics or historical data logs from a remote location, to diagnose/track issues in the field.

- **Integration of maps and GPS** – Many agricultural applications, beyond typical precision farming applications, can now take advantage of integrating mapping and GPS into their applications. By having Google Maps (or other mapping applications) integrated into a customized app for the implement and by using the mobile device GPS, new applications can be enabled such as coordination of multiple vehicles in large farms, tracking harvest throughput by area or marking location of bales.

- **Use of weather information** – In farming, the weather is always a critical factor for consideration. The optimal running modes of many different types of equipment depend on climate factors such as temperature, humidity and barometric pressure. This information is readily available through mobile devices and can be used to “auto-tune” equipment to adjust to the weather conditions.

- **Wireless control** – Few things are more frustrating than losing a remote control that is needed to run a piece of equipment. Using a smart phone as a remote means that the operator is more likely to know where the remote is at all times. Smart phones allow for much more flexibility in monitoring and control as they are not limited to only a few buttons, and entirely different screens can be shown for different operating modes.

Smart phones and tablets can bring real value to the control and monitoring of agricultural equipment, and these are just a few examples. A specialized company like JCA Electronics, Canada brings to the table a deep knowledge of electrical, electronic, and software systems as well as hands-on experience working with agriculture equipment designers, tying expertise in technology with customer’s expertise in agriculture applications.

JCA develops and integrates all the pieces that an agricultural control system requires in order to operate effectively in the M2M communication technology environment:

- controllers on the equipment, to interface with sensors and hydraulics,
- proprietary controllers that bridge the gap between the agricultural equipment control and mobile devices,
- development of control software that is specific to the unique functionality of each implement.
development of apps for tablet and smart phones (iOS, Android, and Windows platforms),

- selection of sensors for the control application, and
- design and manufacture of the wire harnessing to connect the whole system together.

E. Robotics today and in the near future

Robotization or unmanned control of farming operations are regarded as a promising direction for the solution. Because of efficiency improvement to the level of large machines and relatively low cost compared with size enlargement, this method is considered to be a future direction of agricultural machines applicable not only to agriculture in India, but, also to large scale farming like in Europe and America.

Robots are often used for comfort and safety or to save costs. In smart farming, robots perform autonomously; sensors allow them to evaluate a situation and to take decisions. The data from these sensors can be used to compile ever expanding datasets (big data) to improve their decision-making skills. Robots offer many opportunities for the automation of the agro and food sector, including cultivation and harvesting, automation of food preparation and automation of food logistics. At present robots are used in the Netherlands for shoot production, crop protection, sorting and packaging. Experiments are already underway in plucking (tomato, cucumber, strawberry, etc.), weed control, the harvest of peppers and roses, the packaging of food and the handling of soft products. Most people are familiar with the milking robot, but automatic feeding, cow dung disposal, cleaning of barns, and field fencing have come to be just as common. In the near future breakthroughs are expected in miniaturization, efficient use of energy, sensor technology and communication. In the past years robots were operating in the background of production processes, but the focus has shifted to the interaction between the user and robots. Replacing human labour with robotics is, however, an important issue in society. Some view robotics as an undesirable development, but, it is a fact that the agro and food sector is always short of skilled personnel. It is also plagued by rising labour costs and – due to the use of illegal labourers from abroad – a bad image. The large-scale use of robots could, therefore, be part of the solution. Robots could also be used for dangerous work and contribute to a much more efficient production process. Yet, safety and legal liability issues still need to be solved.

1. Autonomous navigation

At the University of Tokyo, Japan a machine vision algorithm for crops was developed and applied to vision-guided navigation of a tractor, which would be used for row crop husbandry such as mechanical weeding and precise chemical applications. For vision guidance, image analysis of the crop field is essential. Thus, highly accurate discrimination of crop area from the surrounding soil area, detection of boundary lines between crop and soil areas, and position identification using a three-dimensional perspective view transformation are required. Discrimination of crop area was performed using color transformation of an HSI (hue, saturation, and intensity) transform. Result of the HSI transfer of cloudy and sunny day images are taken at 12:00 p.m. Discrimination between the crop canopy and soil area was successful using the HSI transfer without the influence of climate and shooting time. A least-squares method was used for boundary detection between crop row and soil area, and a three-dimensional perspective view transformation was used for position identification. The results showed that the offset error was within 0.02 m and the attitude angle error was within 0.5°, which were sufficient for guidance in the field. This algorithm was applied to a vision-guided tractor. Resulting path trajectory and that the offset error was within 0.02 m at a speed of 0.25 m/s. At Hokkaido University, Japan an Neural Network vehicle controller was designed in which the motion of a mobile agricultural robot was specified as a nonlinear system with high learning ability. At Kyoto University, Japan an automatic “follow-up vehicle,” using two small head-feeding combines, is developed. A human operator in the front vehicle controls it, and the follow-up vehicle is automatically controlled by computer. At Ehime University, Japan a small automatic transport vehicle equipped
with a carriage self-correction mechanism was developed for use in greenhouses.

In 1993, the Japanese Ministry of Agriculture, Forestry, and Fisheries (MAFF, http://www.maff.go.jp) initiated the Agricultural Machine Development Project in which the development of unmechanized machinery was promoted. Development of a tillage robot and driverless air blast sprayer were started in BRAIN (Bio-oriented Technology Research Advancement Institute), and a driverless air blast sprayer is now in field use. Many technologies have been developed, and a total station (TOPCON Co. Ltd.) with automatic tracking for moving objects is now being used as the position sensor of a tillage robot in the field. Total station and the navigation is tested in the field. The automatic tracking, position measurement, and data communication performances were sufficient at a distance of 500 m. The tillage work was completed within 2 hours and 15 minutes at a speed of 0.45 m/s. The work area was 50×100 m². A self-diagnosis function and an alarm function are also incorporated.

At the National Agricultural Research Center (NARC, http://ss.narc.go.jp/) at Tsukuba, Inoue, Japan applied a differential global positioning system (DGPS) and an optical fiber gyroscope (three axis) mounted on a 55-kW (75-HP) tractor for tillage, and a Kalman filter was used for estimation of the current position. The accuracy of the DGPS was 0.15 m (sampling speed: 1 Hz), and that of the optical fiber gyroscope was 0.3°. A rotary tillage test was performed in the field (100×160 m) at a speed of 1 m/s. The offset error was within 0.1 m, and that of a U-turn at the headland was 0.12 m. Nagasaka, Japan used a real-time kinematics GPS (RTKGPS) with an optical fiber gyro for an autonomous rice planter. As the GPS data has a delay time (about 0.2 s) caused by communication with the reference, compensation for this delay was added for real-time position estimation. The GPS antenna was mounted on top of the vehicle, resulting in an error of 0.1 m at a roll angle of 3°. This inclination was also corrected. Steering angle was determined according to the difference in attitude angle error.

At the National Grassland Research Institute, Japan (NGRI, http://ss.ngri.affrc.go.jp/), an autonomous tractor for forage production was developed using a fiber-optic gyroscope and an ultrasonic Doppler speed sensor for position identification.

Among manufacturers, the Crop Engineering System Laboratory, Inc., Japan was founded by Kubota Co., Ikegami Tsushinki Co., Ltd., and BRAIN. Application of a tracking laser finder system and laser range sensor on automatic farm machine systems has been performed for an autonomous rice planter. Since the cost of RTKGPS is rapidly decreasing and the performance of image processing is increasing, the combination of machine vision and RTKGPS appears to be the most promising system for the future.

2. Robocrop

Robocrop was developed and brought to market in the UK by the R&D company, Tillett and Hague, and Garford Farm Machinery. It uses video image analysis techniques to identify and locate individual plants to remove weeds mechanically on crops planted with regular spacing. The technology relieves the driver of the need to concentrate on very accurate steering and removes the need to employ gang work force to do the weeding. As a result, it is leading to better quality work maintained for longer periods and at higher speeds.

3. Intelligent robots in agriculture

In Japan, agricultural robotic research is widely performed in the areas of autonomous navigation, harvesting, and nursery production. Research in autonomous navigation is being conducted in universities, in government institutes, and by agricultural machinery manufacturers. In universities, most of the research has focused on methodologies such as navigation, sensing, and the application of control theory. At research institutes and manufacturers, more practical systems were developed. Research in harvesting robots is performed mainly in universities, though the technical levels are still beneath that of the MAGARI robot, which was developed at EMAGREF (France) in the late 1980s.

Nursery robots are developed mainly by government research institutes and manufacturers, and some of them are reaching the market.
In particular, grafted nurseries, such as cucumber, watermelon, tomato, and eggplant, are widely used in greenhouses, and various types of grafting robots are being developed by agricultural manufacturers and other types of industries.

3.1 Harvesting robots

Developments of harvesting robots were conducted in the United States, Europe, and Japan in the 1980s. In Japan, research on a harvesting robot for tomato was initiated in 1984 at Kyoto University, mainly by Fujiura and Ura, who received an award from the Japanese Society of Agricultural Machinery in 1991. Since 1990, Okayama University has been leading the research in harvesting robots, such as for tomato, cucumber, grape, and strawberry crops. In these robots, spectral reflectance was used for the discrimination of fruit from leaf and stem. Spectral reflectance of cucumber fruit and leaf is analyzed by harvesting robot (Fig. 18). The reflectance of the fruit is higher than that of leaf and stem in the near-infrared band; therefore, band-pass filters of 550 and 850 nm were used with a monochrome camera for the recognition of fruit. In this research, the cultivation types were also improved to discriminate the fruit from other parts. Stem of the cucumber was set inclined so that the cucumbers were separated from leaves and stems. A redundant manipulator is used for the harvesting to avoid obstacles such as stems or leaves. Robots for harvesting leaf vegetables such as cabbage are also developed. Little research in harvesting robots is currently under way in Europe and the United States because robotic performance is still low and the human operator is superior in cost and reliability. Therefore, even in Japan, continued interest will depend on new technological innovations.

3.2 Nursery production robots

Nursery production robots such as transplanting and grafting robots are widely commercialized. In Japan, the grafted nursery, which has strong tolerance against injury by continuous cropping, is mainly used in the greenhouse. The ratio of each crop in the grafted nursery is 70% cucumber, 30% tomato, 50% eggplant, and 90% watermelon. Although there is some variety in grafting methods, for the most part, the machines put together a scion and a rootstock using a clip, pin and special bond adhesive method. Proper treatment after grafting is a necessity, typically requiring a dark chamber with high humidity; thus, an increase in the success rate is required, to over 90%. Grafting machines/robots (Fig. 19) operate on the plants one by one or in one row at a time. The performance of the grafting machine is about 800-1,000 plants/h, which is ten times that of human operators. Plug-type seedlings are transplanted from a small tray, in which seedlings are planted at higher density, to a larger tray, and some plants are transplanted into separate pots. A transplanting machine is used for this operation whose performance is approximately 6,000 plants/h. Sensing of the stem is critical in this operation, and photo sensors or capacitance sensors are mainly used. Several types of these machines are already on the market.

Fig. 18 Harvesting robot

Fig. 19 Nursery robot
Although research in tissue culture robots was performed in the early 1990s in the United States, Europe, and Japan, the market for this machine was too small.

**F. Grain storage automation**

With more large bins on the farm, safe grain storage has become more important. Keeping grain from heating or spoiling is more complicated than it would seem. Chance of spoilage really depends on two things: both temperature and moisture. When air is pushed through the grain in the bin, the greater the difference between the air outside and the grain in the bin, the greater the effect on the grain and greater the moisture removal. If loading grain at a high temperature or a high moisture level, storage will be risky. For safe storage conditions, 15 °C is the temperature that is required for cereals or your oilseeds. Safe storage has a two-step process. The first step is to even out the temperature in the bin. Aeration is essentially for cooling.

The recommended airflow rate to remove temperature variation is 0.1 to 0.2 cubic feet per minute per bushel (cfm/bu.). At the recommended air flow rate, it takes about eight days to get the bin to equalize. That is, about 200 hours of drying. The next step is removing the moisture in the bin, through natural air drying, or near ambient drying. For this, the recommended airflow rate is 1.2 cfm/bu., or 10 times higher than aeration. It is a pretty complex relationship, but really, if the air has the capacity, it will dry as it is going through the bin. At 1.0 cfm/bu., it will take seven to 14 days of continual fan operation to dry wheat from 16.5 to 14.5 per cent. Again, it depends on ambient conditions.

With larger bin sizes, farmers have a lot more at stake. So, Prairie Agriculture Machinery Institute (PAMI), Canada continues to test new methods of storing grain. In 2016, PAMI tested a novel fan control system, Aeration Master™, developed by Aeration Control Australia. The Aeration Master™ uses the basic concepts of air temperature and relative humidity and applies them to what’s inside the bin, turning aeration fans on and off automatically, depending on outside temperature and relative humidity. It’s a touch-based system that can control up to eight different bins at one time.

Skyway, Canada uses an automated grain storage monitoring system from OPI Systems, Canada, the StorMax temperature monitoring system (Fig. 21). The StorMax monitor collects all of the data in seconds from individual bins or an entire storage facility. All of the data is retained in the on board memory and it can also be downloaded to your PC. The system can also be linked directly to StorMax Pro, an automated PC-based system that allows you to monitor grain temperature 24/7, sounds an alarm if grain temperature reaches a critical degree, and automatically controls aeration and drying equipment, based on grain temperature and weather conditions.

It can be concluded that there is a dire need of implementing the available advanced technical knowhow all over the world in the Indian agriculture activities for improving the profitability and to achieve the Government target of double digit growth of Indian economy and doubling the farming income.
04-01

PERCEPTUAL MAPPING OF TRACTORS - A CORRESPONDANCE ANALYSIS APPROACH

Bindu Madhavi, N., Nafeez Umar, Sk., Srinivasa Rao, V and Ramesh, D.

In the current scenario of Agriculture the farm equipment i.e Tractors are playing a vital role for precession and profitable farming. Farmers are using various types of tractors for transporting, cultivating the land, harvesting, transplanting, threshing, levelling etc.,. These tractors are having various prices, horse powers (HP), Fuel tank capacity, Ground clearance, wheel base and also mileage. By considering all these factors a study was conducted to know the perceptual mapping of these tractors by using Correspondence Analysis (CA) approach. CA is a technique for graphically displaying a two-way table by calculating coordinates representing its rows and columns. By using the Chi-square test the attributes association can be studied. It is an increasingly popular interdependence technique for dimensional reduction and perceptual mapping. By using this technique which tractors are lying close to which preferred price category were studied. Out of the 10 major brands of tractors in India, there is a high demand for the high milege and Low price tractors.

Keywords: Perceptual mapping; dimensional reduction; Chi-square test

04-02

UTILIZATION AND EVALUATION OF DRUMSTICK LEAVES (Moringa oleifera) AS A FUNCTIONAL FOOD INGREDIENT IN BISCUIT PREPARATION

Navaneetha, Y., Lakshmi, J and Lakshmi, K.
Department of Foods and Nutrition, Advanced Post Graduate Centre, Lam, Guntur.

Corresponding author: yalakanavaneetha@gmail.com

Moringa oleifera is a highly functional plant, which is distributed all over the world. Various parts of this plant were used as food and medicine. Dietary supplementations of these parts were promoted for personal well-being and self-medicine of various disease conditions. Hence the present work was planned with the studies on the utilization and evaluation of drumstick leaves as a functional food ingredient in biscuit preparation based on different compositions. Based on these compositions different blends of sprouted whole wheat flour and drumstick leaves were used in the ratios of 100:0, 95:5, 90:10 and 85:15, respectively. The choice of these ratios was made on the initial acceptability trails of the product. Some common analytical methods were used to standardize the product. Those are sensory evaluations with Hedonic scale and nutrient analysis based on the ingredients used. With the help of these, the standardization was done. The result have shown that the composition of sprouted whole wheat flour and drumstick leaves powder with 90:10 ratio was highly accepted when compared with other compositions. Hence the present investigation showed over all acceptability and possibility of incorporating 10% of drumstick leaves powder in biscuit production in order to improve the quality characteristics and nutritional properties of biscuits.

Keywords: Sprouted whole wheat flour; sugar; butter; drumstick Leaves; milk
APPLICATION OF DRONES IN AGRICULTURE

Sameer, Sk., Srinivasulu, K., Prasad, P.V.N and Prasuna Rani, P.
Department of Agronomy, Agricultural College, Bapatla
Corresponding author: sameersam796@gmail.com

The world-wide farming system faces tremendous challenges. The United Nations Food and Agriculture Organization (FAO) expects that food production must be raised by 70% throughout the following forty years to meet increasing demand due to rising economic welfare and population growth. The main challenge of global agriculture is to provide food to growing population, which is predicted to increase from seven billion people today to approximately nine billion around the year 2050. India is the considerable maker of agricultural products but has very low agricultural productivity. Productivity of farm needs to be improved in a way that farmers can earn more profit from the same piece of land with less labour. Advanced farming technologies include use of drones, unmanned aerial vehicles (UAV’s), may able to do it.

An unmanned aerial vehicle (UAV), commonly known as a drone, is an aircraft without a human pilot aboard. Drones are the future of farming. With greater refinements in drone technology and implementation the farmers will see the agricultural drone sector take off. Drones have long been thought of as expensive toys. One area that has seen little attention from drones is the agricultural sector. Drones can have a significant impact on the agricultural industry, as they can monitor several aspects of farming that humans cannot accomplish on their own. Drones can perform aerial mapping, giving a clear image of the total size of a crop field, as well as showing possibly underutilized areas of land. They can also, if equipped with the appropriate camera equipment can be used for planting, crop dusting/spraying, irrigation management and also monitor the health of plants in terms of temperature, chlorophyll levels, foreign contaminants and even leaf thickness. This information can allow a farmer to adjust the necessary parameters of their agricultural production. This facility addresses the problems before they become more widespread. This, in turn, results in higher crop yields, improve production, efficiency, and get higher yields by identifying problems before they happen with increased crop health awareness and save time.

Keywords: Unmanned aerial vehicles; drones

ROBOTICS - NEW TREND FOR AGRICULTURE: A REAL FLEET OF ROBOTS

Sreenivasreddy, K., Pulla Rao, Ch., Martin Luther, M and Rama Krishna Prasad, P.
Department of Agronomy, Agricultural College, Bapatla.

Robotics is playing a significant role in agricultural production and management. There is a need for autonomous and time saving technology in agriculture to have efficient farm management. The researchers are now focusing towards different farming operational parameters to design autonomous agricultural vehicles as the conventional farm machineries are crop and topological dependent. Till date the agricultural robots have been researched and developed principally for harvesting, chemical spraying, picking fruits and monitoring of crops. Robots like these are perfect substitute for manpower to a great extent as they deploy unmanned sensing and machinery systems. The prime benefits of development of autonomous and intelligent agricultural robots are to improve repeatable precision, efficacy, reliability and minimization of soil compaction and drudgery. The robots have potential for multitasking, sensory acuity, operational consistency as well assuitability to odd operating conditions. The study on agricultural robotic system had been done using model structure design mingled with different precision farming machineries. The agricultural robots are designed using different localization techniques which are vision, GPS, laser and sensor based navigation control system. In recent
years, the development of autonomous vehicles in agriculture has experienced increased interest. Many researchers started developing more rational and adaptable vehicles for agricultural operations. In the field of agricultural autonomous vehicles, a concept was adopted to use multiple small efficient autonomous machines in place of traditional large tractors. Moreover, such a system may have a less environmental impact as it can reduce over-application of chemicals and high usages of energy and inputs by the control that is better matched to stochastic requirements. There are numbers of field operations that can be executed by autonomous vehicles, giving more benefits than conventional machines.

The projected world’s population may grow to more than 9.15 billion by 2050. Therefore, the challenge for the next decades will be to supply the needs of the expanding world population by developing a highly productive agriculture management, whilst at the same time preserving the quality of the environment. Most of the developing countries including India is facing agricultural labor shortage problem. A major portion of youths from village is shifting to urban for led better life. As a result, agriculture operation gets delayed during its peakseasons due to a labor shortage. Human, animal, and Mechanical power source are utilized in agricultural operation in terms of seed bed preparation, tillage, seeding or transplanting, fertilizer and chemical application, intercultural operation and harvesting.

Current status of agricultural robots is MF-Scamp Robots Designed by Blackmore, MF-Scamp robots are designed for scouting, weeding and harvesting. It is designed either four wheel or six wheel drive weed seeking robot to perform weed removing or destroy the weeds. Autonomous Plant Inspection (API) Research Platform designed by Danish institute of Agricultural science (DIAS). The robot has 60 cm height clearance, and a track width of 1 m. It is also equipped with Real Time Kinematic Global Positioning system (RTK-GPS) and there is an operating unit over the head of the frame which implement for agricultural operations like spraying devices, sensors or weeding tools. Agribot is an agricultural robot designed by BITS, Hyderabad students. It is designed to increase the productivity, speed, application accuracy of the work and minimizing the labor of farmers. Its major area of function involved in farming i.e. harvesting, spraying, seeding and removing the weeds. This robot is designed to execute the basic functions required to be carried out in farms.

Robotics and new technologies have begun to improve common practices in agriculture, such as increasing yield performance and decreasing the use of chemicals that may affect the environment. The autonomous robot have potential to work on precision agriculture having continuous monitoring by using different sensing technology, which provides different crop status parameter like, micro nutrient availability, bio mass index, status of pest and disease, water stress, thermal stress, etc. for better remedies of crops. As ever increasing of world population and decreasing of agricultural workers created constraint to farming system. Agricultural robot has potential to take off the load of labour shortage and increasing the productivity.

04-05

MECHANICAL HARVESTING IN CHICKPEA (CICER ARIETINUM L.) FOR HIGHER PRODUCTIVITY

Sabeeha Sultana Sd. and Venkata Rao, P.
Department of Agronomy, Agricultural College, Bapatla.
Corresponding author: sabeehasultana169@gmail.com

Chickpea is the second largest food legume in the world occupying 15 per cent of the total pulse area globally and cultivated in almost 52 countries and it occupies 8.32 M ha with a production of 9.8 MT (FAOSTAT, 2013-14). The crop has been traditionally harvested manually by pulling the stems to avoid excessive losses. Hand-picking labourers collect the chickpea bushes by hand. The process of pulling the entire plant by hand and uprooting the plant from the soil has many disadvantages: the nodules of nitrogen-fixing bacteria are lost, the quality of the plant residue for feeding animals is decreased due to a salty taste and the labourer costs are increased as compared to other harvesting systems.
Machine harvesting of chickpea can reduce cost of production, prevent risk of harvest losses, improve resource use efficiency and reduce drudgery for women who carry out the manual harvesting.

Currently chickpea farming in Andhra Pradesh is partially mechanized – the crop is cut manually and then fed into a threshing machine. The total mechanization of harvesting is cost effective and quicker, reducing the risk of the ripened crop’s exposure to untimely rain or other extreme weather conditions. Machine-harvestable chickpea varieties have the potential to enhance chickpea area and production in India, and can help reach the country’s goal of self-sufficiency in pulse production and doubling farmers’ income.

The chickpea variety, NBeG 47, is the first machine harvestable variety released in Andhra Pradesh (ANGRAU) suitable for the state’s variable climate. Two new machine harvestable chickpea varieties ICCV 08102 (RVG 204) and ICCV 08108 (Phule Vikram) are released recently in the Indian states of Madhya Pradesh and Maharashtra, respectively.

A tractor-pulled harvester with a modified stripper header was designed and fabricated, in which passive fingers with V-shaped slots remove chickpea pods from anchored plant and battle reel sweeps the pods across the platform. Modified stripper harvester can work in unevenness ground where other machines cannot operate. Stripping mechanization and methodology have potential to become an effective system for chickpea harvesting by saving cost and time. Stripper headers have rotating rotor and teeth to detach pods from anchored plant and an adjustable hood to deliver materials. Thus, future research needs to be focused on reduction of losses for the commercialization of the stripper harvester.

**Keywords:** Mechanical harvesting; chickpea

04-06

**FARM MECHANIZATION AND ENHANCING RESOURCE USE EFFICIENCY BY ADOPTION NEW TECHNOLOGIES TO REDUCE THE POST-HARVEST LOSSES**

Reddemma, K., Ashok Naik, M., Srinivasa Reddy, M., Bhaskar Reddy, U.V and Ramesh Babu, P.V.  
Department of Agronomy, Agricultural College, Mahanandi.

Farm mechanization is an important element of modernization of agriculture. The process of developing agricultural machines and substituting this machine power, for human and animal power in agricultural production practices is farm mechanization. Farm productivity is positively correlated with the availability of farm power coupled with efficient farm implements and their judicious utilization. Mechanization and modernization of agriculture requires appropriate machinery for ensuring timely field operations. Various precision agriculture tools like ‘grain yield monitor’ and ‘moisture sensor’ fitted on indigenous combine harvesters are being evaluated through online data collection. Efforts are under way to modify ‘tractor mounted soil sensor’ to appraise electrical conductivity (EC) and compaction of soil at the same time effective application of agricultural inputs and reducing drudgery in agriculture. India has a very high share of labour (55%) for farm operations compared to farm mechanization (40%). It will be helpful to enhance the overall productivity and reduce input costs by 15-20 per cent through savings in seeds and fertilizers, 20-30 per cent through reduction in time and manual labour, 5-20 per cent increase in cropping intensity and 10-15 per cent overall increase in farm productivity.

Under the scheme of farm mechanization the technologies developed by ICAR, CSIR and those identified from within the country and abroad for primary processing, value addition, low cost scientific storage and transport of agricultural produce are promoted to minimize wastage and pollution during post harvesting processes to increase resource use efficiency and farm productivity, which in turn increases farmers income. In addition availability of water is most critical for increasing the productivity in agriculture; because of diversification in agriculture more power is required for water lifting and precision placement/application of agricultural inputs. Adoption of modern irrigation techniques helps in solving problems related precise irrigation...
and fertigation. There has been close nexus between farm power availability and increased productivity. The adoption of farm machinery such as tractors, power tillers, combine harvesters, modern irrigation systems, plant protection equipments, threshers and other improved implements & hand tools to increase the productivity are in vogue. Appropriate and selective mechanization is needed for production agriculture, post-harvest handling, and value addition using a prudent combination of conventional and renewable energy sources. To devise long term strategies for farm mechanization, it is vital to visualize the needs in view of the prevailing and emerging challenges.

**Keywords:** Modernization of agriculture; mechanization; farm productivity; new technologies

### 04-07

**PROSPECTS OF MECHANIZATION IN RICE CULTIVATION**

*Sanjana, G.*

Department of Agronomy, Agricultural College, Naira.

Asian countries are occupying 89% of the world total rice area, and producing 90% of the total rice production. The area under rice in India is 42.50 M ha against total cultivated area of 163.46 M ha, producing 92.33 MT with productivity 2.2 t per hectare. Rice occupies 30% of total cropped area in Andhra Pradesh (about 4.0 M ha of 13 M ha) and is considered as one of the most labour-intensive crops. Though, farm mechanization in India stands at about 40-45%, which is still low when compared to countries such as the U.S. (95%), Brazil (75%) and China (57%). The farm power availability on Indian farms has grown from 1.47 kW/ha in 2005-06 to 2.02 kW/ha in 2013-14.

Decreasing labour force for farm operations coupled with increasing labour wages have adversely affecting the carrying of farm operations in time and reducing profits of rice cultivation. As mechanization saves time in completing different operations with increasing precision, reducing drudgery and cost of cultivation of rice to the greater extent. Mechanization allows the farmer to be more flexible in his farming operations and facilitates multi and relay cropping. Mechanization of small holding will play an important role in increasing rice production.

The Government of Andhra Pradesh has also been taken initiatives for the farm mechanization. Under these initiatives, farm machinery suitable for land preparation, sowing, transplanting, weeding, plant protection, harvesting and post harvesting equipment are being supplied under subsidy. A survey on SRI rice farmers shows that 18% of them own the cono weeder, 17.2% own the power sprayer, 15.8% own the power tiller, 2.2% own the combine harvester, 1.6% own the tractor, 0.8% own the thresher.

Laser land leveler smoothers the land surface with in ±2 cm from its average elevation. It enhanced rice-wheat system productivity by 10% and water saving of 22%, increases water productivity of rice from 0.55 to 0.91 kg grain m⁻¹. Seed cum ferti drill results in simultaneous activities of seeding and fertilization process in single operation. The average population (190 plants m⁻¹) and average yield (40.35 q ha⁻¹) of seed sown by multi crop seed cum ferti drill was approximately 3% higher than the plant population (185 plants m⁻¹) and average yield (35 q ha⁻¹) of seed sown by traditional method. Zero till seed cum ferti drill was brought from Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, helps to seed a crop directly in the cultivated field just after the harvest of the previous crop with the least disturbance of the soil. It reduces the cost of cultivation up to 45.62% less compared to broadcasting and 45.38% less compared to sowing with normal seed drill.

Drum seeder technology was initiated by District Agricultural Advisory and Transfer of Technology Centre (DAATTC), Eluru, Acharya N. G. Ranga Agricultural University, Andhra Pradesh with a lead to promote direct sowing. It reduces cost of cultivation by 11,708 ha⁻¹ and increases gross returns by 2,965
ha\(^{-1}\), increases the net income by 14,673 ha\(^{-1}\) and average yield increases by 243 kg ha\(^{-1}\), labour usage reduced by 90% and saving time by 75% over conventional method of transplanting in the field. A four-row manually operated rice transplanter developed by CRRI, Cuttack. The transplanter saves seed to 21 kg/ha, labour of 40%, average net returns were Rs. 19,798 ha\(^{-1}\) and Rs. 27,462 ha\(^{-1}\) & the yield was 4.83t/ha and 5.70 t/ha in traditional and self-propelled paddy transplanting methods respectively. Cono weeder increases the weeding up to 85.5% and only 1.5% of plants were damaged. Combined harvester saves the average time, cost and grain over manual methods by 97.5%, 35% and 2.75%, respectively. The hold on type pedal thrasher for paddy with wire loop beaters were developed in Japan. Multi crop threshers have been developed by AICRP centres at CIAE (Bhopal), PAU (Ludhiana), TNAU (Coimbatore), ANGRAU (Hyderabad) and other centres. It showed 96.7% threshing recovery, 98.8% threshing efficiency, 90.7% cleaning efficiency at 14% moisture content.

In order to reduce cost of cultivation using zero till seed-cum-ferti drill; rice transplanting technology to increase yield and returns; rice thrasher to work even under high moisture content; laser land leveller to promotes better crop establishment, water and energy savings; drum seeder to promotes early maturation, reduces labour usage and save time, mechanization plays a very important role in agricultural sector, particularly in rice cultivation.

04-08

**IMPACT OF MECHANIZATION ON HIGH DENSITY PLANTING SYSTEM IN COTTON**

*Uma Maheswari M and Karthik, A.*

Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore.

“Cotton” the white gold is one of the most important commercial crops playing a vital role in the economical, political and social affairs of the country. Today India is the third largest producer of cotton in the world. The low yields of cotton are attributed to inadequate inputs, untimely field operation, lack of irrigation (70% area under rainfed conditions) and inefficient crop production technologies. The land preparation aspect is not given a due consideration in cotton cultivation. In dry land areas of central India, cotton farmers still use traditional farm implements that have low field capacity and demand lot of energy. Several operations like planting, weeding and picking are labour intensive and during these operations shortage of labour frequently occurs (Majumdar, 2010). The delay in completion of operations leads to loss of yield. The intercultural machinery operated by tractors is rarely used. The possibilities of mechanical picking need to be assessed. Similarly the custom hiring system for farm implements requires promotion in rural areas.

**METHODOLOGY**

Farm mechanization is essentially a judicious mix of resources, implements, machines, and power sources. It involves injecting extra capital into the farming system with a view to increasing labour capacity to do work, in terms of quality and quality of output per worker. The ability of Agricultural Engineering technologies to increase yields has attributed towards improving the effectiveness of other advanced production technologies. If mechanization does not keep pace with progress in other agro-technologies, it can become a yield limiting factor. Mechanization of farming operation is the only way of reducing drudgery. The experiment was carried out to evaluate the economics of conventional and high density planting systems in cotton. The cost inhered for both the practices were considered and economics were calculated.
Economics of HDPS

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Conventional HDPS</th>
<th>Mechanical HDPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land preparation (Rs/ha)</td>
<td>4000</td>
<td>3375</td>
</tr>
<tr>
<td>Sowing Cost (Rs/ha)</td>
<td>2400</td>
<td>900</td>
</tr>
<tr>
<td>Weeding Cost (Rs/ha)</td>
<td>16875</td>
<td>8400</td>
</tr>
<tr>
<td>Spraying Cost (Rs/ha)</td>
<td>5250</td>
<td>1800</td>
</tr>
<tr>
<td>Total treatment Cost (Rs/ha)</td>
<td>28525</td>
<td>14475</td>
</tr>
<tr>
<td>Other Cost (Rs/ha)</td>
<td>18600</td>
<td>17500</td>
</tr>
<tr>
<td>Total cost of cultivation (Rs/ha)</td>
<td>47125</td>
<td>31975</td>
</tr>
<tr>
<td>Seed cotton yield (q/ha)</td>
<td>13.6</td>
<td>12.5</td>
</tr>
<tr>
<td>Gross return (Rs/ha)</td>
<td>68000</td>
<td>62500</td>
</tr>
<tr>
<td>Net return (Rs/ha)</td>
<td>20875</td>
<td>30525</td>
</tr>
<tr>
<td>Benefit Cost ratio</td>
<td>1.4</td>
<td>2</td>
</tr>
</tbody>
</table>

CONCLUSIONS

Mechanization in cotton is a labour augmenting technology increasing the output per worker rather than output per unit of land. The benefits of mechanization have been greatest where labour is scarce and therefore expensive and/or land is plentiful. This characteristic of mechanization has important implication for its role and impact in the small holder system, where in majority of the cases land, capital and management are limited and labour is generally abundant. All over the world machinery proves one of the most important inputs in cotton production. Hence, mechanization along with high density planting system in cotton will be more effective for farmers in getting better profit.

Keywords: Mechanization; important technology; labour saving; increase in production

04-09

ENHANCEMENT OF PRODUCTIVITY THROUGH MECHANIZATION AND POST HARVEST TECHNOLOGIES

Divya, K., Naipunya, J and Areef, M.
Department of Agricultural Economics, S.V. Agricultural College, Tirupati.
Corresponding author: divya.kathula@gmail.com

Indian agriculture is facing the two most crucial challenges today. If the shrinking resources of land and water are one, the other more serious concern is the availability of human resources. The future of agriculture is dependent on penetration of scale-neutral technologies. The trend has already begun in some ways, with those who remain in farming turning to newer methods of optimizing the output on their farms, including adopting newer technologies to save cost and time. The use of tractors and tillers increasing five-fold in the last four decades is a testimony to this fact. Farm power increases in India have led to substantial improvements in grain production. Farm power in India has reached a level of 1.5 kW/ha. Increasing farm power availability, especially for small holder farmers is a vital ingredient for improved productivity in the agricultural sector. The governments have encouraged farmers to use agricultural machinery by means of development programmes and incentive measures. Unfortunately, in spite of some progress, the role of agricultural mechanization is still
below the level expected. There are several reasons for this, particularly the manner in which structural adjustment programmes were implemented in the 1980s when the respective roles of the public and private sectors were not clearly defined. Since this period agricultural mechanization entered into a vicious circle whereby farm low incomes mean low savings capacity. This leads to low demand for mechanization services which resulted in low farm productivity which in turn explained the low farm income achieved. A second vicious circle results from this as low demand for mechanization services will result in low supply, high unit costs and so even less use by farmers. Farm mechanization and crop productivity had a direct correlation as farm mechanization saves time and labour, reduces drudgery, cut down production cost in the long run, reduces post-harvest losses and boosts crop output and farm income. Use of improved implements had potential increase in productivity up to 30 per cent and reduces the cost of cultivation up to 20 per cent. At present, Indian farmers are adapting farm mechanization at a faster rate in comparison to recent past. Although, the sale of tractors in India cannot be taken as the only measure of farm mechanization but to a great extent it reflects the level of mechanization. Indian tractor industries have emerged as the largest in the world and account for about one-third of total global tractor production. Several studies have been conducted on the impact of agricultural mechanization on production, productivity, cropping intensity, human labour employment as well as income generation. Different researchers have concluded that farm mechanization enhances the production and productivity of different crops due to timeliness of operations, better quality of operations and precision in the application of the inputs. The results indicated that there was significant increase in cropping intensity due to the use of tractors and irrigation as a consequence of mechanization. The increase in cropping intensity has been reported to be 149, 156 and 165 per cent, respectively, for tractor-owning, tractor using and bullock operated farms respectively, according to a NCAER (National Council of Applied Economic Research) survey. Similar results have been reported in other studies which have concluded that as a consequence of mechanization, the cropping intensity increased significantly.

Sustainable crop production intensification necessarily means increased output and this needs to be stored and processed to reduce wastage and add value. Adding value to agricultural produce is becoming increasingly attractive for farmers and other rural sector entrepreneurs. Value addition through crop processing will usually involve the application of engineering solutions in such areas as crop storage and transport, vegetable processing, milling, dairy and meat product manufacture, and so forth. Nearly 40% fruits and vegetables are wasted every year due to improper handling, storage, packaging, and transportation. Food losses were the result of management decisions taken along the production chain from the field to the table and they can dramatically affect the shelf life and quality of the product. Losses are usually around 50 per cent and comprise on-farm losses before, at and after harvest; post-harvest losses in storage and transport; processing and distribution losses; and finally losses at the point of consumption. The application of agricultural and food engineering to farm mechanization and post-harvest technology can have a dramatic impact both on sustainably enhancing agricultural production, and reducing harvest and post-harvest losses, and on adding value to agricultural produce along the post-harvest processing chain. Post harvest management is a strategic area of research, which offers huge untapped potential in increasing the overall availability of horticultural commodities through its appropriate conservation. The purpose of post harvest processing is to maintain or enhance quality of the products and make it readily marketable. Prime example of post harvest processing of agricultural products is rice, a major crop in India. Paddy is harvested and processed into rice. Experiments with paddy crop in farmer’s field in India have shown that if the crop is harvested at 20 to 22 per cent moisture as traditionally done, the field yield is increased by 10 to 20 per cent. Similar is the case with respect to wheat, jowar and other crops. In addition to the prevention and reduction of post harvest losses, advance post harvest management technologies and processing helps to optimize the quality produce for market requirement, assure greater food and nutritional security, generate more employment opportunities and ensures better return the farmers and entrepreneurs. India is the second largest producer of fruits and vegetables in the world. But, the level of processing remains low at single digit figure for many years so far. There is also an urgent need to reduce losses and wastage of valuable food commodities and utilize them in a useful manner.
The post harvest management of fruits and vegetables includes pre and post harvest practices, their harvesting, handling, packaging, storage, distribution, marketing, etc. Since fruits and vegetables contain a very high percentage of their fresh weight as water. Consequently, fruits exhibit relatively high metabolic activity when compared to other plant derived foods such as seeds. This metabolic activity continues post harvest and thus makes most fruits highly perishable commodities. This perishability, with its inherent short shelf life, that presented the greatest problem to the successful transportation and marketing of fresh fruits and vegetables. Thus, enhancement of their shelf-life would be of great help in reducing postharvest losses, avoiding gluts in the peak season and avoiding distress sale. This would also help in ensuring more availability of fruits and vegetables without bringing additional land into production and fetching higher economic returns to the farmers.

04-10

POST HARVEST TECHNOLOGIES

Krishna, M.A., Alam, Dharmendra and Umashankar Kaushik
College of Agriculture, Rewa, M.P.

Post harvest infrastructure also plays an important role in Indian agriculture. A considerable proportion of our produce goes wasted in the absence of suitable post harvest infrastructure. A study puts this losses to the tune of rupees 44,000 crore. This can be avoided if suitable post harvest infrastructure is provided to the farmers. As most of the horticultural produce is perishable, therefore, immediate handling of the produce after harvest is necessary. Suitable post harvest infrastructure in terms of cold storages, processing units, road networks in inaccessible areas, establishment of local regulated markets at the Panchayat levels can give a big boost to the agriculture sector by promoting value addition and food processing. This can also help in creating employment opportunities for the others also.

04-11

POST HARVEST TECHNOLOGIES TO ENHANCE FARM PROFITABILITY IN FRUIT CROPS

Antony Prajwala, K.
Department of Fruit Science, College of Horticulture, VR Gudem.
Corresponding author: kaprajwala1994@gmail.com

India is the world largest producer of many fruits, but, there still exist huge gap between per capita demand and supply due to enormous waste during post-harvest storage and handling which accounts for 30% to 40% caused by improper bagging, lack of temperature controlled vehicles, unavailability of cold chain facilities in various parts of country for preserving the produce, along with significant processing of the agricultural produce which results in immense losses to the nation.

Traditional processing technologies such as thermal processing (bottling and canning), freezing, dehydration (salting, brining and candying) drying, and fermentation are widely applied in the processing of fruits at various levels (artisanal, intermediate and high) and scales (cottage, small, medium and large). Tropical juices and fruit pulps, canned pineapples are examples of fruit and vegetable products produced using traditional processing technologies and which are increasingly entering in international trade (Gundewadi, 2013).

Now-a-days minimal processing technologies, specialized packaging and natural preservation systems are increasingly being applied in the preservation of fruits for both developed and developing country markets, in response to growing consumer demand for convenience and for “fresh-like” fruits of high quality which are nutritious, flavorful and stable. These processing technologies focus on adding value with comparatively little product transformation while increasing product diversity (Lilly, 2013). Example Pineapples minimally
processed and stored at 5 °C with active modified atmosphere (2% O₂ + 10% CO₂ and 5% O₂ and 5% CO₂) using polyethylene plastic film laminated with polypropylene (PP) provided greater firmness compared to pineapples not stored in modified atmosphere (Prado et al., 2003).

Many SMEs lack the capacity to operate competitively in the current globalized market environment owing to problems of scale, the poor quality of input supplies, poor access to technology, limited technical expertise and research capacity, low production efficiency, high marketing cost, lack of knowledge and consequently inability to comply with international standards for processed products therefore minimal and traditional processing technologies present considerable opportunities for innovation and vertical diversification in the fruit, relatively few small and medium enterprises (SMEs) are able to tap into and benefit from these opportunities (Rolle, 2005).

**Keywords:** Small and medium enterprises; minimal processing technologies; bottling; canning; salting; brining; candying

04-12

**FOOD-BASED NUTRITION INTERVENTIONS AND FOOD-BASED STRATEGIES**

*Mahesh M.*

Department of Agribusiness and Rural Management,

Indira Gandhi Krishi Viswavidyalaya, COA, Raipur, Chattisgarh.

Corresponding author: mahesh.merugu14355@gmail.com

The Food and Agriculture Organization of the India promotes nutrition interventions considering food as the basis for action, given the strategic role of food and the agricultural sector to improve food security for the community; thus, a large number of people, especially the poor, who participate directly or indirectly in agricultural activities are able to obtain benefits from its multifunctional character. Food-based nutrition interventions have the purpose of improving food production and availability, processing and conservation, supply and commercialization, as well as access and food consumption. The basis of this focus is community and local government participation in the planning, execution, supervision and evaluation of specific interventions. Food-based nutrition interventions include the development of community gardens and farms in urban and rural areas; hydroponic gardens and other related initiatives in urban and periurban agriculture; as well as the promotion of traditional crops with nutritional value and the development of small agro-industries. Food-based nutrition interventions can be implemented to improve the food supply in street and itinerant markets, town squares and rural markets, and street food sales. In all food-based interventions, food safety and quality control must be taken into consideration throughout the food chain. The interventions on nutrition education increase the family’s capacity to improve access to and consumption of food. Food-based dietary guidelines and nutrition education in schools are highlighted, as well as the utilization of school gardens. Food- and agriculture-based strategies focus on food as the primary tool for improving the quality of the diet and for overcoming and preventing malnutrition and nutritional deficiencies. The approach stresses the multiple benefits derived from enjoying a variety of foods, and recognizing the nutritional value of food for good nutrition and the importance and social significance of the food and agricultural sector for supporting rural livelihoods. The approach encourages and equips people to consider their total diet in relation to their preferences, individual lifestyle factors, physiological requirements and physical activity levels.

**Keywords:** Nutrition interventions; malnutrition; nutritional deficiencies; physiological requirements; food and agricultural sector
FARM MECHANIZATION THROUGH CUSTOM HIRING CENTRES FOR SMALL AND MARGINAL FARMERS

Jhansi, Y and Sunanda, N.
Research Scholar, Department of Agricultural Economics,
Agriculture College, Bapatla.
Corresponding author: jhanstqagsc123@gmail.com

Agriculture scenario has witnessed a great change since last two decades. With the enormous development of urban areas and migration of rural labour class to the urban areas for better employment opportunities has resulted in scarcity of labour for agricultural operations. In this context, the labour cost incurred for the farmer is increasing during the course of time and due to lack of agriculture labour the farmer has no scope for growing second crop. There has been increase in the use of farm machinery in Agriculture as it contributed to the increase in output due to timeliness of operations and increasing precision in input application. The cost reduction technologies in every farm operation instead of depending on human labour by moving to farm mechanization results in reducing total labour costs and input costs. The major constraint identified is that small and marginal farmers cannot afford to purchase costly machinery and equipments, even large farmers/farmer groups unable to maintain and operate need based farm machines as per the prevailing local cropping practices. Due to prohibitive cost of farm machinery, small and marginal farmers are unable to own them. Thus, establishment of Custom Hire and Service Centres and providing farm machinery required for various farm activities right from land preparation to post harvest would enable small and marginal farmers to mechanise farm activities by way of hiring the farm machinery on reasonable hire charges in order to reduce their farm investment. Separate hiring charges is fixed for small and marginal category farmers as a category and other category farmers, wherein hiring charges for small and marginal category farmers will be lower than the other category farmers.

Keywords: Small and marginal farmers; farm mechanization; custom hiring centers; labour; input costs; labour scarcity

FARM MECHANIZATION AND POST HARVEST TECHNOLOGIES TO ENHANCE FARM PROFITABILITY

Amrutha, S.
Department of Agricultural Economics, Agricultural College, Bapatla.
Corresponding author: amruthasavaram@gmail.com

Farm mechanization has been known to provide a number of economic and social benefits to farmers. Among the economic benefits, improved returns come as a result of greater level of mechanization. Looming water scarcity crisis along with the need to ensure food security in the country, the benefits of farm mechanization makes it a crucial component of shaping the future of Indian agriculture.

Farm mechanization and use of modern gadgets or machines and tools for timely and effective completion of different operation in agricultural field is one of the most important factors for maximizing profitability. The mechanization of farming practices throughout the world has revolutionized food production, enabling it to maintain pace with population growth. The importance of enhancing and upgrading such mechanization practices prior to the almost inevitable transition to engine-driven equipment is now well recognized. Automation of agricultural mechanization is an intensive area of research and development with emphasis on enhancement of food quality, preservation of operator comfort and safety, precision application of agrochemicals, energy conservation and environmental control.
Farm mechanization increases the crop intensity and yield thus ensuring better returns to the farmer, reduces weather risk and risk of non-availability of labour thus minimizing postharvest wastages, improving working conditions of the farmer by enhancing safety to the farmer, conservation of uncultivable land to agricultural land though advanced tilling technologies, shifting land used for feed and fodder cultivation for draught animals towards food grain production. One of the main contentions of increased farm mechanization has been that it has affected farm level employment to enhance farm profitability.

**Keywords:** Farm mechanization; employment; income; profitability

**USE OF MECHANIZATION AND ITS IMPACT ON AGRICULTURE**

*Sowjanya, A and Pulla Rao, Ch.*

Department of Agronomy, Agricultural College, Bapatla.

Corresponding author: sowjanyaagron@gmail.com

Indian agriculture is required to achieve food production of 293.60 million tonnes by 2020 with the cultivated land remaining at about 142 million hectares; it has to come through essentially a vertical expansion and gains through productivity in commodities. There is going to be demand for farm machineries that are ergonomically sound, economically affordable, economy in input use and quantum jumps in productivity. Major sources of farm power include both animate (humans and draught animals) as well as inanimate sources such as diesel engines, tractors and electric motors.

Farm mechanization is considered to be one of the several pathways of agricultural development. In modern agricultural practices, mechanization of farm is needed from the point of the profitability of agriculture. Farmers, whether in the developed or developing economies, mechanize farm operations when the biological sources of energy, e.g., human and animal labour become more costly than the mechanical sources. There is a secular tendency everywhere for the biological sources to become costlier than the mechanical sources. This is due to the increasing ease with which capital can be substituted for labour in agricultural and partly to the rise in the cost of human and animal labour relative to that of machines and fuel.

The productivity of farms depends greatly on the availability and use of farm power by the farmers. It implies the use of various power sources and improved farm tools and equipment, with a view to reduce the drudgery of the human beings and draught animals, enhance the cropping intensity, precision and timeliness of efficiency of utilization of various crop inputs such as seeds, fertilizers and irrigation water, increase productivity of land and labour by meeting timeliness of farm operations and increase work output per unit time and reduce the losses at different stages of crop production.

Unlike industry, where men, machines and materials are brought under one roof, agriculture requires these three being moved and thus, availability of appropriate farm power sources are imperative. However, for the current level of intensity of farming and the required level of productivity, electro mechanical sources of farm power have to replace the human and animate sources of power.

The end objective of farm mechanization is to enhance the overall productivity and production with the lowest cost of production. The contribution of agricultural mechanization has been well recognized in enhancing the production together with irrigation, biological and chemical inputs of high yielding seed varieties, fertilizers, pesticides and mechanical energy.

To sum up, agricultural mechanization, increases agricultural productivity and profitability on account of timeliness of operations, better quality of work and more efficient utilization of crop inputs. Also mechanization leads to increase in the human labour employment for the on-farm and off-farm activities as a result of manufacture, repair, servicing and sales of tractors and improved farm equipment.

**Keywords:** Farm mechanization; agriculture
POST HARVEST TECHNOLOGY IN VEGETABLES

Pratyusha, P and Vara Prasad, N.
College Of Horticulture, Dr. Y.S.R. Horticultural University,
Venkataramannagudem.
Corresponding author: pratyushapanigrahi53@gmail.com

India has varied agro climatic conditions; different types of vegetables are grown all over the country. India is the 2nd largest producer of vegetables in the world having production of 45 million tonnes. However, the huge post harvest losses takes place of 10-25% owing due to the improper pre and post harvest management practices. The various reasons for post harvest losses are loss of moisture, stored energy, shrinkage, pest and disease attack, micro organism, Rodents, physiological disorders. Factors influencing post harvest life of vegetables are pre harvest factors like genetic factors, cultivation aspects, harvesting time, method of harvesting and post harvest factors like washing, pre cooling, packing and storage. Pre harvest treatments include application of 0.5% CaCl₂, 1500-2000 ppm malic hydrazide, 10-20 ppm N-benzyl adenine, 0.2% difolatan used to enhance the shelf-life of vegetables. Post harvest treatments such as application of SO₂, Thiabendazole, kinetins, ethephon, waxes, 2,4-D, 2,4,5-T, IAA, NAA, Potassium permanganate, ethylene dibromide and methyl bromide. Drying, dehydration, pre cooling and Irradiation are some of the advanced post harvest treatments used to improve shelf-life. Specialized storage structures like controlled atmosphere, modified atmosphere packaging, zero energy cool chambers are used for better storage of vegetables.

ENHANCEMENT OF FARM EFFICIENCY THROUGH VALUE ADDITION OF AGRICULTURAL PRODUCE; AN EVERGREEN TECHNOLOGY FOR PROFIT MAKING

Sridevi, P and Vijaya Bhaskar, V.
Department of Fruit Science, Horticultural College and Research Institute,
Venkataramannagudem.
Corresponding author: sridevipadala93@gmail.com

Value-added agriculture refers most generally to manufacturing process that increases the value of primary agricultural commodities to improve the profitability of farmers. Value-added agriculture is regarded by some, a significant rural development strategy to empower the farmers and other weaker sections of society especially women through gainful employment opportunities and revitalize rural communities. Fruits are undoubtedly very important for nutrition security with high potential of value addition and foreign exchange earnings. Most of the minor fruits are enriched with nutritional and medicinal value, and can be grown even in wastelands without much care. Therefore, it is worthwhile to look into the organized cultivation and improvement of minor group of crops like anola, Jack fruit, wood apple, bael, etc. so that their utilization can be maximized. There is always demand from consumers for new, delicious, nutritious and attractive food products. To satisfy this demand, there is a constant effort to develop products from diverse sources. The potentiality of processed products from some minor fruits in the country is still untapped. It reflects the feasibility for the development of some diversified value added products from some of the minor fruit crops grown in India in order to minimize the wastage, to promote these products as export items and to uplift the nutritional and socio-economic status of the vulnerable communities of country.
In today’s context, natural dyes are seen as complimentary and not conflicting with the use of synthetic dyes in the textile industry as a whole. In the domestic and export markets, natural dye products are valued more for their novelty and beauty. Natural dyes provide more elegant, soothing and aesthetic colours to the fabric. They are supposed to have a multifold use, besides contributing to the effectiveness of measures to preserve the environment. In this article results were shown the improvement of colourfastness of natural dyes with levelling agents. In this article we reported the improvement of the crock fastness of the Annato natural dye with eco-friendly dye levelling agents. Treatment with levelling agents was given to the fabric while dyeing for 30 minutes. Soda ash, Glauber’s salt, common salt, Di-Ammonium Hydrogen Phosphate and Magnesium Chloride Hexa Hydrate were selected for treatment, this treatment was given by preparing 5 per cent solution of each of the levelling agents. The solution was then divided into three parts. While dyeing, all the three parts were added to the dye solution at 10 minutes gap. After all the three parts of the levelling agents were added, the fabric was removed, rinsed in soap solution and dried. A light weight cotton fabric woven in plain weave was selected for this study. Pre-treatment was required for cotton fabric as it had no affinity towards natural dyes. Myrobalan fruit was selected for giving pre-treatment to cotton as the tannin content present in it, aids in enhancement of dye uptake and levelling of dye on the fabric. Extraction of the colourant from annato natural dye which is a potential orange dye source (known as zatropha in Telugu and Tamil or latpan in Hindi) was used for this study. As per the available literature annato is known as the direct natural dye which is fugitive and thus exhibit limited fastness properties. A wave length of 468 nm was found to give maximum optical density for annato seeds. The alkaline method was used to extract the dye from annato seeds; effects of the three eco-friendly mordants, namely alum, stannous chloride and ferrous sulphate and mordanting methods of mordanting viz., pre-mordanting, simultaneous and post mordanting. Among the three methods of, pre-mordanting method was suitable for many natural dye sources especially for the selected dyes with all mordants (Devi et.al, 2002). Hence; pre-mordanting method was selected for improvement of colourfastness of natural dyes on cotton fabric with levelling agents; dyeing variables; development of newer shades with simultaneous treatment and analysis of colour improvement parameters with levelling agents for cotton dyed with natural dye; assessed colour improvement with colourfastness tests of dry and wet crock fastness.

Key words: Annato natural dye, levelling agents, colour fastness, shade variations with dye levelling agents

VALUE ADDITION: AN APPROACH TO ENHANCE FARM PROFITABILITY

Dhruva Shukla and Santosh Shivran
Department of Genetics and Plant Breeding
College of Agriculture, Rewa, JNKVV, Jabalpur.
Corresponding author: dhruvashukla21@gmail.com

Value-added agriculture refers most generally to manufacturing processes that increase the value of primary agricultural commodities. Value-added agriculture may also refer to increasing the economic value of...
a commodity through particular production processes, e.g., organic produce, or through regionally branded products that increase consumer appeal and willingness to pay a premium over similar but undifferentiated products. In India, there is a vast scope for growing fruit and vegetable throughout the year in one or other part of the country because the climatic conditions are highly suitable for growing various types of fruits and vegetables. Fruit and vegetable are highly perishable but most important commodity for human diet due to their high nutritional value. They are the cheapest and other source of protective food supplied in fresh or processed or preserved form throughout the year for human consumption. In peak season due to improper handling practices, marketing, storage problems around 20-25% fruit and vegetable are spoilt in various stages. Fruit and vegetable are living commodities as they respire. Hence, proper post harvest management handling and processing is required in horticulture crops. Most of the vegetables are highly perishable and have limited life, which need to be marketed immediately or processed into varied value-added products. Diversification of Agricultural products for export and domestic consumption reduces the risk of loss due to price fluctuation. This increased demand for value-added products is due to the change in the market behavior, changes in consumer preferences and emergences of supermarkets, which have resulted in the usages of more value-added, ready-to-use Agricultural products. These products also have a high demand in the defense sector of the different country. Among the different Agricultural value-added products, dehydrated potato, peas, carrot, cauliflower, tomato-based processed products, pickles and chutney from different fruits and vegetables are the most important. Apart from these lycopenes from tomato and watermelon, tomato seed oil, frozen vegetables, organic vegetables, minimal processed vegetables, consumer-packed vegetables, etc., are also important.

**Importance of value addition in Agricultural sector**

1. Scope for many units.
2. Wide variety of raw material base.
3. Vast, growing domestic and export market.
4. Encourages local skills.
5. Women empowerment.
7. Advantages for farmers.
8. Improves socio-economic status of farmers.
9. Strong multiplier effect on all round development.
Theme - 5
Extension Strategies Including e-initiatives
Towards Farmer’s Prosperity
POWERING DISRUPTION IN THE EXTENSION ADVISORY SERVICES

‘There is nothing like extension in digital era: Are we disruption ready’

Shaik N. Meera, Principal Scientist
ICAR- Indian Institute of Rice Research, Hyderabad.
Corresponding author: meera.shaik@icar.gov.in

Powering Extension and Advisory Services (EAS) with disruptive technologies such as mobile/cloud computing, Internet of Things, location-based social networks etc. is a new game changer.

Use of digital technologies in rural advisories has been documented well in past two decades. While most of the digital pilots reported success, the empirical evidences of such digital extension strategies on farmers’ income and in adding value to the extension advisory systems are not sufficiently deliberated.

On the other hand, digital disruption is happening across the industries (with an exception to agriculture!) bringing significant values to individuals and organizations. Spotting something and doing something about it are very different things. We are spotting disruptive trends in commerce, health, hotel, governance, banking industries, but seldom tried to relate them to rural advisories and agricultural development.

Researchers recently proposed two important qualifications to disruption theory that could be relevant to rural advisory services. First, higher-performing products and services result in higher profitability (so they have an economic motivation) and Second, using “extendable core” that could be used to do more and more sophisticated things at a lower cost than incumbents (Wessel and Christensen, 2012). Extension as a discipline and as a service qualifies to both these.

Disruption in extension advisory services will happen when EAS embraces big data analytics and linking them to unique Aadhaar (12 Digit unique identification number of Indian citizens) numbers of farmers. Supplemented with the digitized land records and soil health status connected with GPS coordinates, the future of input supply can undergo a radical transformation. Big data in extension advisory systems cover the integration of information provided by farmers, players in the agri-food chain and markets (e-National Agricultural Market) which can be used to enhance productivity, reduce risk, increase resilience and improve profitability. This will bring new values to farming and small & marginal farmers would get maximum benefit out of such strategies (Shaik N. Meera, 2017).

1. Are we disruption ready?

A disruptive technology is an innovation that creates a new market and value network and eventually disrupts an existing market and value network, displacing established market leading firms, products and alliances. The term was defined and phenomenon analyzed by Clayton M. Christensen beginning in 1995.

There is a difference between bringing improvements to the existing extension system with digital technologies and bringing radical transformations into the very nature of extension services. To explain in easy terms, personal computer (PC) displaced the typewriter and forever changed the way we work and communicate. We are not talking about improving the efficiency of type writer here. Instead, we have witnessed a new form of communication and publishing. Social networking has had a major impact on the way we communicate. It has disrupted telephone, email, instant messaging and event planning. Smartphones with mobile apps disrupted pocket cameras, MP3 players,
calculators and GPS devices among many other possibilities.

Online and mobile banking makes it possible
to almost completely bypass the physical bank entities
and human bank teller. Amazon, Flipkart and Olx
have revolutionized the classified advertisements and
person-to-person sale of all matter of items, including
farm equipment. Big basket has changed the way we
buy fresh vegetables and fruits.

A disruptive innovation in agriculture will allow
a whole new set of small and marginal farmers’
accessing a technology or a service that was
historically inaccessible to them or accessible at higher
costs only. For instance, rural communities are now
able to access e-commerce goods and other services
such as railway tickets as platforms to this digitally
are available. Similar goods (agri-input, credit) and
services (extension advisory, marketing) are yet to
be accessed in agriculture because there is no
disruption.

Are we ready for digital disruption in
extension? Or do we continue to initiate new digital
xtension pilots? The moot point is eventually how
fast we can disrupt (in a positive way!) the way
xtension organizations work. Are extension systems
working towards capitalizing on the potential
efficiencies, cost-savings, or new opportunities
created by low-margin disruptive technologies?

Initially big organizations dismiss the value of a
disruptive technology because it does not reinforce
current organizational mandates. I see similar
indifference in extension organizations as well.
Improving the efficiency of extension systems had
been attempted with a series of digital pilot projects
in India. (Please read: http://www.aesa-gfras.net/

One of the digital pilots that is rolled out (in
2016) at nation level is eNAM (www.enam.gov.in)/.
We are aware of National Agriculture Market
(NAM) - a pan-India electronic trading portal which
networks the existing agriculture produce market
committees (APMC) mandis to create a unified
national market for agricultural commodities. The
NAM Portal provides a single window service for
all APMC related information and services. This
includes commodity arrivals & prices, buy & sell
trade offers, provision to respond to trade offers,
among other services. While material flow
(agriculture produce) continues to happen through
mandis, an online market reduces transaction costs
and information asymmetry. This is an essential
condition for disruption. But not a sufficient one.
Individuals are the backbone of innovation and many
entrepreneurs are doing innovation in their own
ingenious ways with disruptive technologies. Often
recognized as what is called “Jugaad Innovation”, it
is a very flexible, frugal and un-structured method
of generating original ideas and solutions. We have
enough of pilots, but what we need is a disruption in
extension advisory systems.

Think about Amazon that could be
compared to eNAM initiative. Amazon= eNAM+
Complementors (aggregators + retailers+
courier+ payment gateway). While eNAM can
not be a disruptive force in EAS, a combination
of complementary organizations will help
bringing disruption in the way agricultural
marketing is seen in recent past.(please read
subsequent sections).

As EAS organizations adopt disruptive
platform strategies, an organization’s ability to
leverage complementary organizations may
increase its likelihood of success. For example
technology organizations manage
complementors through developer programs
(e.g., Apple’s developer program and App Store),
innovation ecosystems (Adner and Kapoor,
2010), and engaging with individuals through
activities like crowd sourcing (Howe, 2008) and
innovation contests (Boudreau, Lacetera, and
Lakhani, 2011). Platforms may enable new
market disruption since complementor
interactions introduce new competitive
dimensions. For example, Facebook enabled
Zynga to create a new market disruption of
casual gaming appealing to customer groups
who otherwise would not have consumed video
games because they were
too complicated; Airbnb enabled college students to become hotel proprietors despite their lack of capital and expertise. This link between the management of complementor ecosystems and disruptive innovation has yet to be fully explored and offers promising avenues for future research. Extension organizations need to envision what that disruption looks like!

2. The Singularity in Extension is here

Let us see what kind of disruption is expected from extension systems. Digital technologies can bring disruption in an extensionists’ functioning that includes transformed services, new innovations in the way extension is handled and completely new players in extension advisory system. Advisories (crop / varietal choice, pre-production, production and post production advisories) and input supplies.

Cloud computing has been a hugely disruptive technology in the business world, displacing many resources that would conventionally have been located in-house or provided as a traditionally hosted service. The next and most radical generation of mobile communications – fifth generation (5G) – is three years away from now (expected by 2020). The 5G may radically change the technologies and business models of the mobile telecommunications industry. It will have positive consequence in primary sector like agriculture and extension systems will have to gear up to develop frameworks for best use.

Input supply App can become a disruptive force in the supply chain management in agriculture. The app allows a user to submit a request for a specific input based on the personalised advisory. Approved input suppliers in the area are notified by the app and respond. Payment is not passed from farmer to input dealer – it’s done via the app which accesses the farmers Adhaar Card / Unique ID card linked to bank account number / credit card. The app also makes use of smart phone GPS capability to show you exactly where and how far away the prospective input dealer / field officer of a private company is. The app itself and the technology is quite simple, but it provides a completely new approach that challenges how input supply services have been obtained for decades. This is disruption!

Farm Marketing App can become a disruptive force in the way farmers sell their produce. The app allows sellers to submit a request for selling a specific produce / commodity. Approved buyers in the area are notified by the app and respond. Payment is not passed from buyer to farmer– it’s done via the app which accesses the buyers Adhaar Card / Unique ID card linked to bank account number / credit card. The app also makes use of smart phone GPS capability to show buyers exactly where and how far away the prospective buyer is. Similarly it will show buyers how many prospective sellers are available in nearby villages and how to virtually pool the marketable surplus (you remember your olx experience?). The app is quite simple, but it provides a completely new approach that challenges how agricultural marketing services have been addressed for decades. This is disruption!

3. Powering Disruption: Avenues

From pre-production (credits, input supplies) to production (varietal to management) and to post production (processing and marketing) extension systems can harness big data platforms for better and informed decision making. Micro level data (such as soil health status, soil temperature, rainfall, moisture content) pooled at the village, block, district and regional level could serve as the big data for planning agricultural interventions. Extension Informatics (personal, field history linked to advisory) can be achieved with predictive modelling.

Connecting extensionists’ smart phones to a cloud-based analytics engine, in order to give farmers customised products and increase efficiency of their services. This technology will be more suitable for developing countries, characterised by the pre-eminence of small farms with very low investment capacity and which rely on intermediaries to a greater extent than farms in developed markets. Better market, crop and input information could boost yields and returns for farmers. For private firms, inventory tracking and
product traceability with GPS vehicle tracking (telematics—like in case of ePDS) will result in better supply chain management.

If you take seed sector, streamlining the seed production and supply chain by linking Aadhar with soil characteristics/varietal/crop profiling will solve some critical issues that hitherto were not addressed. Distribution of quality seed through ePOS machines is a good idea, but needs to be backed by identifying the seed growing areas and target (seed consumption) areas. Particularly this will have excellent positive consequences when it comes to contingency crop planning. Can Governments think of providing the seed/inputs to farmers by linking with aadhar (biometric-Jandhan accounts— and some assurance from department— Please refer to my blog on the subject http://www.aesa-gfras.net/admin/kcfinder/upload/files/AESA%20Blog-68-March%202017.pdf).

There are numerous technological options and contexts for exploring digital disruption. Few of them are discussed below;

### 3.1. Blockchain & Value chain

Blockchain in development can ensure trust and alignment across the value chain. It can reduce middle man costs, and allows relevant stakeholder to do business with each other securely without even knowing each other. This transformative technology can dramatically disrupt the way we approach development. Blockchain technology could be important in agriculture in different ways (http://www.e-agriculture.org/blog/can-blockchain-improve-livelihoods-smallholder-farmers) such as:

- Food traceability: Blockchain could make an entire supply chain transparent and provide information from the production of the crops till the consumption of the food. As the data along the chain are hard to modify, it will not be possible to change the information. A perfect traceability.

- Improved use of mobile payments, loans and insurance: Currently mobile finance is extremely important for smallholder farmers, but every transaction comes with a fee, due to the fact that there is an intermediary (Mobile Network Company offering the service).

- More efficient supply chains: Payments and transactions could take place real-time by using blockchain, while currently farmers have to wait often very long until they get paid for their produce, which delays further investments in the production. Using blockchain also adds transparency and trust which is important for example for farmers applying for a loan.

### 3.2. Big Data Analytics

Big data is extremely large data sets that may be analysed computationally to reveal patterns, trends, and associations, especially relating to human behaviour and interactions. I guess if there is one sector that can harness this functionality to the maximum, it would be agriculture. And extension advisory systems can do wonders with big data analytics. The extension advisory systems intentionally or unintentionally work on empirically driven data but such data, information and knowledge continuum could not be managed till now, because the data was not digital.

Farmers in Brazil, for example, are expected to use unmanned tools such as drones, to collect, analyze and transmit real-time crop intelligence to keep a check on the usage of chemicals, and irrigate dry fields to generate sustainable and high-yielding results. This information can then be transmitted to farmers over mobile phones. Analysis of vast data generated, enables farmers to make informed real time data-based decisions about utilisation of their resources and overall performance of their yield.

Heavy payload drones along with very efficient flight platforms, can help dispense fertilizer and pesticides over acres of farmland in a very efficient manner, guided by precise positioning and long range wireless connectivity. Saving INR 3000 (50 USD) from cost of cultivation per hectare will be phenomenal in the livelihoods of small and marginal farmers. Moreover, this ensures a steady
and uniform distribution and removes the health risk.

The big data analytics in extension will bring significant changes in the personalised, field specific solutions along with pre-production to post production service needs of farming community. It will lead to higher yields, lower input use per hectare and lower cost of cultivation. For example, the magnitude of yield improvement from commercial precision fertiliser application according to various agribusiness market participants ranges from 10% to 15%. Credit requirements to marketing gains, at every step like this may help small and marginal farmers, if effectively implemented (in combination with Internet of Things discussed below).

### 3.3. Internet of Things

According to Industry Trend Analysis, IoT & Big Data in Agribusiness the integration of Internet of Things (IOT) and big data technology in agriculture will pick up in the coming years, and be a major factor behind future improvement in global yields. (http://www.agribusiness-insight.com/)

‘Internet of Things’ (IoT), defined as the trend of connecting ‘things’ that can passively or actively monitor, collect and exchange data over a wired or wireless communication network. The Internet of Things can have positive consequences on Farm Production, Soil Health, Water, Nutrients management, Pests management, Traceability and Tracking, Supply Chain Management, Processing, Transportation, Storage, Retailers, Inventory management, Food Safety et., The IoT can provide farmers with on-demand information based on the differential contexts that can be sensed through a network of IoT sensors. Large scale utilization of IoT systems in extension organizations will optimize efficiency of advisories and supply chain management.

Dairy and livestock farmers have been using RFID to enable tracking of individual animals’ health and levels of production for quite a few years. There are many other active areas of development including sensor networks to monitor soil & crop conditions, equipment monitoring and automation (self driven planters/harvesters etc). These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices.

I see potential of the IoT more at the level of extension professionals (both public and private) rather than at field/farmers’ level. For example customised advisories can be planned for a village/cluster of villages based on sensor based data received on irrigation (channels), pests surveillance / management, weather based agro-advisories, real time contingency plans, animal disease out breaks etc..

For instance, take the case of municipal dustbins with sensors sending alerts to garbage collectors (truck drivers) to come and pick them up. Similarly sensors can send alerts to extension professionals about the possible outbreak of a pest / any other exigency under his jurisdiction. This is one way of reducing the higher costs of face to face contact methods of extensionists and will appropriate the human resources in extension systems.

To facilitate the purchasing of farm inputs and selling of farm products, buyers’ and sellers’ smartphones can be equipped with IoT technologies such as Near-Field Communications (NFC) that facilitate the purchasing of products without using cash. Mobile internet and low-cost sensors could enable farmers to interact directly with the consumers, cutting off the middleman. Kenya has developed M-Pesa kiosks in the rural communities for mobile money transfer.

Large scale extension programs enable decision makers undertake appropriate agricultural interventions with the use IoT technologies. These technologies can be integrated with a central system and help disseminate relevant advice to farmers. This can be used to identify pest outbreaks and trends. IoT systems can track farmers requiring transport to carry their farm products to distant markets. Similarly IoT systems will help the
consumers and traders with the traceability of agricultural commodities.

3.4. Location based Social Media

The inclusion of mobile positioning in social networking services that lets people know where they are at any given time may be termed in short as Location based Social media (LBS). Location-based social media monitoring could be used for segmentation of data from social networks (e.g. Facebook, LinkedIn and Twitter) by geographical location to identify patterns. For EAS, location-based social networks present unprecedented large-scale check-in data to describe a farmer’s (extensionist’s) mobile behaviour in spatial, temporal and social aspects. Based on the trends, contingency action plans and time critical advisories can be made available to farmers.

Several location based services could be provided using LBS - such as resource tracking along with dynamic distribution, finding nearest farmers willing to transport together to fetch higher market prices, weather fore-warning, proximity-based notification (push or pull) of extensionists / experts targeted advertising

3.5. 3D Printing in Extension?

3D printing, otherwise known as additive manufacturing, is a technological process in which physical items are produced in layers to form a three dimensional object from a digital model. Embracing 3D printing techniques will improve farming efficiency in rural areas. For example, 3D printing has the ability to produce specific parts for use in farm machinery. This can gel well with Uberization involving Farmers Producers Organizations.

4. EAS Framework & Disruptive Processes

There is never going to be a blueprint for how to proceed with disruptive technologies in extension. As stated by Andy Hall (https://fooodsystemsinnovation.org.au/blog/thoughts-about-what-disruptive-innovation-means-agriculture-research-organisations), what is clear is that business as usual is the anti-thesis of disruptive innovation. It is evident from e-commerce sector that in the early stages of disruption, the lower-performing technologies only meet the needs of a small segment of the existing customer base. In most of the digital pilot projects initiated across the globe during 1990 - 2002, this was witnessed in agriculture sector.

As the new technology evolves, its efficiency improves and the innovation meets the needs of additional customers in the industry. Eventually, the original firms are driven out of the industry as the disruption meets the needs of the mainstream market. In case of extension advisory systems, the disruption may not be to the magnitude of e-commerce (though agri-commerce may be).

The EAS Framework for harnessing disruptive technologies may be explored with three distinct areas viz., pre-production, production and post harvest.

4.1. Pre-production:

With incumbent extension approaches focus on blanket recommending crops / varieties suiting to a particular agro-ecosystem (ignoring inter-farm diversity). Personalized/landholding specific planning was never thought of Extension systems could be powered with individual farm level weather details, aberrations, climatic factors, crop selection etc., that is backed up by remote sensing, geographic information systems, management information systems, predictive modelling solutions and high impact knowledge management models. This also requires harnessing big data analytics and at times Internet of Things (for example - advisories based on soil temperature, humidity). Farming systems mix, various government schemes, access to credit and insurance could be handled with the emerging technologies to give personalised solutions to farmers. For this digital networking solutions will be of great help.

4.2. Production:

Incumbent extension approaches focus on package of practices or good agricultural practices that are recommended either variety wise / agro-climatic condition-wise.
Extension systems could be powered with sowing apps, cooperative land preparation, input management, water fertilizer management, pest management can be effectively handled by efforts made in the areas of sensory devices, proximity devices, e-commerce/m-commerce platforms/applications, digital networking solutions, big data analytics, smart mobile apps and high impact knowledge management solutions.

4.3. Post-harvest:

Incumbent extension approaches focus on, if at all they do, market prices, online marketing, warehousing, processing options, value added products etc.,

Marketing, food processing, packing, storage and transportation will play an important role in future farming. Perhaps these factors will drive global agriculture in coming years and this will have a bearing on the way small scale farmers would operate. Digital cashless transactions, transactions linked to unique IDs and bank account numbers, linking the credit and marketing with the bio-metrics will give extension advisory systems a leverage over the past efforts. Digital networking solutions, risk sharing systems for agricultural lending, agricultural value chain networks, e-vouchers distributed through mobile interfaces will transform the EAS strategies in the developing world.

5. **How to build Complementors Ecosystem?**

We know by now that we need to both essential and sufficient conditions for disruption to happen. The disruptions in each of the EAS services will take place when a complementors ecosystem is evolved. For a better understanding I may like to give an example of eNAM and how disruption like Amazon could be possible with an ecosystem. 

\[ \text{Amazon} = \text{eNAM} + \text{Complementors (aggregators + retailers + courier + payment gateway). While eNAM can not be a disruptive force in EAS, a combination of complementary organizations will help bringing disruption in the way agricultural marketing is seen in recent past.} \]

The electronic National Agriculture Market (eNAM) portal provides a single window service for all market-related information and services. This includes commodity arrivals and prices, buy and sell trade offers, and provision to respond to trade offers, among other services. Although material flow (agricultural produce) continues to happen through mandis, an online market reduces transaction costs and information asymmetry. This is a typical (conventional) digital pilot that I was discussing in the beginning of this blog. Anyone with basic understanding of agricultural marketing would know that price information (or price prediction as well) is only an essential condition but not sufficient condition for realizing the benefits to small holder farmers. If a farmer gets to know about higher price in a distant market, it is not economical to lift his produce to such market. In such case there is a need for market disruption (with the technologies discussed) to realize the benefits to farmers. Virtual pooling (that was tried to some extent in ITC’s e-choupal in India) will help pool the marketable surplus of farmers with proximity who wish to market in distant markets. Who knows there may be commission agents/farmers with digital skills - transforming themselves in taking advantage of this win-win situation (remember local retailers taking advantage of online marketing). Together with the virtual polling, a series of eVoucher platforms across the country could enable extension agencies to provide specific noncash services. Such eVouchers are much easier to track than cash vouchers, and they also help to avoid fraud, which is a common problem with paper vouchers. Think about joining this with the online soil health cards, Nutrient Manager App, optimum fertilizer recommendation, and hence fertilizer supply using eVouchers. This will dramatically improve fertilizer demand and supply dynamics.

Another interesting aspect to look is the effect of product imagery and experience with the upcoming technology in virtual reality environments? Apart from 3D, virtual reality is going to be a huge player in ecommerce in agriculture both at farmers and private organizations. When all the support
systems are in place, I guess the market disruptions may happen that would ultimately help farmers and consumers alike.

Google is a good example of how innovative companies drive digital disruption across many industries. It was a simple website search engine few years back. Now Google has changed dynamics in many industries such as media, retailing and banking. With many new initiatives like fibre-to-home, home automation, Google Car and Google Glass, the company will continue to drive creative disruption in telecoms infrastructure, utilities, and the insurance industry. In a similar way disruptive technologies may offer new expanded opportunity for extension system to evolve themselves into a completely unimaginable service providing organizations.

6. Digital Extension Dilemma

Clayton Christensen, in his book, ‘The Innovator’s Dilemma’, argued that successful executives tend to follow the path of past successes in their decision making. This helps to sow the seeds of their own demise by allowing other firms that innovate to move beyond the status quo. He therefore defined the innovator’s dilemma as “doing the right thing is the wrong thing”. If we really feel there is a need for radical change in extension advisory systems, disruptive technologies provide better opportunities.

To begin with few private firms started exploiting prescriptive planting strategies that have the potential to disrupt the agricultural industry. For example there are big data applications to precisely understand where in one of the 25 million mapped agricultural fields in the US to plant what type and volume of seed to achieve the desired crop yield. Monsanto’s FieldScripts product combines an extremely detailed database of 150 billion soil observations, 10 trillion weather-simulation points and hundreds of thousands of seed-yield data points. Monsanto’s planting machines, which can steer themselves via GPS, can plant a field with different varieties at different depths and spacing according to the climate data. Farmers that have trialled Monsanto’s system claim it has increased yields by around 5% over two years. All these do not mean that the same could be replicated at farmers’ level in South Asia or in many other developing countries. But within EAS, these strategies could well be deployed. Or other forms of disruption suiting to South Asian conditions could happen.

Investing in disruptive innovations in agriculture can boost garnering and harnessing the new ideas. Governments should facilitate nurturing / handholding entrepreneurs whose business models are put to use in digital agriculture. Many start ups are coming up that can initiate the digital disruption in EAS. The vision of digital disruption is exciting and pathways to prosperity need to be clear.

The success of disruptive technologies such as IoT and big data analytics for rural development depends on the participation and support of both, public and private bodies. Support could be in terms of finance, standards development, data sharing and access, analytical tools and technology.

7. Enabling Disruption: Envisioning Extension

Digital strategies will be good when farmers get benefit out of them. We need to understand farming and farmers before we adapt to these strategies. Unfortunately the islands of wisdom prevail because digital strategies are being experimented by eager beavers. But it is extension organizations that need to integrate them into their functional and structural components. Currently, there is a lull in the thinking while we enjoy the technology fad.

A case study of Kodak’s response to digital technology (Lucas and Goh (2009) revealed that inability of Kodak’s rigid, bureaucratic structure and middle managers hindered them to undertake a fast response to emerging technology which dramatically changed the process of capturing and sharing images. Kodak was so blinded by its success that it completely missed the rise of digital technologies. By the way, the first prototype of a digital camera was created in 1975 by Steve Sasson, an engineer working for Kodak. The camera was as big as a toaster, took 20 seconds to take an image, had low quality, and required complicated connections to a television to view, but it clearly had massive disruptive potential.
Unfortunately it could not capture the new opportunities. (Remember hybrid rice development in China as a disruptive force! Way back in 1954, two scientists from CRRI, Cuttack, India, S. Sampath and HK Mohanty were the first to draw attention to the possibility of developing hybrids in self pollinated crop like rice. But it was China that surged ahead.)

Companies often see the disruptive forces affecting their industry. They frequently divert sufficient resources to participate in emerging markets. Their failure is usually an inability to truly embrace the new business models the disruptive change opens up. Kodak created a digital camera, invested in the technology, and even understood that photos would be shared online. Where they failed was in realizing that online photo sharing was the new business, not just a way to expand the printing business.

Whether one likes it or not, disruptions are likely to happen (or already happening) in the extension processes, activities and methods. Perhaps, disruption may not happen within EAS immediately. I wrote this to provoke thought process about disruption in the extension processes rather than bringing disruption in the organizational structures. A series of such disruptive extension processes will surely transform the very nature of extension advisory systems. Until then keep thinking and explore what best could be done by us.

REFERENCES


Dr Shaik N Meera is a Principal Scientist at the ICAR-Indian Institute of Rice Research and is a pioneer in digital extension movement in India. He is a Digital Optimist and is involved in creating an ecosystem for shaping ICTs; knowledge & innovation management, capacity building and large scale demonstration strategies for Indian rice sector. Contact him at shaiknmeera@gmail.com, meera.shaik@icar.gov.in
05-01

ICT INITIATIVES RELATED TO AGRICULTURAL MARKETING IN INDIA- A CONTENT ANALYSIS.

Bhavani, G and Bhuvana, N.
Department of Agricultural Extension, College of Agriculture, Hyderabad.
Corresponding author: bhavanig0712@gmail.com

Rural computing is need of the hour ICTs play a significant role in the development of farming sector. Market and weather information are uncertain in nature where farmer fails to predict it. There is need to tailor the ICT policies according to the requirement of farmers. The government has taken major step in this scenario to develop ICT infrastructures and to provide services to the doorsteps of farmers. This article provides an insight into the content and direction of ICT initiatives revolving in the country related to market sector. Content analysis method is followed to identify the roles and importance of ICTs in relation to market information for farmers. The paper reveals that majority of ICT initiatives are online oriented and provides vast information related to market. It is observed that AGMARKNET and Digital Mandi provides apt location specific information needed for the farmers and is popular among the farming community. e-NAM is still in the process of development and establishment. Only limited farmers can access the source and majority have no clear information as how to use? to relish the benefits. It is also noted that there is need for the e-literacy among the farmers to make use of the available e-facilities in the country. Involvement of local stakeholders in creating awareness and delivery of services to farmers, results in a disciplined market. E-initiatives acts as an agent for changing agrarian and farmers life by providing market information. This helps the farmers to get timely and accurate information related to market. Farmer feels empowered and can adopt appropriate measures to market his produce in time. Thus, in future there would be substantial upliftment and sustainable development in rural areas.

Key words: ICT, AGAMRKNET, digital mandi, e-NAM, e-literacy, content analysis

05-02

EXTENSION APPROACHES AND POLICY ISSUES FOR RURAL DEVELOPMENT IN INDIA

Naipunya, J and Divya, K.
Department of Agricultural Economics, S.V. Agricultural College, Tirupati.
Corresponding author: juturu.punya@gmail.com

India’s agricultural extension system is at a pivotal point in its evolution. The investments in agricultural research and extension have served the country in positive way, particularly in achieving food self-sufficiency. But so far today gap between technology developed/released and the technology disseminated/adopted is wide. The frontier extension programmes such as KVK and ATMA still struggling with quality HRD and resources to cater the need of farming community. Efforts required a shift from technology dissemination to technology application mode and for this extension efforts has to be intensified. The biggest challenge with extension policy makers is 1) Mismatch between technical knowhow & extension professional skills 2) Low level and number of extension professional 3) Low resources with rapidly-changing rural context 4) Diversified cliental with multifold challenges 5) Production & climate change challenges. National goals for agriculture and natural resources management include food security, improving rural livelihoods to reduce poverty and food insecurity, and sustainable use of natural resources.
Agricultural extension and advisory services are concerned with (1) transferring technologies associated with production systems; (2) enhancing the skills and knowledge (i.e. human capital) among all farmers so they can select the most appropriate mix of enterprises; and (3) use the most efficient agricultural practices and sustainable natural resources management. This is achievable if farmers organize into groups (i.e. social capital) to increase market access and more effectively articulate their goals and needs to policy makers, researchers and extension providers. In India ICT applications such as Warana, Dristee, E-Chaupal, E-Seva, Lokmitra, E-Post, Gramdoot, Dyandoot, Tarahaat, Dhan, Akshaya, Honeybee, Praja are quite successful in achieving their objectives. e-Extension (e-Soil Health card Programme): The Department of Agriculture, Gujarat State is one of the ambitious programmes which aims to analyse the soil of all the villages of the state & proposes to provide online guidance to farmers on their soil health condition, fertilizer usage and alternative cropping pattern. AGRISNET - uses state-of-the-art broadband satellite technology to establish the network within the country. AGMARKNET is a comprehensive database which links together all the important agricultural produce markets in the country. Agri-Clinics and Agri-Business Centres: It provides a web based solution to the small and medium farmers as well as owners of large landholdings. It brings on a single platform all the stakeholders in agribusiness. e-KRISHI VIPAN: This initiative professionalizes and reorganizes the agriculture trading business of Mandi Board by installing cost effective digital infrastructure using latest advancement in ICT by collecting and delivering real time information online. It makes the operations more effective, totally transparent, benefiting all stakeholders (farmers, traders & the government), empowering them through accurate and timely information for effective decision making. Query Redress Services: Empowering the farmer community through effective, need-based interventions. It enhances livelihood promotion of farmer community through information dissemination and extension services, using ICT as tool. The project helps the farming community by making available a 10000 plus network of experts to them. Kisan Call Centres: Kisan Call Centres have been established across the country with a view to leverage the extensive telecom infrastructure in the country to deliver extension services to the farming community. The sole objective is to make agriculture knowledge available at free of cost to the farmers as and when desired. Queries related to agriculture and allied sectors are being addressed through the Kisan Call Centres, instantly, in the local language by the experts of State departments, SAUs, ICAR institutions etc. There are call centres for every state which are expected to handle traffic from any part of the country. SMS using telephone and computer interact with farmers to understand the problem and answer the queries at a call centre. The infrastructure is placed at three locations namely-a professionally managed call centre (level-I), a response centre in each organization, where services of SMS are made available (level-II) and the Nodal Cell (level-III). Tata Kisan Kendra: The concept of precision farming being implemented by the TKKs has the potential to catapult rural India from the bullock-cart age into the new era of satellites and IT. TCL’s extension services, brought to farmers through the TKKs, use remote-sensing technology to analyze soil, inform about crop health, pest attacks and coverage of various crops predicting the final output. This helps farmers adapt quickly to changing conditions. This resulted healthier crops, higher yields and enhanced incomes for farmers. e-Choupal ITC’s Agri-Business Division launched”e-Choupal” in June 2000 in which village internet kiosks managed by farmers called sanchalaks-themselves, enable the agricultural community access ready information in their local language on the weather & market prices, disseminate knowledge on scientific farm practices & risk management, facilitate the sale of farm inputs (now with embedded knowledge) and purchase farm produce from the farmers’ doorstep (decision making is now information-based). e-Sagu: an ICT based personalized agro-advisory system is being developed since 2004. The word ‘Sagu’ means ‘cultivation’ in Telugu language. It aims to improve farm productivity by delivering high quality personalized (farm-specific) agro-expert advice in a timely manner to each farm at the farmer’s doorstep without farmer asking a question. The advice is provided on a regular basis (typically once a week) from sowing to harvesting which reduces the cost of cultivation and increases the farm productivity as well as quality of agri-commodities. AKASGANGA: (Meaning “milky way” in Hindi) was established in 1996 under the banner of Shree Kamdhenu Electronics Private Ltd.
E-TECHNOLOGY IN THE AID OF THE FARMERS


Department of Agronomy, Agricultural College, Mahanandi.

Agricultural practices and advancements differ globally since plants have their own differences and the location plays a role on their development as well. But through the exchange of knowledge from different agriculturally involved individuals from all over the world, improvement of techniques can be experienced as well. It has made an impact on how information is shared and being able to use this information for the advancement of the agricultural sector gives a great positive impact that is beneficial for everyone. IT has become a bridge for people from all over the world. e-Agriculture is a new area of knowledge emerging out of convergence of IT and farming techniques. It enhances the agricultural value chain through the application of Internet and related technologies. Basically IT helps farmers to have better access to information which increases the productivity. It also enables him to get better prices through information of change in price in different markets.

In India, there have been several initiatives by State and Central Governments to meet the various challenges facing the agriculture sector in the country. The E-Agriculture is part of Mission Mode Project, which has been included in NeGP (under National E-governance Plan) in an effort to consolidate the various learning’s from the past, integrate all the diverse and disparate efforts currently underway, and upscale them to cover the entire country. Government steps to provide e-aid to farmers are National Telecom policy, National mission on agricultural extension and Technology, Mobile values added services (m-VAS), Kisan SMS Portal, Irrigate via smart phone, GPS mapping. Benefits of e-aid to farmers are improved decision making, better planning, Community involvement, Precision agriculture (PA).

With the new extension of ITC initiatives like Krishivihar, i-Kisan, e-kutir, e-Sagoo, ICT models- AGROWEB, Agropedia, AgriInnovate, etc. Indian agriculture has come to a long way and established several records in terms of production and productivity. IT had the potential to transform agriculture into a better prospect in the wake of climate change and decrease in the cultivable land.

Keywords: E-Agriculture, GPS mapping, AGROWEB and agropedia.
05-04

FARMER PRODUCER ORGANISATIONS – A TOOL FOR THE WELFARE OF FARMERS

Vedasri, R and Uma Devi, K.
Department of Agricultural Economics, Agricultural College, Bapatla.
Corresponding author: ravadavinitha@gmail.com

Small holder agriculture is argued to remain important for economic development and poverty reduction in developing countries, but its development is challenged by the need for institutional innovations to overcome market failures. There is a renewed interest from donors, governments and researchers in cooperative producer organizations as an institutional vehicle to improve small holder agricultural performance, particularly through improved market participation. Small holder producers participation in market-oriented production holds potential for diversifying their incomes and increase agriculture productivity hence promoting food security and poverty eradication. With the numerous farming problems in developing countries, low agricultural productivity has negative effect on the economic welfare of the rural population. Farmers’ organizations have been suggested as a key tool to improve the living conditions of the resource-poor farmers in developing countries. Farmer groups are important institutions for the transformation of smallholder farming, increase productivity and incomes thereby reducing poverty.

Farmers Producer Organizations (FPO) are a legal form of the company and according to 2002 Act passed in parliament, only farmer – producers can become members of FPOs. In the Indian context, the role of farmer organizations is to help smallholder farmers specifically, improve their position in the emerging value chains. FPO helps the farmers in production, harvesting, processing, procurement, grading, pooling, handling, marketing, selling, export of primary produce of the members or import of goods or services for their benefit. FPO renders technical services, consultancy services, training, education, research and development for the promotion of the interests of its members.

Member farmers of FPO can have easy access to market information, credit, machinery and input for their production, processing, and marketing activities. The members of FPO can save their cost in purchasing seeds, fertilizers and Plant Protection Chemicals (PPC) as the producer organizations give subsidies to the member farmers. Members can obtain higher price for the sale of output as producer organizations have higher bargaining ability. This shows that farmer members can increase their income by reducing the costs and by using resources efficiently with the help of training obtained from the FPO. Thus producer organizations are beneficial for the farming community working as a good tool to improve small-scale farmers’ welfare.

Key words: FPO, farmer members, small holder, production, income.

05-05

PERCEPTION ON ONLINE COCOON TRADING SYSTEM AMONG SERICULTURE FARMERS IN KOLAR DISTRICT OF KARNATAKA

Harisha, N and Chinmayi, V.
Dept. of Agril. Extension, Agricultural College, Bapatla.
Corresponding author: harishnmuni@gmail.com

Agricultural marketing scenario in the country and the state has undergone a change since independence, owing to the increase in the quantity and the variety of commodities produced, the marketable surpluses, changing consumption pattern in the society, linkages with the international market, etc. With respect to sericulture, the department of sericulture has established cocoon markets to facilitate both rearers / farmers and
reelers to get competitive and fair price to their cocoons. This type of regulated cocoon marketing system exists only in Karnataka. In these markets, the cocoons brought from the rearers are transacted as separate lots and dealt in open auction mode of cocoons marketing through open bidding; it causes confusion during price determination by the reelers. This system had limitations such as Tray/Jallery problem, Confusion during auctioning, delayed and cut down payments, lack of marketing information etc. To make sericulture as a profitable occupation, government of Karnataka reformed the cocoon market system by introducing online cocoon trading system in the year 2016, to bring the transparency in all cocoon market operations such as price determination, weighing, payments, and container allotment by introducing online trading system from cocoon gate entry to payment to the farmers. Presently online trading system is implemented in govt. cocoon market, Shidlagatta and Ramanagara. Thousands of farmers were registered and cocoon trading under online cocoon trading system. This is an attempt to know perception on online cocoon trading system among sericulture farmers in Kolar district of Karnataka. The present study conducted in Kolar taluk of Kolar district in the year 2017. The three villages such as M. Malandahalli, Iragasandra and Rajakallahalli were selected based on number of farmers involved in sericulture and registered under online cocoon trading system at Govt cocoon market, Shidlagatta. The 10 from each village collectively 30 sericulture farmers were selected for the study. The purposive sampling method was used for selection of respondents. The collected data was tabulated and analyzed by using frequency and percentage. The study revealed that 93.33 per cent of farmers perceived that online trading avoids quarrel among farmers due to e-allotment of jallery/containers and because earlier farmers used to stay one or two days before at cocoon market for jallery reservation and it leads to creates problem of food, accommodation and time waste and online trading system provides a jalleries before 30 minutes of auction for placing of cocoons through e-allotment. Similarly 90.00 per cent of the respondents perceived that online trading helps to scientific price determination by creating competition among reelers through online bidding and because in open auction, prices of cocoon was low, due to lack of transparency and malfunctioning/ pre-fixing between reelers and auctioneers. It is also revealed that 73.33 % of the farmers perceived that online cocoon trading system brings transparency in marketing functions like billing, container allotment and weighment and it avoids distress sales among sericulture farmers and this is due to farmers has right to accept or reject prices determine during auction. It is concluded that though the online cocoon trading system is at an infant stage in the state, however, the results obtained on pilot basis study depicted that online trading process which enhances 11.11 per cent and 11.82 per cent of market price and income of the sericulture farmers, which encouraging and farmers got a remunerative price for their produce. It has built confidence among the sericulture farmers about transparency of online trading and its benefits. By observing the good performance of online trading in Karnataka, the present Union Government has made an attempt to replicate this new intervention as an e-NAM in 13 states of the country. The Karnataka state was given wonderful e-innovation for marketing of agril. commodities especially copra, turmeric and cocoon, which acts as an intervention for doubling the entire farmers income by the end of 2022-23. It provides hopes for sustainable development of farming community of the state and country.

**Key words:** Online cocoon trading system, open auction, e-innovation.
05-06

FARMERS’ PROBLEMS WITH REFERENCE TO FERTILIZERS USE IN CHITTOOR DISTRICT OF ANDHRA PRADESH

Sudheer Varma, A and Sreekanth, M. V.
Institute of Agribusiness Management, Tirupati.
Corresponding author: aketisudheervarma@gmail.com

In Chittoor district 78 per cent of farmers were using black DAP and 2 per cent were using grey, remaining 20 per cent of farmers were using DAP without considering colour as preference. Farmers’ preference for coloured DAP was influenced by quality to the extent of 8 per cent, peer group was 74 per cent and dealers’ advice was 0 per cent and remaining 18 per cent purchased based on their experience. The awareness on use of zincated DAP was only 10 per cent but that too was non adopting category, with remaining 90 per cent of farmers being unaware of Zincated DAP. In villages of Renigunta, Chandragiri, Madanapalli, VKota, Kalikiri mandal farmers were not at all aware of zincated DAP. SSP(G) was preferred by 26 per cent and 24 per cent preferred powder form and the remaining 50 per cent were not giving preference of SSP form while purchasing. The application of fertilizers by farmers was influenced by several factors. Among the factors that influenced fertilizers consumption were self assessment followed by soil testing results followed by dealers advice. Undoubtedly quality followed by price and ease in availability were the major factors in deciding the grade of fertilizers and farmers’ preference towards the particular brand mostly influenced by quality followed by credit, ease in availability and price. In respect of micronutrients usage zinc was used by 52 per cent, Boron 12 per cent and the remaining farmers were not using micronutrients. Only 10 per cent of farmers were using speciality nutrient fertilizers through drip irrigation in Chittoor district. The response of farmers on soil sampling was almost driven by the dissatisfaction of farmers on getting the results but if professional services are made available who can provide the results timely then all the farmers are willing to get soils tested even on payment. The activities that the farmers required on priority were farmer’s meetings followed by field demonstrations, soil testing, field visits, technical literature, toll free telephonic advisory etc. The availability of SMS alerts on crops were not known to most of the farmers. Only 6% of farmers were willing to opt for alternative enterprise for livelihood.

Key Words: Fertilizers, micro nutrients, soil testing, zinc coated DAP.

05-07

STRATEGIES TO ENHANCE MARKETING OF AGRICULTURAL PRODUCE THROUGH ELECTRONIC NATIONAL AGRICULTURE MARKET (E-NAM)

Pruthvi Kumar, K., Rohinda Kumar, M and Rafi, D.
IABM, S.V. Agricultural College, Tirupati.
Corresponding author: pruthvi709@gmail.com

National Agriculture Market (NAM) is a pan-India electronic trading portal which networks the existing APMC mandis to create a unified national market for agricultural commodities. The NAM Portal provides a single window service for all APMC related information and services. This includes commodity arrivals & prices, buy & sell trade offers, provision to respond to trade offers, among other services. While material flow (agriculture produce) continues to happen through mandis, an online market reduces transaction costs and information asymmetry. Agriculture marketing is administered by the States as per their agri-marketing
regulations, under which, the State is divided into several market areas, each of which is administered by a separate Agricultural Produce Marketing Committee (APMC) which imposes its own marketing regulation (including fees). This fragmentation of markets, even within the State, hinders free flow of agri commodities from one market area to another and multiple handling of agri-produce and multiple levels of mandi charges ends up escalating the prices for the consumers without commensurate benefit to the farmer. Strategies to be followed to enhance marketing of produce through e-NAM is wide coverage of APMC as if now government has fixed a target to cover only 585 APMC in next two years, transparency should be followed while procuring produce through e-NAM, afford encouragement for private agencies to register in e-NAM so that the role of middle men can be controlled in procuring produce directly from farmer, integration of Food Corporation of India (FCI) with e-NAM shall benefit farmers in getting assured Minimum support price to them, farmers should be encouraged to register in groups on commodity basis so that they can sell their produce at fixed price to private firms through contract farming approach and finally fruits and vegetables should be included in e-NAM as price fluctuations are more in case of fruits and vegetables, so in order to get assured price to farmers and availability of produce at affordable prices to consumers.

**Key words:** Strategies, e-NAM, transparency, mandis, APMC

05-08

**DIGITAL GREEN –PARTICIPATORY VIDEOS AND MEDIATED INSTRUCTION FOR AGRICULTURAL DEVELOPMENT**

*Kishor Kumar, N., Jaswanth Naik, B and Srinivasrao, M.*
Department of Agricultural Extension, Agricultural College, Bapatla.

India is a largest emerging nation on global today was with huge population of about 120 crores. More than 60% of Indian population are directly and indirectly depending on agriculture sector. It is having rich natural resources and world 7th largest country in terms of area. Agriculture is said to be back bone of Indian economy. It contributes more than 16% of total nations GD and was spending crores of rupees in scientific research for agriculture development. Scientists are contributing their part by inventing new technologies. Even though it was provided with indefinite resources it was lagging behind other small countries in terms of production and productivity. Overall GDP rate has been decreased significantly .The main reason for this is due to less development of agriculture sector which in turn is due to lack of effective extension system. There was a large gap between research results and adoption level of farmers.

Digital Green, a new extension strategy, disseminates targeted agricultural information to small and marginal farmers in India using digital videos. The components of Digital Green are: (1) A participatory content production (2) Generated digital video database (3) A human mediated instruction model for dissemination and training and (4) Regimented sequencing to initiate new communities. Unlike some systems that expect information technology alone to deliver useful knowledge to marginal farmers Digital Green works with existing extension systems and tend to increase effectiveness of the extension systems. As videos are created with the help of local people more trust is created about the particular practice

or technique. People shows interest in participation apart from learning also favours them to appear on televisions and projectors. In a controlled evaluation, on a cost per adoption basis, Digital Green was shown to be at least 10 times more effective, per one rupee spent, than a conventional extension system.
Digital Green is a global development organization that empowers smallholder farmers to lift themselves out of poverty by harnessing the collective power of technology and grassroots-level partnerships. Digital green diffuses innovations and follows Standard extension procedure for information dissemination. It maintains rough “storyboarding” which facilitates repetitive pattern that favours easy learning. It also reduces Overall post-production costs. Local farmers learn on their own fields which reduces perception of “teachers” and unnecessary doubts about particular practice or innovation or technique.

It creates “local stars” thus it brings name and fame to particular participant. People are much fascinated to see themselves on television and other mass media. Learn by seeing and doing is the main principle hidden in the digital green. People participate and learn the particular technology or innovation in effective manner.

**Conclusions**
Digital Green’s approach is primarily a technology-enabled means of behavior change communication, which is cost-effective, scalable, and brings together researchers, development practitioners, and rural communities to produce and share locally relevant information through videos. In a controlled evaluation, on a cost per adoption basis, Digital Green was shown to be at least 10 times more effective, per one rupee spent, than a conventional extension system. In collaboration with existing extension systems it will enhance efficiency of the present extension scenario in the country.

**05-09**

**DIGITAL INNOVATIONS FOR TRANSFER OF TECHNOLOGY AMONG SMALL AND MARGINAL FARMERS – AN EXTENSION PROSPECTIVE**

*Venkata Reddy, I., Gopi Krishna, T., Harisha, N and Archana, K.*
Department of Agricultural Extension, Agricultural College, Bapatla.

Diffusion of reliable agricultural information now a day’s important factor to rural areas. In that context mobile phones are entry into dissemination of agricultural information that day’s entry the mobile phones rapid growth of mobile telephony and the introduction of mobile-enabled information services provide ways to improve information dissemination to the knowledge intensive agriculture sector and also helps to overcome information asymmetry existing among the group of farmers. It also helps, at least partially, to bridge the gap between the availability and delivery of agricultural inputs and agriculture infrastructure. As mobile penetration continues to increase among farming communities and information services and to adapt and proliferate, the scope exists for a much greater rural productivity impact in the future. Leverage of the full potential of information dissemination enabled by mobile telephony along with supporting infrastructure and capacity building amongst farmers it is essential to ensure the quality of information, its timeliness and trust worthiness. Extension services help to disseminate information regarding the technology relevant for their geographical areas and cropping system and generate awareness among farmers by recommending the appropriate quantity and quality of inputs and their timely use. It also educates farmers about good agricultural and crop management practices. But recent stagnation and in some regions total breakdown of extension services has led to large gaps in the farm yield and crop productivity. Insufficient extension services and poor access to information has impeded the transfer of technology at the farm level. Information needs are growing rapidly with the introduction of modern technology, hybrid seeds and changing climatic conditions. Thus, farmers often find that their traditional knowledge, experience and guesswork to make decisions for day-to-day activities are not very effective in changing circumstances. The high cost of delivering information through face-to-face interaction, crumbling extension services and poor market information has paved the way for the use of modern information and communication technology (ICT) like mobile phones in disseminating agricultural information to targeted farmers.

**Key Words:** Diffusion, ICT, Information, Extension services.
Climate change is the long-term pattern of weather in a particular area. It is measured by assessing the patterns of variation in temperature, humidity, pressure, wind, precipitation and other meteorological variables in a given region over long periods of time. Climate is different from weather. Weather only describes the short-term conditions of these variables in a given region. Poor and developing countries are mostly affected by climate change. In developing countries like India, climate change is an additional burden because ecological and socioeconomic systems are already facing pressures from rapid population industrialization and economic development. Greenhouse Gases (GHGs) are gases in the atmosphere that absorb and emit radiation within the thermal infrared range. Greenhouse gas emissions from agriculture have increased by approximately 17 per cent since 1990. CO₂ is the most important anthropogenic GHG as it constitutes about 70 per cent of the total emissions. The per-capita emission of an Indian citizen is 1.2 tonnes of carbon dioxide where as in US with 20.6 tonnes. The green house gases have a drastic effect on temperature, human health, biodiversity loss etc. National Action Plan on Climate Change (NAPCC) estimates that 68% of the forest areas in India are likely to experience shift in forest types by the end of the 21st century, which needs our immediate attention. Rise in temperatures likely to affect crops differently from region to region. India is a predominantly agriculture-oriented economy, as around 50 per cent of the population directly depends on agriculture either as farmers or agricultural laborers. Food production in India is sensitive to climate change like variations in temperature and monsoon. It is predicted that a loss of 10 to 40 per cent in production may occur by 2100 in India due to climate change (NAPCC). The direct physical effects on forests caused by climate change, such as droughts, storms fires and insect infestations, could also hurt the productivity of managed forests. Both the supply of and demand for forests products will be affected by climate change. The distribution and population of many species will change due to the adverse effect of climate change. For example, western Indian coastline, tropical ecosystems and species such as mangroves and coral reefs are threatened by changes in temperature, rising sea levels and increased concentration of CO₂. “In the next 50 years, the central Arctic is going to be warmed by approximately 3-4 degrees C”. At present a whopping 1.1 billion people around the world lack access to water. By 2025, 40 per cent of the world’s population may be living in countries experiencing water stress or chronic water scarcity. India accounts for about 17.5 per cent of the world’s population but has roughly 4 per cent of the total available fresh water resources. Per capita water availability in India in 2001 was 1820 m³/person/year which is projected to go down to 1341 and 1140 m³/person/year by the years 2025 and 2050 respectively. Climate change itself is a global problem requiring a global solution. As agriculture is directly dependent on the climate so as the Agribusiness sector is most sensitive to the climate conditions.

Key words: Climate, meteorological, industrialization, NAPC, biodiversity, agribusiness.
05-11

UTILISATION OF SOCIAL MEDIA BY PROFESSIONAL GRADUATE STUDENTS

Swathi, A.
Dept of Home Science and Extension and Communication Management, College of Home Science, Advanced Post Graduate Center, Lam, Guntur.
Corresponding author: avulaswathi69@gmail.com

Social media has played a pivotal role in knitting the fabric of Indian society. It has transformed the Indian society from a native society to a more mature society and provides a space to acquire knowledge, connect the people and to raise people voice against injustice and inequality. The use of it effect the In order to identify study the media utilization patterns and its impact on professional women graduates, a study was conducted using 30 professional graduates and with regard to number of hours, 63.33% spend to 2 to 5 hours on social media daily followed by 33.33% spend 8 hours.

Forty percent of graduates expressed that recreation and relaxation is the main purpose followed by updating knowledge (36.66%), collaborating with fellow students and study (13.33%) and socialization (10%). The best advantage of using social media is sharing information quickly (60%) followed by learning technology becomes easier (36.7%) while the worst advantage of using social networks are reduced focus on studies and affects the academic performance (40%) followed by lesser physical activity results in health problems (30%), decreases/destroys social skills (23.33).

Most of the students (56.67), disagreed with the concept that friends made through social media are trust worthy. According to students negative impact on their grades and studies issue was found to be the biggest disadvantage of using social media. Fifty percent of the students agree on social media proving to be helpful in their studies by any means. 46.67% of the students strongly agreed. Only 3.3% students disagreed. Hence, it can be concluded that, if appropriately used, the use of social media can prove to be a very useful source of learning, sharing and healthy activities.

05-12

DIGITAL AGRICULTURE: PATHWAY TO PROSPERITY

Saikumar, R., Prasad, P.V.N and Lakshman, K.
Department of Agronomy, Agricultural College, Bapatla.
Corresponding author: rsaikumar1995@gmail.com

Agriculture must become more efficient and sustainable if it is to provide enough food for a growing world population. Given that 68 per cent of India’s population is rural and agriculture is the main source of livelihood for 58 per cent of the population, with advancement in technologies especially in the field of information technology, there is need to consider the role of Digital Agriculture in increasing the productivity by efficient and timely management of inputs. Digital Agriculture refers to use of ICT(Information and communication technology) and data ecosystems to support the development and delivery of timely, targeted (localized) information and services to make farming profitable and sustainable (socially, economically and environmentally) while delivering safe, nutritious and affordable food for all. The key components to support the implementation of Digital Agriculture is Spatial (and Temporal) Data Infrastructure (SDI) and low-cost smart phones and tablets to support the bi-directional flow of data and information to rural consumers.

Digital technology will be key to increasing agriculture productivity by delivering tailored recommendations to farmers based on crop, planting date, variety sown, real time localized observed weather and projected market prices. These recommendations will be based on advanced big data analytics related to
down-scaled daily observed weather conditions that feed into crop growth models to estimate yields, harvest date and potential pest and disease outbreaks to optimize pest control measures. Remote sensing is another big data resource to support the development of derived weather products (radar), improved hydrology and watershed management, soil health, crop coverage and crop health estimates among other application. Agriculture is a data-intense enterprise when one considers soil variability, moisture and nutrient levels, rainfall variability, timing of key operations like planting and harvesting, and market price volatility. Advanced agriculture industries help farmers manage these production and market risks through the application of spatial/temporal data bases that are cloud enabled and integrated through Application Programming Interfaces (APIs). This creates a rich and dynamic data ecosystem that enables advanced analytics to inform farmers of the best economic options to maximize profitability and minimize risk - the two critical variables in farming.

**Key words:** APIs, digital agriculture, ICT, spatial, temporal, remote sensing.

05-13

**INFORMATION AND COMMUNICATION TECHNOLOGY-A BOON FOR FARMERS**

Vysali, K., Ram Babu, P., Mukunda Rao, B and Gopi Krishna, T.
Department of Agricultural Extension, Agricultural College, Bapatla.
Corresponding author: vyshali.kantheti12@gmail.com

It is essential for the farmers to collect important, updated information and proper advice regarding the farming which is retrieved by the extension functionaries from Information and Communication Technology (ICT) based initiatives. Many ICT projects in Indian agriculture have emerged, either substituting or supporting extension services by providing farmers with access to agricultural information. Knowledge gaps contribute to yield gaps. Services and quality inputs are essential productivity-enhancing tools. But, their optimum use requires knowledge. ICTs have the potential to reach many farmers with timely and accessible content. But the content that the ICTs deliver has more relevance if it is localized and context specific, as this improves the value and actionability of the information, which can have important impacts on farm management.

The application of ICT can play an important role in efficient dissemination of information. The information needs of the farmers include package of practices, warning systems on pests and diseases, Input prices, weather forecasting, Subsidies, dairy and animal husbandry related information, Post harvest technology. The ICT can deliver fast, reliable and accurate information in a user-friendly manner for practical utilisation by the end user. Numbers of approaches have been followed by the service providers ranging from text to voice SMS, digital videos, tele-infrastructure, internet, etc. to get the information delivered to the end users effectively. Sanchalak, i.e., the facilitator or the linkage between the user and service provider and also mobile phones acts as a key for effective delivery of the information for some of the initiatives.

The ICT initiatives for agriculture are AGMARKNET (Agricultural Marketing Information System Network), DACNET (Department of Agriculture and Cooperation), ARISNET (Agricultural Research Information System Network), SeedNet (Seed Information Network), COOPNET (Primary Agriculture Cooperative societies and credit societies), HORTNET (Horticulural Informatics Network), FERTNET (Fertilizers Information Network facilitating Integrated Nutrient Management), PPIN (Plant Protection Informatics Network), APHNET (Animal Production and Health Informatics Network), FISHNET (Fisheries Informatics Network), LISNET (Land Information System Network), AFPINET (Agricultural and Processing Industries Informatics Network), ARINET (Agriculture and Rural Industries Information System Network), NDMNET (Natural Disaster Management Knowledge Network), Weather NET (Weather Information). Farming community is facing a multitude of problems in terms of information. So, It will be a better practice to maintain ICT initiatives in region wise manner as it contains local information rather than global one.
EXTENSION STRATEGIES FOR PROMOTION OF MILLETS FOR SUSTAINABLE DEVELOPMENT AND FUTURE FOOD SECURITY IN KARNATAKA

Harisha, N., Chinmayi, V., Venkata Reddy and Archana, K.
Dept. of Agril. Extension, Agricultural College, Bapatla.
Corresponding author: harishnmuni@gmail.com

Before the introduction of modern agricultural practices, millets assumed an important position in traditional agriculture. Millets such as foxtail millet, kodo millet, little millet and brown top millet, etc. are well known for their hardiness. They have the capacity to withstand prolonged drought periods, high temperatures and still produce grains and fodder. Millets are known to grow on low fertile lands with locally available inputs like farmyard manure. They are also resistant to disease and pest attacks. India is the largest producer of millets in the world, and accounts for more than 40 percent of the global consumption. Millet cultivation is the mainstay of rainfed farming which provide livelihood to nearly 50% of the total rural workforce and sustain 60% of cattle population in India. Karnataka is promoting millets as nutri-cereals that are good to eat and grow and kind on the planet. Millet production and promotional programmes are being taken up by the department of Agriculture. The perception of ragi (finger millets) and jowar (sorghum), the principal millets of the state, as food of the poor is changing mainly among those with lifestyle diseases. Karnataka has developed a brand called “Siri” for millets as they are referred as ‘Siridhanya’ or rich grains. Karnataka has started implementing distribution of millets through PDS -where in the grains are sourced and distributed locally. Today, Karnataka is one of the leading producers and consumers of millets in the country. It also stands at the top of the market with a huge demand for millets. The Government of Karnataka is promoting millets to make ‘The Food of the Future’ through various extension strategies such as Siridhanya Melas, Let’s Go Millets Campaigns across the Karnataka and encouraging farmers to grow millets by providing Rs.2500/ha as support price and get their due remuneration. It is procuring ragi & jowar by giving a bonus of 20-25 percent above the MSP from farmers. The Government of Karnataka Organized the Organics and Millets Trade Fair 2018 was host an international conference and trade fair to further the promotion of organic and millet foods. After the success of a series of the National Trade Fair in Bangalore in 2017, and a series of road shows in the major metros of the country, the conference and trade fair will bring together research and industry experts, with retailers, entrepreneurs, policy makers and other stakeholders engaged in the promotion of more sustainable and nutritious foods. In addition to an international conference with leading experts, the fair was combined an exhibition area to show millet processing and products, farmer workshops, facilitate business-to-business and business-to-farmer meetings, host a food court to showcase organic and millet products. The millets got platform for promotion of millets on Social media like face book, twitter, whatsapp, e-portals, YouTube etc. The Hon’ble Ministry of Agriculture, Krishna Byregowda is pioneer of millets revolution in Karnataka and given great appeal for ‘International Year of Millets, 2018’. The Researchers, public policy advocates, government agencies and NGOs along with the millet farmers from across the country through their collective campaign and continuous dialogues with central government made it possible for millets and has given the focus they deserve; the coarse cereals of the dry land population of India to enter Public Distribution System(PDS) through a provision made for them in the Food Security Act, 2013. Several years of efforts made by the millet farmers and their demands to make space for their indigenous crops were thought to be fulfilled when the Act was made three years ago. However the act was unable to provide such status to millets as expected; except in the State of Karnataka. While attention for millets is increasing, it is important to revitalize the nutri-cereals cultivation in the country. Finally concluded that the only way is to have a focused and integrated approach to aim, strategize and implement the programmes/policies to attain the underlying goal of doubling the millets farmers’ income by 2022 as well as to make millets as future nutri-food for future generations.

Key Words: Millets, food security, food for future.
05-15

PERCEPTION OF THE FARMERS ABOUT ECO-FRIENDLY FARMING IN REWA DISTRICT (M.P)

Rakhi Kori
Department of Agriculture Extension Education, College of Agriculture, JNKVV, Jabalpur, Rewa, (M.P.)
Corresponding author: rakhikori91@gmail.com

In India green revolution has witnessed a quantum jump in forming sector with the introduction of high yielding varieties of major crops along with the application of fertilizer, pesticides and other inorganic inputs. The harmful effects appeared in the ecosystem are due to indiscriminate use of chemicals particularly fertilizers and pesticides in order to balance the ecosystem, ecofriendly farming is a sound alternative for raising crops &sustainable agriculture production without affecting the environment adversely. Keeping this in view the present study was carried out in Rewa district of M.P. with a view to assess the perception of farmers about eco-friendly farming. The sample of the study was consisted of 100 farmers from selected blocks of the districts. The data were collected personally with the help of a pretested interview schedule. The study revealed that higher percentage of the respondents (43%) had moderate level of perception regarding eco-friendly farming practices of major crops of the region. It was also observed that majority of the respondent (61%) exhibited low level of utilization regarding eco-friendly farming practices. The major barriers in utilizing eco-friendly farming practices perceived by the farmers were as lack of perfect knowledge, lack of proper linkage with agriculture scientist &extension agencies, more time consuming nature of eco-friendly farming, unavailability of bio agents & organic products and lack of demonstrations, trails and training regarding eco-friendly farming practices.

Key words: Eco-friendly farming, perception, demonstrations.

05-16

EMPOWERMENT OF FARMERS THROUGH THE USE OF ICT

Uday Bhaskar, M., Srinivasa Rao, M and Gopi Krishna, T.
Department of Agricultural Extension, Agricultural College, Bapatla.

The occupational structure of India is dominated by the “agricultural sector” (53%) and next the “manufacturing sector” and the “service sector” which were far lagging behind and we know that major of the farmers in India are of small and marginal farmers (80%). This shows that India is predominantly an agricultural economy and the future of sustainable agriculture growth and food security in India depends on the performance of small and marginal farmers hence it is required for strongest protection and development of “agricultural resources”.

Access to technological information is one of the most important enablers for smallholders to improve productivity sustainably. The cost of cultivation per hectare is high on small and marginal farms than medium and large farms. Innovative mechanisms for technology transfer are required to bring relevant tools, knowledge and knowhow to farmers. Market linkages are common weak points between the smallholders and formal supply chains. Intermediaries are required not only to aggregate production from small-scale growers, but also to provide support and services to ensure the quality and consistency of production.
ICT applications can foster dissemination of information on technology, market demand and price information; weather pest, and risk-management information, best practices to meet quality and certification standards. Some of the well-popularized and widely used ICT applications were m-Kisan SMS Portal, Kisan Call Centres, e-Choupal AGMARKNET, KISSAN, i-Kisan, Agri-watch, Indiaagronet, Agropedia and others manage portals providing good on-line information for various clienteles.

Precision farming, popular in developed countries, extensively uses IT to make direct contribution to agricultural productivity. Consequently other IT technologies like remote sensing, GIS, autonomous farming will be more suitable for farming in India if taken up on corporate lines.

The indirect benefits of IT in empowering Indian farmer are significant and it remains to be exploited. Hence to bridge the information gap between the farmers and to build productive and competitive market, different ICT interventions can be used to support rural and underdeveloped markets to become efficient and productive and also appropriate use of ICTs can facilitate to meet the expectations of Good-Governance in Agriculture by improving transparency and Farmers’ participation in Agricultural Planning, implementation and Monitoring and to reach up to over 90% of Farming community (from current level of below 50%), within next 5 years, with Agricultural Information.

05-17

FARMER PERCEPTION TOWARDS PRADHAN MANTRI FASAL BEEMA YOJANA

Soni Verma
Department of Agricultural Economics, College of Agriculture, JNKVV, Rewa, M.P.

Corresponding author: soniverma076@gamil.com

The Pradhan Mantri Fasal Beema Yojana (Prime minister’s crop insurance scheme) was launched by prime minister of India Narendra Modi on 18 Feb. 2016. To provide insurance coverage and financial support to the farmers, in the event of failure of any of the notified crop due to natural calamities, pests and disease. To stabilise the income of farmers to ensure their continuance in farming. To encourage farmers to adopt innovative and modern agricultural practices. To ensure the flow of credit to agriculture sector. The present study on farmer’s perception towards Pradhan Mantri Fasal Beema Yojana was conducted in the year 2017-18 in Sehore district. For this study 150 respondents were Purposively selected from tehsil of district with the help of multistage sampling method, Frequencies, Mean Standard deviation, Correlation of Co-efficient analysis were found to be employed for interpreting the result. Study revealed that education. Subsidiary Occupation, extension contacts, except caste Social participation, benefits availed, crops Covered in crop insurance were positively and significantly correlated with perception and age annual income, Farming experience, source of information were negatively but significantly correlated with perception except land holding and loan availed from bank which are on significantly related with perception crop diversification, forward marketing, adjustment of investment, timeliness of the field operations were the important risk management strategies adopted by the farmers in view of loss occurred to crop failure.

Key words: Pradhan mantri fasal beema yojana perception, multistage sampling.
05-18

AWARENESS ABOUT KISAN CALL CENTRES AMONG THE FARMING COMMUNITY

Meena, D., Archana, K and Srinivasa Rao, H.
Cost of Cultivation Scheme, RARS, Anakapalle.
Corresponding author: meenadudla@gmail.com

It is difficult for the extension system to reach each and every farmer in the corner through direct contact method. An ICT initiative is to disseminate the right information at the right time to the farming community is provided at free accesses. Queries are provided with the spot solutions by dialling toll free number 1800-180-1551. Kisan Call Centre (KCC) is the product of the Information Communication Technology and Agricultural Technology. The study was conducted in Guntur district with a total of 50 respondents have selected randomly to know the awareness of the farming community about KCC besides their opinion. The results of the study revealed that the farmers had poor awareness on KCC. About 50.80 per cent of the farmers had no knowledge on call centres and their toll free number. On the other hand, 28.33 per cent of the farmers had medium awareness on the concept of KCC. Only 20.87 per cent of the respondents had high awareness. Regarding the opinion of the farmers about KCC, 33.33 per cent of the respondents were highly favourable. Favourable and unfavourable opinion was expressed by 40.00 and 26.67 per cent of the farmers respectively.

Key words: Awareness, Opinion, ICT, KCC.

05-19

A STATISTICAL STUDY ON ARRIVALS AND PRICES OF PADDY IN CHHATTISGARH STATE

Chowa Ram Sahu, G., Mohan Naidu and Lakhera, M.L.
Dept. of Agricultural Statistics & Social Science, College of Agriculture, Raipur.

The research study was conducted in Chhattisgarh State of India to study the market arrivals and prices of paddy. The state was selected purposively, major production and marketing area. The study utilized time series data to compute trend, seasonal, correlation coefficient, ANOVA and forecasting. The secondary data pertaining to monthly arrivals and prices of paddy were collected from Agricultural Market Committee of Chhattisgarh for the period from 2009-10 to 2017-18. The results showed a raising trend in arrivals and prices. The lowest market arrivals were observed during the months of April, October and August whereas maximum arrivals during the months of December and January. Lowest prices were observed during the months of June and July while highest prices during the months of December and January. The market arrivals and prices there was a presence of seasonality within a year and seasonal pattern did not change over the years. A positive relationship was observed between the market arrivals and prices over the year and across months in the market. The SARIMA (1,1,1)(1,1,1)_12 and (2,1,1)(1,1,1)_12 were selected as the most suitable models to forecasts of paddy arrivals as well as prices. With these models there were made forecast for 12 months, which are from January 2018 to December 2018. The best models were chosen based on least Mean Absolute Percentage Error (MAPE) value and highest R^2 value

Key words: Correlation, trend, seasonal indices, ANOVA, SARIMA, R^2 and MAPE
Theme -6

Agri-preneurial Interventions for Food and Nutritional Security
Paradigmatic shift from focus on agricultural growth to rising farmers’ incomes coincided with renewed focus on building value chains with larger role for private enterprise in various segments of value chain (Rao et al., 2017). While this represents a continuation of the government’s thrust on value addition through food processing, it is a break from earlier paradigm in that it puts more emphasis on interactions among different segments as well as strengthened focus on hitherto neglected areas like post-harvest technologies, cold storage and transport infrastructure, disintermediation through shortening chain from producers to consumers, reworking tax structure, apart from creation of common national agricultural market and digitalisation of transactions including eNAM. On the other hand, private initiatives in agriculture have been increasing at accelerated pace due both due to these supply side factors as well as demand side factors like income growth, urbanisation etc.

Dualism and inequality worsen due to relative lack of technological innovations and reduced welfare in the less modernising sector viz., agriculture (Barrett et al., 2010). A modernising value chain, viewed in this theoretical perspective, is one of the development agendas for overall growth of the economy with no sectoral disparities in income. Agri-food transformation has been going on in the world in waves after early nineties, first in Latin America, South East Asia, China and now in India (Minten and Reardon, 2011). India is said to be the last major frontier in this transformation along with China and countries from less developed parts of Africa. While diet diversification and globalisation of diets as a result of higher disposable incomes is at the core of this transformation, changing relative role of players and institutions led to what are called demand driven value chains in the world. Gone are the days when what is produced is automatically consumed. Now, retailers at the end of value chains give signals to producers on what to produce, how to produce and how much to produce. In other words, markets have come to play bigger role in the farm decisions.

Various segments of value chain from consumption to production that includes retailing, wholesaling, logistics, processing and production have been undergoing rapid and unprecedented changes in recent times in the country (Pritchard et al., 2010; Chand, 2012; Singh, 2012; Reardon and Minten, 2011; Vijayashankar and Krishnamurthy, 2012; Narayanan, 2014; Rao et al., 2016). The term ‘value chain’ or value chain approach differs from the earlier approaches in studying different actors in their dynamic interactions and associated effects. One of the earliest definitions states that agribusiness is the ‘sum total of all operations involved in the manufacture and distribution of farm supplies; production operation on the farm; and the storage, processing, and distribution of farm commodities and items made from them’ (Davis and Goldberg, 1957). While this is comprehensive, the term ‘agribusiness’ does not address the net effect of interactions among all these nodes. Value chain approach is superior in so considering these actors in their dynamic settings.

A supply chain or value chain, as defined by Boehlje (1999) is a set of value creating activities in the production-distribution process and the explicit structure of linkages among these activities or processes. Value chain is associated with quality differentiation and value added from the consumer perspective, while supply chain is a supplier perspective with a focus on efficiency and logistics and coordination aspects of moving products from ‘farm to fork’. However, there is a need to integrate both the terms as food systems need to deliver both value and efficiency (Reardon, 2015). On the other hand, food value chains (FVCs) ‘comprise all activities required to bring farm products to consumers, including agricultural production,
processing, storage, marketing, distribution and consumption’. In their influential article in Science, a group of eminent scholars working in this area called for ‘research focus on public policies, private-firm decisions, and food value chain innovations that can improve the functioning of domestic food value chains, not just on export channels’ (Gomez et al., 2011).

The food policy in our country mostly concentrated on increasing food production to the relative exclusion of other segments of value chain. The situation of acute poverty, illiteracy, and lack of physical as well as social infrastructure riddled with endemic food shortages and spiralling prices immediately after Independence justified this approach. However, as the economy and disposable incomes gradually picked after 1980s, the central government started making course correction with a new ministry for food processing and emphasis on value addition. After 1991, the policy framework has been responding pro-actively to the new challenges in food and agriculture by changing policy architecture at both the central and provincial levels. Several policy initiatives for freeing the licensing system, foreign investment etc., are taken during this time for encouraging the sector.

The concept of food parks, agri-export zones, mega food parks, cold chains and human resource development have been initiated besides several incentive schemes during this period. The central government has released a food processing policy in 2001 and again in 2005, while a new policy is being finalised. The new agro-processing industries set up to process, preserve and package fruits and vegetables are allowed under Income Tax Act, a deduction of 100 per cent for five years and 25 per cent of profits for the next five years since 2004-05. However, the role of state is considered to be vital. Hence, the centre has urged the state governments to allow exemption for this sector from sales tax and other local taxes. Several state governments have also announced food processing policies. Most recently, centre has allowed 100 per cent FDI in domestic trading of food products including through e-commerce to boost growth of the sector. As many as 42 food parks were sanctioned with a total government subsidy of 2100 crores. The developers are expected to invest an amount of Rs 4500 crores for infrastructure development which in turn kick-in investments of around the same amount for setting up of processing units.

On the other hand, the growth of exports and inflow of FDI into the sector were impressive.

Foreign direct investment, which was just 11,759 crores or 2.62 billion US dollars from 2005-2011, has accelerated to 5.3 billion from April 2012 to December 2015. In fact, the sector received a total of 4 billion dollars in 2013-14 alone. Exports worth Rs.36,172 for processed foods and Rs.33,442 crores of marine products coming to a total of 69,614 crores out of a total of Rs.1,31,000 crores of agricultural exports constituted 53% of all exports in the latest data available year. Outbound exports of these products as well as inbound foreign direct investment have been rising steeply. Recently Global Food Event in Delhi attracted commitments of 10 billion US Dollars of investment into this sector.

The rise of organised retail (supermarkets) as a result of demand driven value chains changes the entire paradigm of value chain from production to retail with bigger say for the retailers as explained above. The defining feature of these organised retailers are direct procurement from farmers through their own collection centres at supposedly higher prices¹ for better quality fresh products and assured supply leading to disintermediation. A study among farmers supplying vegetables to supermarkets like RelianceFresh in Hyderabad found that a 1% increase in participation in these procurement leads to a 0.38% increase in income and a total increase of 23% (Rao et al., 2017). The situation is now fluid with several new players emerging every day and old players changing course correction. E-commerce has been exploding with large number of purchases of fresh food and grocers through players like big basket, amazon.com and other start-ups like zoomato and so on.

The story of agri-preneurial interventions will not be complete without mention of start-ups in the contemporary landscape of players in food and agricultural sector. They represent another big
stream of investments and enterprise into agriculture. Globalisation, revolution in information and communication technologies, diaspora, and increasing confidence of entrepreneurs have been resulting in a virtual explosion of start-ups in disparate activities of the economy in general and food and agriculture in particular. Though the quantum of investments into this sector on the whole is relatively low, it still has been making disruptive changes in the food value chains and associated activities. The government of India has plans to select few start-ups for addressing the key challenges in agriculture and support them through different stages of funding. This indicates the kind of significance these start-ups have assumed in the policy framework. More than 300 technology business incubators (TBIs) have been started across the states for different activities and some of them have focus on agriculture. ICAR has been managing few of them, most notably in IARI and NAARM, Hyderabad.

Broadly, these start-ups can be shown as rendering either input or output services in marketing and related jobs. BigHaat.com, Flybird, AgroStar, Stellaps, Kedut, EcoZen, MITRA, EM3, Skymet, YCook, IFFCO Kisan, Aarav Unmanned Systems and CropIn are some of the start-ups involved in input services. There are several output services such as Ninjacart, TheAgrihub, SVAgri, Sabziwala, Flipkart and Big Basket. The input-based start-ups disrupt the upstream value chain by connecting farmers directly with input companies for seeds, fertilisers, pesticides and machinery. In contrast, some output-based start-ups connect farmers with the buyer of their produce. In some cases, such as Ninjacart and Big Basket, the produce is brought directly from farmers in collection centres such as supermarkets. Besides these start-ups, online retailing companies like Amazon started buying directly from farmers replicating the Amazon Fresh model for its grocery business that started in 2016 in a tie-up with 12500 kirana stores.

The changing scenario in food value chains and arising innovations with start-ups necessitate changing research priorities with special emphasis on few of the issues below:

Reardon et al (2009) explain this phenomenon in much more detail.

- The nature of innovations arising in product, process, marketing and organisational issues need to be studied and their impact on the value chain functioning as well as their impact on farmers income, and food and nutrition security
- Various start-ups emerging in the sector need to be studied for their emergence, geographical spread, innovations, and their impact on income, employment and investments
- Recent initiatives like electronic national agricultural market (eNAM) might be looked into for their effects on reducing intermediaries and accruing benefits to farmers in terms of income and transaction costs
- Rising organised retail and their procurement methods through collection centres are to be studied for their effects on income, technology, prices and employment, consumption and nutrition
- Gender impacts of these changes in the background of feminisation of agriculture merit detailed studies on their impacts on income and nutrition.
- Growing food processing activities in grain processing, animal processing, oil processing, sugar processing, animal feed making, bakery, nuts, dairy, poultry, fruit and vegetables and their effects vis-à-vis regulatory policies.
- Inadequacy of the current data sets as move along new developments might be studied in the light of newly available data methods.
- Are the regional variations in non-farm activities and incomes go down or exacerbate due to these changes?
References


Davis, J.H. and R.A. Goldberg (1957), A Concept of Agribusiness, Division of Research, Graduate School of Business Administration, Harvard University, Boston.


EFFICIENCY OF NATIONAL AGRICULTURAL INSURANCE SCHEME—A DEA ANALYSIS

Ajith, S., Srinivasa Rao, V., Nafeez Umar, Sk and Krishna, V. V.
Department of Statistics and Computer Applications, Agricultural College, Bapatla.

National Agricultural Insurance scheme (NAIS) aims at tackling the issue of production risk faced by the agricultural sector. The Government of India allocated Rs.1.50 crore for the scheme, which will be utilized as 50 per cent contribution of the State towards the NAIS scheme implemented by the Agricultural Insurance Corporation with crops such as paddy, banana, tapioca, ginger, turmeric and pineapple. It was initiated on 1.4.1999.

Data Envelopment Analysis (DEA) is a non-parametric method in Operation Research and Economics for the estimation of production frontiers. It is useful to empirically measure efficiency of Decision Making Units (DMUs). This paper aims to measure the efficiency of the 28 states of India about the usage of National Agricultural Insurance Scheme. The secondary data were collected from the Agricultural Statistics at a Glance - 2016, from the Ministry of Statistics and Program Implementation about the number of farmers, area insured, some insured, farmers premium, state government premium, Government of India premium, gross premium, claims reported, claims paid and number of farmers benefitted. The State-wise technical efficiency, Allocative Efficiency, Economic efficiency and Scale efficiency were measured.

Key words: Decision making units, efficiency

FORECASTING OF ARRIVALS AND PRICES OF CHICKPEA IN CHHATTISGARH

Department of Agricultural Statistics and Social Science (L.), College of Agriculture, IGKV, Raipur.

Chickpea in one of the most important pulse crop in India and also in Chhattisgarh. Chickpea contributes about 40% of total pulse production of Chhattisgarh. This study was conducted to know the trend of total arrivals and prices of chickpea in all the markets (mandis) of Chhattisgarh. Time series data on monthly arrivals and prices of pulses were collected from the records of the corresponding Agricultural Market Committees and the website of Chhattisgarh State Agricultural Marketing (Mandi) Board, http://cg.nic.in/ agrimandi/ for the study period, i.e. 2009-10 to 2017-18 (9 years). Component analysis was done to figure out the trend of arrivals and prices and it is found that arrivals have increasing trend from April 2009 to December 2014 and then showing decreasing trend from January 2015 to December 2016 but the overall trend during the study period was increasing with the highest arrivals in the month of June 2014. In case of price, it has overall increasing trend with a decreasing trend between January 2013 to December 2014 and the maximum price was recorded in the month of December 2016. For forecasting of arrivals and prices different linear, non-linear and time series models were tried and the best model was identified on the basis of highest R-square, lowest RMSE, MAE, MAPE criteria. For arrivals ARIMA(1,1,2)(1,0,1)[12] was found as best model and arrivals were forecasted for the next 24 months, which revealed that there will be highest arrivals in the month of March 2018 and 2019. For price, ARIMA (0, 1, 0) was found as the best model and price forecasting was done for the next 24 months. It is shown that the price will be almost same for the coming two
years. This study gives an idea of how the arrivals and prices of chickpea have varied over the time and the forecasted arrivals and prices can be beneficial for farmers as well as for policy makers. The analysis was done with ‘R-statistical package’.

**Key words:** Forecasting, trend, arrivals and prices.

**06-03**

**A STUDY OF FORECASTING ONION PRICES IN INDIA**

Venkata Viswa Teja, B., Srinivasa Rao, V., Ramesh, D and Venkata Krishna, V.
Dept. of Statistics and Computer Applications, Agricultural College, Bapatla.

Onion is one of the most important commercial vegetable crops grown in India. Recently the prices of onion are so volatile that at sometimes the production was very high and the prices were very low and on the other side, the production was low and the prices were very high. Hence, to study the pattern of price variations, the study was taken up based on the prices of onion in India obtained from the secondary monthly data for a period of 4 years 7 months i.e., 55 months. Different time series models were fitted to the data and the best model was identified based on the highest $R^2$, lowest Bayesian information criterion (BIC), Root Mean Square Error (RMSE) and Mean Absolute Error (MAE) criteria. SPSS package software was used to analyse the data in this study. It is found that ARIMA (2,1,1) was identified as the best fitted model. The onion prices were forecasted for a period of one year i.e., 12 months and they showed that during the month of May the onion price per quintal was lowest ($1336 \pm 520$) and in the month of September the onion price per quintal was highest ($2802 \pm 520$). Based on this study, the farmers can be benefitted to bring the produce to the market yards in the month of high prices and also the government can make necessary policies to control the variations in onion prices.

**Key words:** Forecasting, ARIMA, BIC, RMSE

**06-04**

**AGRI - ENTREPRENEURSHIP FOR DEVELOPMENT OF SUSTAINABLE AGRICULTURE DEVELOPMENT**

Venkata Reddy, I. Bhavani, G. Archana, Harisha, K and Gopi Krishna, T.
Department of Agricultural Extension, Agricultural College, Bapatla.

Indian economy is basically agrarian economy. Over 85 per cent of the rural population in India is dependent on agriculture for livelihood but the contribution of agriculture in national income has declined to 26 per cent and that of service sector has increased to more than half of the total national income. Uneducated and unskilled mass of India’s population living in rural area is not fitting in to the employment market created by service sector growth. They are therefore depending on agriculture for their livelihood. With employment of more than 50 per cent of labour force, agriculture sector is the major employment provider even today. The seasonal nature of agriculture and lack of irrigation facilities creates problem of seasonal and cyclical unemployment. Large number of persons employed in agriculture leads to disguised nature of unemployment. They seem to be employed but their marginal productivity is zero. Even if some of the farm rural youth shift from primary agriculture production activities to secondary agriculture (processing, value addition) and agri entrepreneurship, the present level of agricultural production may not get affected at all. The agricultural
sector and allied sectors contributed to around 17.32% of the gross domestic product of India. In the absence of local entrepreneurship, the opportunities in agriculture are high risk jacked by outsiders, particularly the urban businessmen and traders, leading to exploitation and deprivation of employment for the farmers.

Entrepreneurship is a purposeful activity of an individual or group or group of individuals, undertaken to initiate, maintain, or to earn profit by production and distribution of economic goods and services.

Enhancing farmers Entrepreneurship

An entrepreneur is someone who builds an enterprise or venture, and who produces for or serves the market. The typical entrepreneur is depicted as a determined and creative leader, constantly looking for opportunities to improve and expand his or her business; somebody who takes more or less calculated risks, and who assumes responsibility for both profits and losses.

Small-scale farming has undergone enormous changes in recent decades. Many of these changes have not just been driven by external factors. They have also been inspired by farmers who continuously look for better ways to organise their farm, new crops and cultivars, better animals, and of alternative ways to develop alternative income earning opportunities. Such income earning opportunities may have some link to agriculture, but are also found outside the direct realm of agriculture.

Creating conditions for growth of entrepreneurs: Markets and uncertainty as shown by the sudden rise of food prices recently, commercialisation and trade taking place within a very uncertain environment, and many factors (such as import regulations, subsidies and trade restrictions) are involved for effecting the growth of entrepreneurs. But increased market participation does offer many opportunities. Farmers may receive extra income through higher volumes of sales, and may, as a consequence, better able to improve and diversify their diets, to invest in education for themselves and their children, and re-invest in their farm and make it a more productive enterprise.

It is important to mention that access to credit remains highly problematic, as financing institutions still find it difficult to serve the agricultural sector. Information provided through extension and support services mainly focuses on technologies, and not on prices, contacts or possibilities. Through market information systems are emerging in many developing countries, many of these systems are difficult to access and do not generate all the relevant information in time, or at affordable cost.

It is quite clear that rural entrepreneurship cannot be developed without significant training. Therefore, an intensive training needs to be provided to the youth in rural India. What’s required is to create a devoted team to take up rural entrepreneurship trainings as per integrated rural development program.

06-05

A STUDY ON MEGA FOOD PARKS IN INDIA

Sushmitha Reddy, Ch., Rupa, K.V.N.S.L and Suneesha, G
Institute of Agri Business Management, S. V. Agricultural College, Tirupati.
Corresponding author: cherddy.sushmitha@gmail.com

Mega food park scheme of the Government was enacted to ensure establishment of world-class infrastructure and common user facilities in the food processing sector. The scheme was rolled out in 2008-09 and at present it is in fourth phase. The objectives included are the comparative analysis of the scheme with similar schemes of the Government, an evaluation of selection criteria and other terms and conditions of the scheme, role of state Government and financial institutions, capacity utilisation and socio-economic impact of the scheme. As per the scheme guidelines the primary objective of mega food park scheme is to provide modern infrastructure facilities for food processing along the value chain from the farm to the market and
expected outcome was increased realisation for farmers, creation of high quality processing infrastructure, reduction in wastage, capacity building of producers and processors and creation of efficient supply chain along with significant direct and indirect employment generation. Farmers were benefitted in various ways with the mega food park. These include increased income and reduced wastages, access to technology, modern methods of production and improved social conditions.

**Keywords:** Capacity building, Employment, Food processing, Mega food parks, Socio-economic impact, Technology.

06-06

**PRICE DISCOVERY IN BASMATI RICE**

*Anil Kumar Reddy, K and Phani Vardhan, J.*

Institute of Agribusiness Management, S.V. Agricultural College, Tirupati.

Corresponding author: anilkumarreddy.katha@gmail.com

India produces about 70 per cent of the total world basmati rice production and the rest is produced by Pakistan. Punjab, Haryana, U.P, Uttarakhand and Jammu and Kashmir are the main basmati growing states in India. The share of Punjab in total Indian basmati production was about 40.03 per cent followed by Haryana with 37.88 per cent and Uttar Pradesh with 19.55 per cent. Basmati rice is a good source of export among the agricultural commodities. Export of basmati rice from India has increased from about 7 lakh tonnes during 2001-03 to about 12 lakh tonnes during 2004-07 and jumped to a range of 20-25 lakh tonnes during 2009-11 and the country earned crucial foreign exchange between Rs 1850 and Rs 12000 crores during the same period. Normally, the average international price during 2001-10 varied between Rs. 2400 to Rs. 2900 per quintal except during 2008 and 2009 when the price suddenly jumped to Rs. 5921 and Rs. 5217 per quintal due to sudden jump in demand particularly from Iran for Pusa 1121 variety of rice which was declared basmati by Government of India in 2008. Major portion of the total Indian basmati production is being exported as 80 per cent Indian population consume non-basmati rice and the prices in the domestic market are more or less determined by the movement of international prices of basmati. The domestic price of basmati rice varied from Rs. 1050 to Rs. 1900 per quintal during 2001-07 which jumped to Rs. 2950 during 2008 and started declining to Rs. 2700 during 2009 and Rs. 2450 in 2010 and Rs. 1600 in 2011 consistent with jump in international prices during the same period.

**Key words:** Basmati rice, exports, production, price discovery.

06-07

**VALUE ADDITION: AN EVER GREEN TECHNOLOGY IN AGRICULTURE FOR PROFIT MAKING**

*Rafi, D., Kandeebun, M and Pruthvi Kumar, K.*

Institute of Agribusiness Management, S.V. Agricultural College, Tirupati.

Corresponding author: rafilucky34@gmail.com

Agriculture forms the backbone of Indian economy and even though there has been large industrialization in the last 60 years, agriculture still occupies a place of importance. Agriculture has abled to provide us more or less food security, but, still failed in providing nutritional security. Value addition is one of the important components of nutritional security. Sometimes surplus production is the cause of lower price of produce in the market. One way to solve the problem is crop diversification which is responsible for a viable market system,
creates opportunity to earn more as well as strong step toward nutritional security. Other step is value addition of agricultural produce. Crop diversification and value-addition are the two important pillars of nutritional security as well as two important techniques of profit maximization. The most important problem facing the country today perhaps is providing remunerative price to the farmers for their produce without incurring additional burden of subsidy through minimum support price or some such measures. This problem could be solved largely in the surplus production of cereals, vegetables, fruits, milk, fish, meat, poultry, etc., which are processed and marketed aggressively both inside and outside the country. Value addition coupled with marketing has thus the potentials of solving the basic problems of agricultural surplus or wastage and providing rural jobs, ensuring better prices to the growers, etc.

In the present agricultural scenario when the globe has become a single market, agriculture has to be competitive. The diversification, quality enhancement and value addition have become key words of success in agricultural trade at international level. If our agriculture has to be competitive, we will have to diversify and the agriculture produce will again have to be subjected to product development and product diversification for harnessing full advantage from present scenario. Besides making agriculture competitive, value addition also helps in avoidance of post harvest losses, industrialization, employment generation, export promotion, extended availability of produce, foreign exchange earnings, product diversification, easy marketing, etc. It is therefore, appropriate time for us to come out of primary processing and bulk exporting of crops and get into newer product development and marketing of ready to consume product through value addition.

Keywords: *Post harvest losses, product diversification, quality enhancement, value addition.*

06-08

**AGRIBUSINESS INCUBATION: AN EFFECTIVE INTERVENTION FOR PROMOTING AGRIPRENEURSHIP AMONG RURAL AREAS IN INDIA**

*Rohindra Kumar, M., Bhavani Devi, I and Chalam, G.V.*
Institute of Agribusiness Management, S.V. Agricultural College, Tirupati.  
Corresponding author: rohindrakumar81@gmail.com

Amid the global challenges today, many developing countries have embarked on a growth strategy focused on agricultural revitalization in order to achieve broad economic and societal transformation. Higher farm incomes raise demand for industrial goods, lower food prices, and curb inflation. They encourage broad entrepreneurial activities, diversification into new products, the growth of rural enterprises, the emergence of agro-processing industries, and expansion into new markets. Modernizing the agro-food system can therefore be a strong engine for direct and indirect growth and poverty reduction. To move toward this path, we must view agriculture and allied sectors as a business endeavor, and veer away from the traditional and subsistence mode of doing things.

Agripreneurship is defined as generally sustainable, community oriented, directly marketed agriculture. It thereby acts as a catalyst for economic growth and national competitiveness. By providing a nurturing ecosystem for the growth of agripreneurship, business incubators are now gaining recognition as a vital link between agriculture and industry by improving economic, social and environmental conditions especially of rural areas. Agri-Business Incubation Program has been an effective intervention for transforming the agri sector through its initiatives and work in agripreneurship and promoting agribusiness ventures that focus on helping farmers, women and rural youth. There are many challenges that these incubators will face in the near
future. We should be ready to address them through innovative public and private sector partnerships and solutions. We must sustain these incubators because they made us challenge ourselves. Most importantly, we must sustain these incubators through effective intervention research results and impact the lives of millions who depend on this sector.

**Key words:** Agribusiness incubation, agripreneurship, sustainable, rural areas

### 06-09

**COMPARATIVE ECONOMICS OF DIRECT SOWN PADDY V/S A VIS A VIS TRANSPLANTED PADDY**

_Archant, K., Saidhar, R and Srinivasa Rao, H._

Cost of Cultivation Scheme, RARS, Anakapalle.

Corresponding author: archanakaviti8@gmail.com

Present study was conducted to examine the profitability of direct sown paddy over transplanted paddy in Srikakulam district of Andhra Pradesh. Due to the acute labour scarcity during the important operations in paddy cultivation, farmers shifted to direct sown paddy over transplanted paddy to avoid nursery management and transplanting operations. To identify profitability of direct sown paddy, partial budgeting technique was employed. Results revealed that reduced costs due to direct sown paddy were around Rs.10893/ha but added costs were Rs.1939/ha as direct sown paddy needs extra care in weeding. Reduced returns from direct sown paddy were Rs.5928/ha against transplanted paddy with yield difference of 3.9 Q/ha. The Benefit Cost Ratio (BCR) in direct sown paddy was 0.98 against 0.90 in transplanted paddy crop.

**Key words:** Direct sown paddy, transplanted paddy, partial budget technique, BCR

### 06-10

**YOUTH AS SOCIAL ENTREPRENEURS IN ACHIEVING FOOD TO NUTRITIONAL SECURITY**

_Uday Bhaskar, M., Srinivasa Rao, M and Gopi Krishna, T._

Department of Agricultural Extension, Agricultural College, Bapatla.

India is the seventh-largest country in the world in terms of land mass and has 17.5% of the world’s population, making it the second most populous country after China. It is also the youngest country in the world in terms of demography with approximately two-thirds of the population aged below 35 and we are adding about 15 million people every year. They all will need food to survive and perform their task. Less food intake will lead to widespread sickness due to malnutrition, stunting and other disorders due to imbalanced diets.

So this challenge of attaining food and nutritional security can also be attained by making youth as social entrepreneurs. Social entrepreneurship is nothing but the recognition of a social problem and the uses of entrepreneurial principles to organize, create and manage a social venture to achieve a desired social change. Considering the facts on ground level, let us be clear that the two most limiting resources for food security will be land and water. There must be national policy to manage both these resources with the help of modern technologies like remote sensing, digital recording of soil health and water table measurement on real time basis, water recycling plants, desalination plants on coastal areas, sewage treatment plants and we also knew that soil organic matter is a key indicator of soil health.
Therefore a necessary investment need to be made and entrepreneurial activity need to be started by the youth to promote generation of organic residues and green biomass in situ and also by setting up those above said modern technologies as enterprises by the youth so that they can be economically benefited and also indirectly help in maintaining food security by conserving those limiting resources and finally reaching both the objectives i.e., social entrepreneurship and attainment of food and nutritional security.

There is no alternative to food security and there is no food security without soil quality and water availability. If these two aspects are not given on priority, this will also lead to social and political unrest in various parts of the country. In the new millennium, India needs youth and especially students for sensible and accountable National Food Security by making them as social entrepreneurs before we think of any other meaningful option. With every passing day, we are losing time and pushing ourselves to a point of no-return. It is high time to think out of box about what is the way forward.

06-11

RESOURCE USE LEVELS OF FARMERS IN WANAPARTHY, GADWAL, MAHBOOBNAGAR DISTRICTS OF TELANGANA

Rafi, D., Pruthvi Kumar, K., Kandeaban, M and Rohendra Kumar, M.
Institute of Agribusiness Management, S.V. Agricultural College, Tirupati.

Subdivision has an impact on the landholding possessed by the sample farmers. But in Wanaparthy and Mahboobnagar, the holding held by sample farmers registered a marginal increase in over the extent of land possessed by preceding generation. Cent per cent of farmers in selected three districts, were found to have assured source of irrigation. All the farmers in Wanaparthy used power drawn machinery for harvesting which was not so in Gadwal and Mahboobnagar. Cent per cent of farmers in selected districts were using Urea and DAP. NPK GRADE was used by 77% of farmers in Wanaparthy, 93% in Gadwal and 20% in Mahboobnagar. The average consumption of fertilizers in Wanaparthy was 320 kg, while 530 kg in Gadwal and 450 kg in Mahboobnagar. On an average of 15 tonnes of organic manure per hectare was used in Wanaparthy, 0.93% in Gadwal and 6.9% in Mahboobnagar. Farmers preference for colour DAP was influenced by quality expectation to the extent of 88% in Wanaparthy and more or less similar trend was found in other two districts. The awareness of ZNDAP was not uniform among selected districts. The farmers of Mahboobnagar were totally ignorant in the use of ZNDAP. The application of fertilizers by the farmers was influenced by their own self assessment followed by dealers’ advice in Wanaparthy, while in Gadwal and Mahboobnagar farmers own experience was most powerful factor. Undoubtedly price and quality were the major factors in deciding the grade of fertilizer in all the districts. In respect to micronutrient usage in the form of zinc was used by 55% in Wanaparthy, 68% in Gadwal, 60% in Mahboobnagar. Given the present scenario in farming 77% in Wanaparthy, 81% in Gadwall and 80% in Mahboobnagar farmers were willing to opt for alternative enterprise for livelihood. The constraints that the farmers encountered in farming were weather / inadequate rains / drought as lamented by all the farmers in three districts. Other constraints were non availability of labour in Wanaparthy and Gadwal and lack of technical support in Mahboobnagar. Yet other constraints were indebtedness, lower returns, non-availability of inputs.

Keywords: Productivity, subdivision, micronutrients, livelihood, indebtedness.
IMPACT OF CLIMATE ON PRODUCTIVITY OF AGRICULTURAL CROPS AND RESOURCE ALLOCATION FOR COST MINIMISATION

Areef, M., Vishnuvardhan, P and Divya, K.
Department of Agricultural Economics, S.V. Agricultural College, Tirupati.
Corresponding author: areefnulla009@gmail.com

Climate and Agriculture are interdependent factors playing a pivotal role in achieving food security not only to mankind but also all other living beings. As change is inevitable, climate change is expected to influence crop and livestock production, hydrologic balances, input supplies and other components of agricultural systems. Climate change may also change the types, frequencies, and intensities of various crop pests, the availability and timing of irrigation water supplies and the severity of soil erosion. Being managed eco-systems, agricultural systems are crucial to understanding and estimating the effects of climate change on production and productivity. These are also dynamic producers and consumers are continuously responding to changes in crop yields, agricultural product prices, input prices, resource availability, and technological change. Accounting for these adaptations and adjustments was difficult but necessary in order to measure accurately climate change impacts.

Present study investigates climate change, combined with an alarming risk of resource scarcity. Climate adaptation of existing production technologies was becoming increasingly important. The cost of climate change can be high if no action is taken. According to The International Food and Policy Research Institute report (2009) food calorie production ability will be lower in the future due to the environment and with higher prices for commodities, the demand will change (Ahammad et al., 2009). Farmers are facing the risks due to climate change and climate variability. A nonlinear model most suitable when working with parameters that include variability. The climate variability increases, the risk increases (Semenov and Porter, 1995). A nonlinear regression analysis was used to explain the relationship between yield and climate effects, a slight increase in temperature will increase yield and benefit production, but if the temperature increases further there will be a steep decrease in yield and the environmental effects will be negative for the agricultural sector (Roberts and Schlenker, 2008).

The shadow prices for irrigation and hectares were analysed because the shadow price represents the marginal value of the input in terms of its contribution to revenue on the farm to its marginal cost. The shadow value was computed by comparative-statics analysis on farm level (Ziolkowska, 2015). Farmers have the possibility to change crop management, which means changing sowing date, cultivar, fertilisation, irrigation and cultivar, in order to optimise their net revenue. The timing, intensity and predictability of future weather are important factors in choosing the optimal cropping management. Adapting to the climate by changing these variables means that net revenue can be maximised (Aboudrare and Debaeke, 2004). Crop output and productivity growth rates in agricultural crops were decelerated in the recent period (From 2010-17) due to two consecutive droughts in 2014-15 and 2015-16. Since growth in productivity was the main driver of agricultural output growth, deceleration in the growth rates of yield should be a matter of great concern for the researchers and policy makers.

Foodgrains production, horticultural crop production and doubling farmer’s incomewere major development challenges. This can be achieved through developing a comprehensive economic and environmental policies and mobilising the resources and increase resource efficient usage capacity at the village level. Give information on the type of soil in each village with recommendations for proper type and dose of nutrients and
it will help to reduce imbalance in usage of fertilizers. At the same time, it will help in maintaining the soil health for sustainable production. Investment in large machinery is not a viable option for marginal and small farmers. Hence, there is a need to promote farm mechanization through Custom Hiring Centres (CHCs) established through Public-Private-Partnership (PPP), private entrepreneurs, co-operative basis and farmer’s organizations. System of preparing of market outlook reports for agricultural crops, which helps in temporal and spatial integration of markets and prices thus strengthening the market intelligence network and reduces the volatility in market prices.

**Key words:** Climate change, nonlinear regression analysis, scarce resource allocation, productivity, foodgrains.

06-13

**DEVELOPMENT OF VALUE-ADDED FRUIT CAKE WITH GERMINATED SORGHUM FLOUR AND WHOLE WHEAT FLOUR**

**Soumya, P., Lakshmi, J and Lakshmi, K.**
Department of Foods and Nutrition, Advanced Post Graduate Centre, Lam, Guntur.
Corresponding author: soumyapathisarveswara@gmail.com

Millets contain macro and micro nutrients in remarkable amount. Millets are recognized as high energy nutritious food which helps in reducing the malnutrition especially children under the age of 5. Millet grains can be source of value-added health products. But, consumption of millets has been decreased day by day due to various dietary adaptations and also the processing that’s been involved in millets. Sorghum is an important staple food in many parts of the world. Sorghum is a good source of micronutrients like vitamins and minerals. It contains good amount of fiber that helps in effective management of constipation, bowel related problems. In view of the nutritional advantages of millets, the present study was carried out to develop value-added fruit cake made using a combination of germinated sorghum flour and whole wheat flour. Different formulations were fabricated by incorporating germinated sorghum flour and whole wheat flour in three different proportions i.e., 25:75; 50:50; 75:25 respectively and presented for sensory evaluation to a panel of 10 trained judges at laboratory level along with control sample. Nine point hedonic scaling was used for sensory evaluation. The developed value-added cakes were also studied for shelf life. The results showed that the cake made using 75 g of germinated sorghum flour and 25 g of whole wheat flour was good with highest mean scores of 8.5, 8.6, 8.0, 7.7 and 8.6 for color, taste, texture, flavour and overall acceptability when compared to the other two proportions of cake and control sample. Overall acceptability was highest for value added cake and least for control sample. The results of shelf life studies showed that there was decrease in the acceptability of the cake after 5 days of storage, indicating that cakes could be consumed up to 4 or 5 days of storage at room temperature in air tight packaging. Mold growth was observed on 7th day of storage. This study was an attempt to increase the utilization of sorghum through various processing aids thereby promoting healthy eating practices in children. Hence, millet grains can play pivotal role in promoting nutritional security.

**Key words:** Sorghum, Germinated Sorghum Flour, Value-added cake.
06-14

DEVELOPMENT OF VALUE ADDED READY-TO-COOK BREAKFAST MILLETS

Anusha, T., Lakshmi, J and Lakshmi, K.
Department of Foods and Nutrition, Advanced Post Graduate Centre, Lam, Guntur.
Corresponding author: anushachinni.944@gmail.com

In Indian agriculture, millets occupy a relatively lower position among the food crops. These are rather important from the stand point of food and nutrition security of the population both at the national, regional and household levels. There is growing demand for ready-to-cook foods, which have been recognized as economical, convenient and healthy. The present study was planned with the objective to develop ready-to-cook breakfast flakes from sorghum and to examine the sensory evaluation of prepared product. Sorghum flakes were developed using flaking machine. Carrot, onions, tomatoes, green peas, corn kernels with 2% salt were blanched at 100°C for 5 minutes and then sun dried for 2 days for removal of moisture. Masala powder was prepared using red chillies, coriander seeds, cumin seeds, dried onion powder and dried garlic powder and was added to sorghum flakes to enhance taste and flavour. The sorghum flakes, dried vegetables and masala powder used in the product were in three different proportions 80:10:10, 70:20:10 and 60:20:20 respectively. The developed sorghum flakes were subjected to sensory evaluation. Sensory evaluation was done for the developed product for colour, appearance, taste, texture, flavour and overall acceptability of the product using ten trained panellists based on 9 point hedonic scale. The mean scores of sensory evaluation developed for ready-to-cook sorghum flakes with 70:20:10 formula were high i.e., 8.1 for colour, 7.4 for taste, 8 for flavour, 8 for texture and 7.25 for overall acceptability. Developed ready-to-cook sorghum flakes were rated high for colour.

Key words: Ready to cook, convenient, blanched, sensory evaluation.

06-15

THOUGHT OF OPEN EQUITABLE GLOBAL FOOD SYSTEM IN AGRIBUSINESS FOR FOOD SECURITY

Bhavani, G.
Department of Agricultural Extension, College of Agriculture, Hyderabad.
Corresponding author: bhavanig0712@gmail.com

World faces multiple and complex challenges in the 21st century. Over the years, the emphasis of policy makers for application of latest technology in agriculture is concentrated. It was mainly to meet the needs of growing population. A focus on investment in agriculture and other allied sectors helps to bring food security in the world. This demands for innovations in the agricultural field to increase the quality food production. Agri-business is one such innovative venture which provide a valuable opportunities and benefits for developing countries, in terms of overall processes of economic development, export performance, food safety and quality. The paper focus on the concept of open equitable global food system in the agribusiness, as the best chance to meet all the food challenges which the country faces. It is unlikely that we can construct an open, equitable global food system through traditional GATT/WTO-style negotiations. That approach is too confrontational and mercantilist to achieve the degree of collaboration or comprehensiveness of ambition needed. Having a vision of providing food security to the country and to the world, there is need to analyze the dysfunctionalities existing in the system and to identify the strategies to overcome the dysfunctionalities. Agri-business encompassing an open, equitable global food system, which requires combination of trade, investment and technology supports to bring food safety and sustainability in the system and in the country.
which helps to address the global food insecurity issues. To conclude, it is high time for agricultural trade policies to focus on the Agripreneurs and support them to get a market for their initiatives.

**Key words:** Open equitable global food system, agriculture, agribusiness, food security and global food system.

06-16

**AGRI-PRENEURIAL INTERVENTIONS FOR FOOD AND NUTRITIONAL SECURITY.**

*Shwetha Soju and Radha, Y.*
Department of Agricultural Economics, Agricultural College, Bapatla.
Corresponding author: shwethasoju2107@mail.com

A systematic review of the impact of potential “win-win agricultural interventions that aim to improve nutritional status by improving the incomes and the diet of the rural poor. The search was broken down by interventions of the following types: biofortification interventions; home gardens; aquaculture and small fisheries; dairy development; and animal source food promotion. Projects promoting the adoption of new technologies for higher incomes and better diets fall in two main categories:

- Production diversification projects: in particular those promoting dairy production, fisheries, vegetable gardens and livestock. Bio-fortification projects: by conventional crop breeding or genetic engineering that increase the content of iron, zinc and vitamins in crops such as rice, wheat and sweet potato. We outlined a programme theory of the interventions and we assessed the efficacy of the interventions on five outcome indicators: programme participation; income; diet composition; micronutrients intake; and nutritional status. It was found that the agricultural interventions considered have a positive impact on the production of agricultural goods promoted by the interventions, but poor evidence of impact on total household income. Only one study that tested for impact on total household income was found. This study found a positive effect of the intervention.

**Key words:** Agricultural intervention, nutritional security, sustainability

06-17

**FOREIGN DIRECT INVESTMENT**

*Sanskala Patel*
Department of Agricultural Economics, College of Agriculture, JNKVV, Rewa, Jabalpur.
Corresponding author: patelsanskala95@gmail.com

Investment, or creation of capital, is a vital determinant of economic growth. In general, the investment may lead to the creation of physical capital goods, finance, and human capital. In grouping with other factors of production and technology, investment determines the levels and growth through changes in production and consumption of goods and services. Investments consist of foreign investment and domestic investment. Foreign investment can decrease the domestic saving gap. Hence, notwithstanding the domestic saving gap, economic growth can be increased in an open economic with inflows of foreign investment. The foreign investment in India would encourage the domestic investment. The foreign investments are approving to economic growth and developing countries like India. The multinational corporation is a suitable device to integrate world economy. The growth of foreign investment directly associated growth of multinational corporations. Foreign direct investment has been associated with economic growth of developing countries; every country is in a race of attracting more and more FDI into the nation. For India FDI plays a very important role. Many countries strive to attract foreign direct investment (FDI) hoping that knowledge brought by multinationals will
spill over to domestic industries and increase their productivity. In contrast with earlier literature that failed to find positive intra industry spill overs from FDI, this study focuses on effects operating across industries. For the first four decades after achieving independence from British colonial rule, the economic policies of the Indian government were characterised by planning, control and regulation. There were periodic attempts at market oriented reform, usually following balance of payments pressures, which induced policy responses that combined exchange rate depreciation and an easing of restrictions on foreign capital inflows. However, the latter were relatively narrow in scope and had little impact on actual inflows, which remained small. It is nowadays accepted that FDI plays a crucial role in industrial development of the developed and developing countries alike and can help in boosting economic growth through, for example, total factor productivity growth. FDI increasing comprises sets of inter-connected operationalized business decisions by multinational enterprises (MNEs) in response to changing global and regional competitive, strategic considerations and factor conditions. As such, FDI Policy Instruments, which have analytical and regulatory dimensions, are required to manage the landscape of MNEs’ FDI operations in order to maximize positive externalities accruing to the host location, as well as optimizing the allocative efficiencies involved in FDI.
NATIONAL CONFERENCE FOR
POST GRADUATE STUDENTS (NCPGS-2018)

TECHNO-STRATEGIC INTERVENTIONS
for
PROFITABLE AGRICULTURE

26-27 MARCH, 2018

ACHARYA  N.G.RANGA AGRICULTURAL UNIVERSITY
Lam, Guntur, Andhra Pradesh