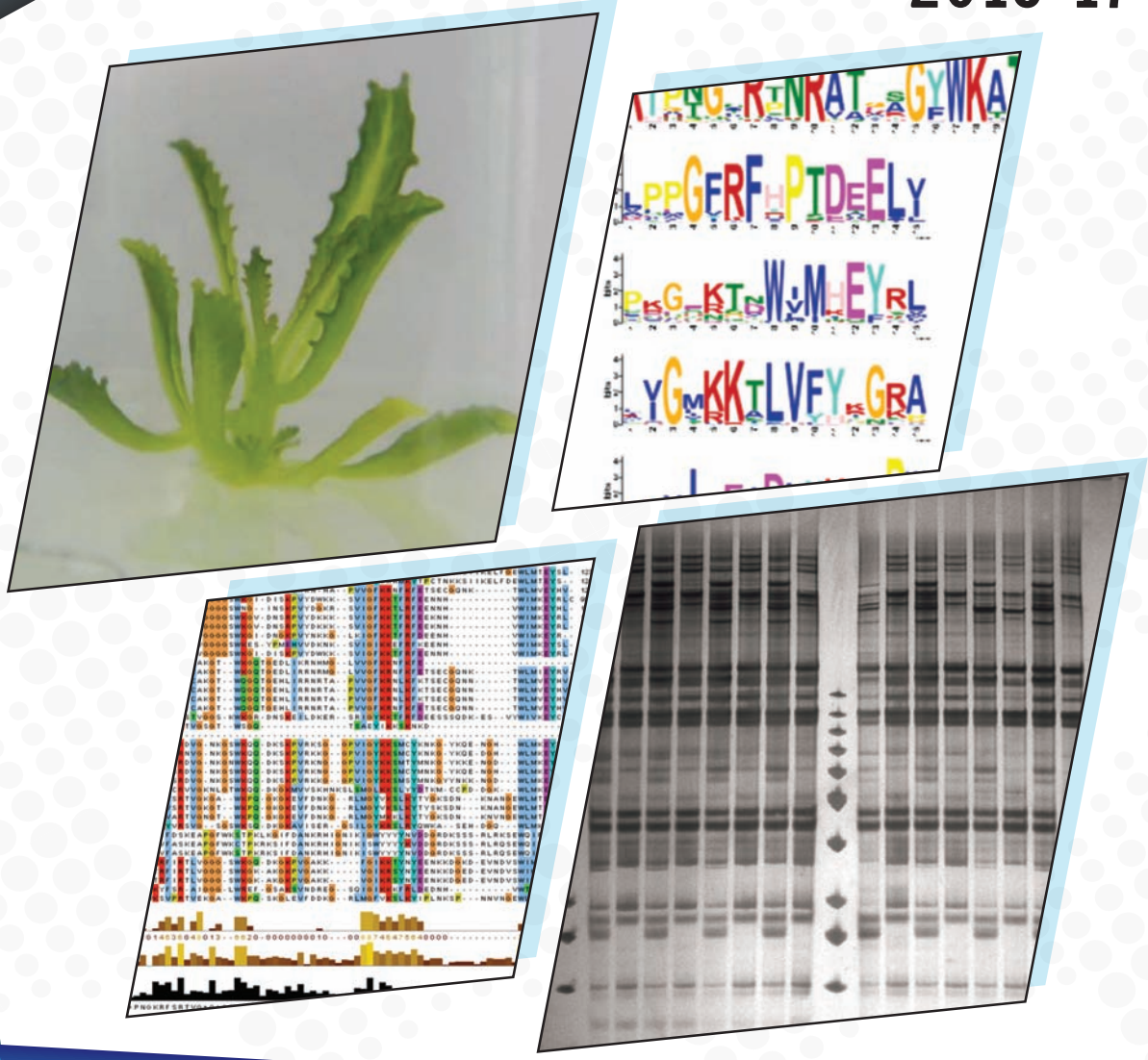
भाकृअनुप
ICAR

ANNUAL REPORT
वार्षिक प्रतिवेदन
2016-17



ICAR-Indian Institute of Agricultural Biotechnology

भाकृअनुप-भारतीय कृषि जैवप्रौद्योगिकी संस्थान

(Deemed to be University)

Garhkhatanga, Ranchi - 834 010 (Jharkhand)

गढ़खटंगा, राँची - 834 010 (झारखण्ड)

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PREFACE

The agriculture with its allied sectors continues to be the backbone of Indian economy. It is the means of livelihood for two-third of our population. The Indian agriculture has witnessed profound changes during the preceding decades, more particularly in the wake of new technologies adopted in the mid-sixties. However, India's agricultural yield still suffers from low productivity and thus calls for a change in agricultural strategy.

Biotechnology can bring major breakthroughs in agriculture. The unprecedented advancements in molecular biology, genomics and bioinformatics may facilitate the researchers to dissect the complex traits and identify the key genomic regions underlying the crucial biological processes relevant to crop improvement. This would facilitate the scientists in breeding crop cultivars with precision. ICAR-Indian Institute of Agricultural Biotechnology (IIAB) established at Ranchi envisages to fulfill the demand of biotechnology product, process, technologies and world class human resources by undertaking research in frontier areas and post graduate teaching in all domains of agricultural biotechnology. At present, the Institute is operating from a camp office established at the Process and Demonstration Unit (PDU) campus of ICAR-IINRG located at Namkum Ranchi with nine scientists of different disciplines. Although, at this stage, developmental activities are being taken up at priority, scientists of the Institute have also initiated research programmes under the major fields of relevance including Genomics and Bioinformatics, Translational Research for Crop Improvement, and Fish Health Management with the modest research facilities available at the Institute. This report describes the activities undertaken during the past financial year and presents major achievements and the annual accounts.

I wish to heartily congratulate all the scientific, administrative and finance staff of ICAR-IIAB and accord my gratefulness to all who contributed to this report. I sincerely express my appreciation to the members of the publication committee for their tireless efforts in preparing and bringing out this report.

I express my profound sense of gratitude and place on record my thankfulness to Dr. T. Mohapatra, Secretary, DARE, Government of India and Director General, ICAR; Dr. J. S. Sandhu, Deputy Director General (Crop Science) and Dr. D. K. Yadav, Assistant Director General (Seeds), ICAR for their diligent supervision and guidance.

Ranchi
August, 2017

K. K. Sharma
Director

CONTENT

Executive SUMMARY

EXECUTIVE SUMMARY

ICAR-Indian Institute of Agricultural Biotechnology (IIAB), established in 2012 with the mandate of basic and strategic research in the frontier areas of Agricultural Biotechnology and development of quality human resources for academic excellence in agricultural biotechnology and policy support is functioning from a camp office at the ICAR-IINRG, Ranchi. With the modest research facilities, the institute has started research with three major projects *viz*., Genomics and Bioinformatics; Translational Research for Crop Improvement and Biotechnological Interventions for Fish Health Management. The progress of work done during the year under report has been summarized in the following paragraphs:

- Transcriptome analysis of *Cicer microphyllum* has been performed under control and drought stress using RNA-Seq approach. The data analysis has been performed using various tools of Bioinformatics. The differential gene expression analysis has identified important drought responsive genes in *C. microphyllum*.
- *Flemingia semialata*, a lac host plant is used for lac cultivation but availability of quality seed is a problem because of poor seed set resulting in low seed yield. For enhancing seed set and seed yield, different plant growth regulators (PGRs) were used as foliar applications during anthesis and flowering stage and it was observed that thiourea @1000 ppm and NAA @30 ppm were found to be effective in enhancing number of raceme/plant, floret number/raceme, seed set %, 1000 seed weight and seed yield.
- Twenty-six genotypes of Lentil (*Lens culinaris* L.) have been collected. Genes encoding heat shock proteins (HSPs) and heat shock factors (HSFs) have been identified in lentil. Expression analysis of these genes under heat stress is in progress in various genotypes.
- Crosses were made with donor rice genotypes for *Pup1* with recipient parents during *Kharif* 2016. The F_1s along with recurrent parents are being raised at ICAR-IIRR, Hyderabad for attempting backcrosses. In addition, crosses were also attempted using varieties of irrigated ecology with a highly drought tolerant plant of *O. rufipogon* collected from Chhattisgarh for developing mapping populations.
- Crossings between contrasting parents in terms of zinc use efficiency and phosphorus uptake and utilization efficiency were made and the resulting F_1 seeds were sown at the off-season nursery at ICAR-IIRR farm located at ICRISAT Campus, Hyderabad for generation advancement.
- The target gene for oral vaccine production has been amplified from Pathogenic strain of *Aeromonas hydrophila* and cloned into pQE60. Preliminary vaccine studies were conducted to evaluate the efficacy of inactivated *A. hydrophila* vaccine along with Lac and aleuritic acid as probable adjuvant.
- The liver-expressed antimicrobial peptide-2 and hepcidin from different tissues of striped catfish, *Pangasianodon hypophthalmus* were PCR amplified and cloned in pTZ57R/T vector. A pathogenic strain of *A. hydrophila* has been procured from ATCC and revived for determination of LD_{50} dose.
- Feeding of dietary microbial levan to fingerlings of *Labeo rohita* conducted for 60 days and post feeding trial challenged with virulent strain of *Aeromonas hydrophila*, led to significant increase in survival

percentage as compared to control in a time dependent manner. Primers for some immuno-responsive genes have been standardized

- Silver nanoparticle (AgNPs) has been syhthesized using guar gum and starch as stabilizer. Silver nanoparticle (AgNPs) was also synthesized using rice leaves which showed antibacterial activity against rice pathogen, *Xanthomonas oryzae*.
- Two WRKY transcription factor genes, StWRKY58 and StWRKY68 have been identified as multiple stress responsive genes in potato. Both the genes have been cloned from potato cDNA and inserted into pCAMBIA1302 vector for plant transformation.

About the INSTITUTE

ABOUT THE INSTITUTE

ICAR-Indian Institute of Agricultural Biotechnology (IIAB) is a premier national level institute set up by the Indian Council of Agricultural Research at Ranchi, Jharkhand to meet the growing demand of agricultural products and processes with faster pace by using cutting edge revolutionary biotechnologies. The institute is entrusted with the mission of developing excellent human resource by undertaking teaching and training programmes at master, doctoral and post-doctoral levels in all the frontier areas of agricultural biotechnology. Flexible, dynamic and modular educational curriculum will be developed by the Institute to ensure demand-driven availability of biotech academia for teaching, research and allied organization/industry. The institute is mandated to address the country's mission for a better and self-reliant future in food and nutrition sector by sensing the need in various aspects of agricultural research. Molecular marker techniques will be used as an integral and supplementary part in all breeding programmes. Trait-based genomic tools and resources will be developed by utilizing native landraces and wild species. Search for new genes, alleles and promoters from the vast biodiversity available in the country will be the focus of the institute. In future, transgenic will take the central stage in solving the food security and other problems related to farmers' distress. The application of gene expression modulators to manipulate biochemical processes/pathways for desired developmental change, enhanced productivity and input use efficiency will be in common place of routine research. Development of designer agricultural crops with added beneficial components of the stakeholder's preference will be in place through biotechnological intervention. Considering the explosion in sequence information of various species, strengthening the big data management and analytical capability of the country with respect to infrastructure as well as human resource would be a prime mandate of the institute. Development of molecular diagnostics for precise identification of major diseases in plants, animals and fisheries and prophylactic measures for their control will help in minimizing the expenditure and damage to the environment. Nanotechnology, being a naive and fast evolving scientific field, will be used for improvement in crop production through ultrasensitive detection system for disease and pest management, nano-delivery of pesticides, vaccines, nutrients/hormones, genes etc.

The institute will serve as a hub for biotech research activities undertaken under NARS by providing technical support and service facility for products, tools, protocols, techniques, database, sequencing, bioinformatics, safety studies and knowledge. The institute has initiated research in the areas of molecular breeding for guided integration of known QTLs for drought tolerance and phosphorus uptake in rice. Efforts for search of novel QTLs/genes and their characterization for phosphorus use efficiency, zinc homeostasis in native germplasm of rice, drought responsive genes from wild chickpea (*Cicer microphyllum*) and heat tolerance in lentil have been initiated under Institute research projects. Similarly, work on bacteriophage for fish disease control, nanoparticle based recombinant protein oral vaccine and characterization of genes responsible for immune response in fish has also been initiated. Research programmes are also being taken up earnestly to assess knowledge and attitude of people towards agricultural biotechnology and create public awareness about biotechnology driven deliverables and their impact and acceptability among the farmers. In addition to these, the Institute is also taking all possible measures to fulfill the aspirations of Government of India to empower the tribal farmers especially women farmers by improving their livelihood through implementation of various outreach programmes like Farmers' FIRST Project, Tribal sub Plan and Front Line Demonstrations of leading crop varieties.

MANDATE

- Basic and strategic research in agricultural biotechnology
- Development of quality human resources for academic excellence in agricultural biotechnology and policy support

STAFF STRENGTH OF THE CENTRE

Staff	Sanctioned	Filled	Vacant
Scientific	38	16	22
Technical	Nil	Nil	Nil
Administrative	02	02	Nil
Skilled Supportive Staff	Nil	Nil	Nil
Total Strength	40	18	22

Research ACCOMPLISHMENTS

INSTITUTIONAL RESEARCH PROJECTS

IIAB-CBB-01: GENOMICS AND BIOINFORMATICS

During last few decades, tremendous progress has been made in sequencing technologies, which has revolutionized biological research. With the advancements of these technologies, it has now become possible to sequence an eukaryotic genome within a very short span of time with very low cost. In order to analyze such gigantic amount of sequencing data, several programmes and softwares have been developed by Bioinformatics scientists, worldwide. As a result, the whole genome sequencing of a large number of organisms has been achieved, including agriculturally important crops, animals, fish and microbes. With the progress in Next Generation Sequencing (NGS) technologies, it is possible to profile the transcriptome of those organisms for which entire genome sequence is not available. This has allowed researchers to identify key genes and other regulatory sequences important for growth and development and response towards various biotic and abiotic stresses. With this in mind and with the availability of trained scientists, a major project entitled Genomics and Bioinformatics is being carried out at ICAR-IIAB, Ranchi with special emphasis on pulse crops.

IXX12585: Identification and characterization of drought-responsive genes in wild chickpea (*Cicer microphyllum*)

Cicer microphyllum (wild relative of cultivated chickpea) is the only species of genus *Cicer*, which is naturally adapted to cold desert areas of trans-Himalayas. It is widely distributed in cold desert areas of Leh and Ladakh (Jammu & Kashmir) and Lahaul and Spiti (Himachal Pradesh). High altitude ecosystems have traditionally been characterized as harsh due to extreme low temperature and dry conditions, thus, only fewer species are able to sustain their growth and development under such environmental extremes, this response is primarily controlled by gene expression. Thus, gene expression analysis provides valuable insights in to the mechanism of adaptation of a species under environmental extremes. The seeds of *C. microphyllum* were initially procured from DRDO-Defence Institute of High Altitude Research (DIHAR). In Sep. 2016, a trip to Leh, Laddakh was made for the survey and collection of seeds of *C. microphyllum* (Fig. 1).

Transcriptome profiling of *C. microphyllum* under control and drought stress was performed to identify drought-responsive genes using RNA-Seq approach. A total of 141 million raw paired-end reads were generated which were subjected to quality filtering, resulting in to 133 million (94.17%) of high quality (HQ) reads. These HQ reads were subjected to *de novo* assembly using CLC genomics workbench resulting into 69,214 contigs with average length of 834 bp and N50 of 1100 bp. A total of 40,877 transcripts were annotated using gene ontology *viz.* GO, EC and KEGG (Fig. 2). Differential expression analysis

Fig 1: Pods and seeds of *C. microphyllum* collected from Leh and nearby areas (Laddakh, J&K)

has identified differentially expressed transcripts in response to drought stress with prevalence of genes associated with response to abiotic stimulus, mRNA modification, response to stress, under biological process, while under molecular function, oxidation-reduction reaction, catalytic activities, protein binding, transferase activities, endonuclease activity were found in majority.

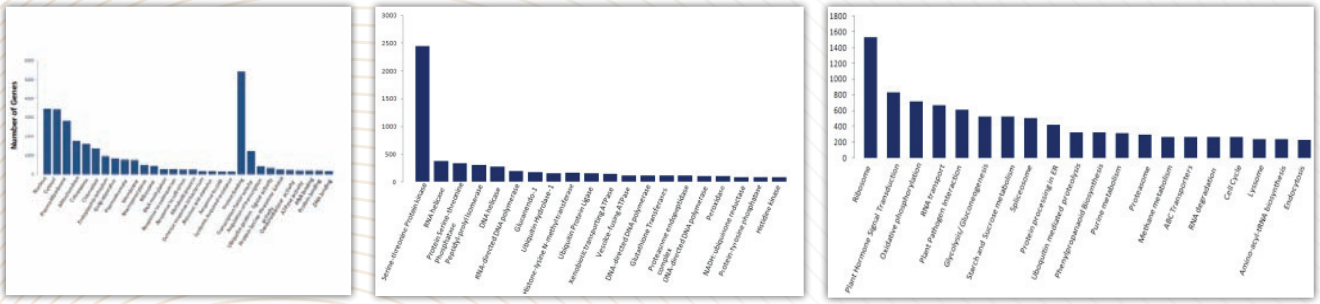

Fig 2: (A) Annotations of genes using GO, (B) Annotations of genes using EC, (C) Annotations of genes using KEGG

Hierarchical cluster analysis of some of the important genes was performed and differentially expressed abiotic/biotic stress related and signalling related genes have been identified (Fig. 3).

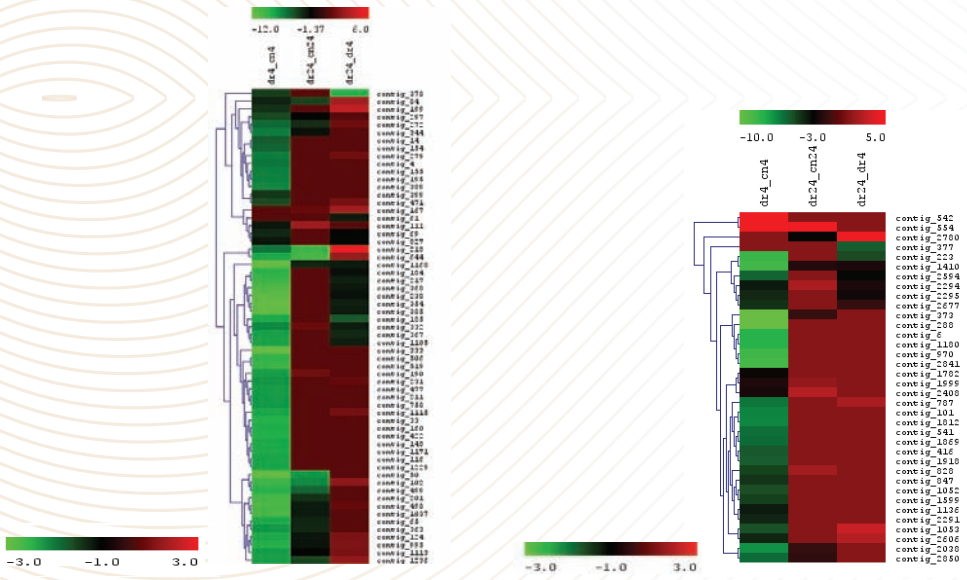

Fig 3: Hierarchical Cluster analysis of Abiotic/Biotic stress related genes.

IXX12644: Identification of genes/QTLs for heat tolerance in lentil

Lentil is an important pulse crop and contributes significantly to food and nutritional security. India is the second largest lentil producing country in the world. However, the productivity of lentil is around 600 kg/ha in comparison to global average of about 1000 kg/ha due to various abiotic stresses, mainly heat and drought. Thus one of the major objectives of lentil breeding strategy is to develop abiotic stress tolerant, high yielding varieties. However, screening of local cultivars of lentil grown in eastern part of India, particularly in Bihar and Jharkhand for identification of heat tolerant genotypes has not been carried out, so far. Therefore, a project was initiated to perform screening of lentil genotypes for heat tolerance and to identify genes and QTLs associated with heat tolerance. Twenty-six genotypes of lentil

having varied characteristics were procured from BAU, Sabour. Genes encoding heat shock proteins (HSPs) and heat shock factors (HSFs) have been identified in lentil. Expression analysis of these genes under heat stress is in progress in various genotypes.

IIAB-TRCI-01: Translational Research for Crop Improvement

There is a pressing need for plant researchers to produce solutions to ensure food security in a sustainable and safe way from less land, less labour, less inputs and water while facing more complex challenges posed by climate change. There is need for developing new types of crop plants that can yield more with less input and are resilient to harsher environment, and are disease and insect smart. Under translational research, three projects are being undertaken for the marker-assisted convergence of known QTLs for drought and phosphorus uptake, and identification of new genes/QTLs for phosphorus use efficiency and zinc homeostasis in rice.

IXX12649: Introgression of genes/QTLs for drought tolerance and efficient phosphorus uptake in rice using MAS

Low nutrient availability in acidic soils coupled with drought in rainfed ecology of Jharkhand is a major bottleneck in realizing higher yield in crops. Moreover, varietal development for such complex situations did not receive adequate attention in the past and therefore the productivity in these areas continued to be low as farmers are still growing local landraces which are low yielder but adapt well to the prevailing conditions. In order to meet and sustain increased food production demand in future, varieties capable of giving reasonably good performance under drought and low nutrient availability need to be developed. Recent developments in the identification of major QTLs/genes for various biotic and abiotic stresses led to development of varieties with improved stress tolerance. Such varieties, once developed will lead to increased rice production in India and help farmers overcome yield losses under the changed climatic conditions. This project aims to introgress *Pup1* a major QTL for P-uptake and combinations of DTYs for the development of drought tolerant and phosphorus use efficient high yielding rice varieties. Donor genotypes for *Pup1* namely, Vandana, Kasalath and Swarna and DTY 2.2 and DTY 4.1 (IR 64 Drt1) were raised and crosses were made with recipient parents during *Kharif* 2016 (Fig. 4). F_1s along with recurrent parents were raised at ICAR-IIRR, Hyderabad for attempting backcrosses during *Rabi* 2017. In addition, crosses were also attempted using varieties of irrigated ecology with a highly drought tolerant plant of O. rufipogon (Fig. 5) collected from Chhattisgarh for developing mapping populations.

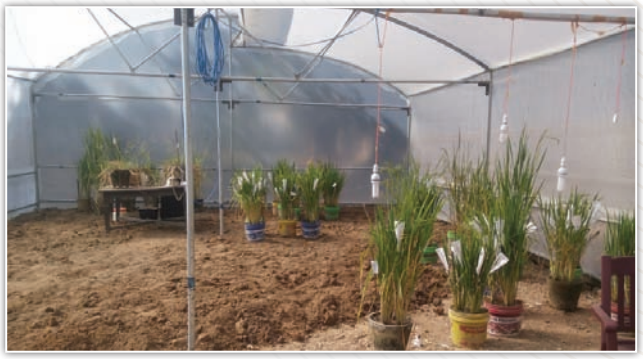

Fig. 4: Plant growing in green house after crossing

Fig. 5: Oryza rufipogon collected from wild habitat

IXX12645: Identification and functional characterization of genes/QTLs responsible for Zinc homeostasis in rice

Zinc deficiency is one of the most common micronutrient deficiencies in rice crop, which adversely affects rice yields (Fig. 6). Seed materials of a total of 467 released varieties/traditional cultivars/landraces/wild species of rice were procured from ICAR-IIRR, Hyderabad, ICAR-CRRI, Cuttack and different AICRP centers of rice and multiplied in the preceding *Kharif* season in pots at ICAR-IIAB, Ranchi and in field at ICAR-NBPGR, Regional Station, Garhkhatanga, Ranchi. Exploration of wild germplasm of rice was carried out in Rohtas, Aurangabad, Kaimur, Bhojpur, Buxar and Patna district of Bihar and Ranchi, Ramgarh and Hazaribagh district of Jharkhand and collected more than 100 traditional cultivars/landraces/wild species of rice.

Crosses between contrasting parents in terms of zinc use efficiency viz. (IR64-Drt1, Anjali and Sahabhagi Dhan having better Zinc use efficiency) and (DRR45 with poor zinc use efficiency) were made and the resulting F_1 seeds were sown at the off-season nursery at ICAR-IIRR farm located at ICRISAT Campus, Hyderabad for generation advancement.

Fig. 6 Zinc deficiency symptoms in rice plants grown at ICAR-IIAB farm

IXX12651: Identification and mapping of novel genes/QTLs for phosphorus uptake and use efficiency in rice

Seed materials of a total of 467 released varieties/traditional cultivars/landraces/wild species were procured from ICAR-IIRR, Hyderabad; ICAR-CRRI, Cuttack, and different AICRP centers of rice. These seed materials were multiplied during the preceding *Kharif* season (Fig. 7). This germplasm was also maintained and evaluated at farm of ICAR-NBPGR Regional Centre, Ranchi. An exploration of rice growing as well as forest areas of Namkum, Itki, Bero, Bharno and Sisai blocks of Ranchi; Raidih, and Navagarh blocks and adjoining areas of Gumla, and some areas of Simdega, Khunti, Ramgarh and Hazaribagh was also conducted during the preceding *Kharif* season and seeds of more than 100 traditional cultivars/landraces/wild species of rice were collected (Fig. 8).

Crosses between contrasting parents in terms of phosphorus uptake and utilization efficiency viz. (Vikash and Rasi; known for better phosphorus utilization) and (RPBIO-226 and IR-64; less efficient in terms of phosphorus utilization) were made and resulting F_1 seeds were sown in the off-season nursery at ICAR-IIRR farm located at ICRISAT Campus, Hyderabad for generation advancement (Fig. 9).

Fig 7: Rice germplasm growing at ICAR-IIAB, Ranchi

Fig 8: Some of the rice germplasm collected from Jharkhand

Fig 9: F_1s of cross between Vikash and RPBIO-226 growing at ICAR-IIRR farm located at ICRISAT Campus, Hyderabad

HAB-FHM-01: Biotechnological Interventions for Fish Health Management

Fishery represents fastest growing animal food producing sector delivering simple digestible protein, healthy lipid and generating employment to millions. It shares 6.5% of all varieties of consumed protein and reached a total harvest of 148 million tons (US $ 217.5 billion) in 2010 (FAO, 2012). But sustainability of this sector is in danger as biotic stresses like diseases prevalence have appeared as a paramount threat and enhanced in the context of global climate change scenario and over-intensification of aquaculture practices. Diseases like fin and gill rot, EUS or red-spot diseases etc. are still prevailing, whereas new pathogenic invasions have crept into the system. Being the fifth major shrimp producing country, loss due to shrimp diseases was marked as 48700 matric ton valued at Rs. 1022 crores and employment of 2.15 million man days in India. The US $15 billion global ornamental fish is faced with antibiotic resistance problem. Conventional drug delivery as well as traditional disease detection methods are still not highly efficient. At this juncture, research projects on fish health management based on prophylactics and therapeutics, designing suitable nutraceutical candidate as feed supplement for boosting immunity, and application of nanoparticles for recovering fish from microbial diseases have been initiated.

IXX12177: Development of nanoparticle based recombinant protein oral vaccine for Indian major carps against *Aeromonas hydrophila*

Pathogenic strain of *Aeromonas hydrophila* was obtained from Department of Fisheries Microbiology, College of Fisheries, Mangalore. Bacterial DNA was isolated according to standard procedures. Specific primers were designed to amplify Surface layer protein gene (the target gene) of *A. hydrophila*. Target gene was amplified and the gene was cloned into pQE60 for further work.

Preliminary vaccine studies were conducted to evaluate the efficacy of inactivated *A. hydrophila* vaccine along with Lac and aleuritic acid as probable adjuvants and the details of experiment are shown in Table 1 & 2:

Table 1: Vaccines and vaccination

Group	Oil	Vaccine dose	Adjuvant dose (mg)	Volume	Period (day)	No. of Fish
Naive	None	None	None	None	21	15
Control	None	PBS	None	200 µl	21	14
IV	Rice bran oil	10^8 cfu/ml	None	200 µl	21	15
IV-LA-10		10^8 cfu/ml	10	200 µl	21	15
IV-LA-20		10^8 cfu/ml	20	200 µl	21	15
IV-ALA-10		10^8 cfu/ml	10	200 µl	21	16
IV-ALA-20		10^8 cfu/ml	20	200 µl	21	16

IV, Inactivated vaccine; IV-LA-10, Inactivated vaccine with 10 mg/dose of Lac (unpurified); IV-LA-20, Inactivated vaccine with 20 mg/dose of Lac (unpurified); IV-ALA-10, Inactivated vaccine with 10 mg/dose of Aleuritic acid (bleached); IV-ALA-20, Inactivated vaccine with 20 mg/dose of Aleuritic acid (bleached).

Table 2 : Overview of the dose of adjuvants (lac and aleuritic acid) injected and mortality recorded due to acute toxicity in *Labeo rohita* weighing 13.1 ± 1.43 g (n=15)

Adjuvant	Dose/fish	Antigen	RBO	Polysorbate-20	D/T	Latency	% mortality
Lac	20 µg fish-1	108 cfu/ml	20%	0.5%	7/15	1-3	46.6
	10 µg fish-1	108 cfu/ml	20%	0.5%	5/15	1	33.3
Aleuritic acid	20 µg fish-1	108 cfu/ml	20%	0.5%	10/16	1-4	80
	10 µg fish-1	108 cfu/ml	20%	0.5%	8/16	1-2	53.3
Inactivated vaccine	-	108 cfu/ml	20%	0.5%	6/15	1-2	40
PBS	-	-	-	-	0/14	-	0
Naïve	-	-	-	-	0/15	-	0

RBO: Rice Bran Oil; D/T: dead/treated fish; Latency: Time to death post-administration of antigen/adjuvants/ Polysorbate-20.

IXX12178: Molecular characterization and functional analysis of antimicrobial peptides in response to pathogenic bacteria in striped catfish, *Pangasianodon hypophthalmus*

Certain groups of antimicrobial peptides (AMPs) with broad spectrum bacteriostatic or bactericidal activity were identified in fishes with reference to the previous reports. The sequences of the concerned AMPs were retrieved from GenBank. The sequences available for a particular AMP reported from different fishes were aligned to find out the conserved domains. The primers targeting different AMPs were designed from the identified conserved sequences. Out of four targeted AMPs, the primary amplification could be obtained for liver-expressed antimicrobial peptide-2 and hepcidin from different tissues of striped catfish, *Pangasianodon hypophthalmus* (Fig. 10). The amplified PCR products were cloned in pTZ57R/T vector and transformed into DH5α strain of *Escherichia coli*. The positive recombinant clones were selected using blue-white selection method in LB-ampicillin agar plate (Fig. 11). The plasmids were isolated from the recombinant clones and sequenced using M13 universal primers in both directions. We have obtained the novel sequence of LEAP-2 gene from striped catfish (Fig. 12). This is first ever antimicrobial peptide cloned from catfishes cultured in Indian subcontinent. From bioinformatics analysis it showed similarity to the LEAP-2 of channel catfish and yellow catfish cultured in European countries. For tissue distribution study of different AMPs in healthy animals, RNA from different tissues were isolated and cDNA were prepared. We have also collected and screened some infected catfish field samples for identifying pathogenic bacteria. Simultaneously, we have also procured different pathogenic strain of *Aeromonas hydrophila* from ATCC and revived for determination of LD_{50} dose (Fig. 13). Following determination of LD_{50}, challenge study will be carried out.

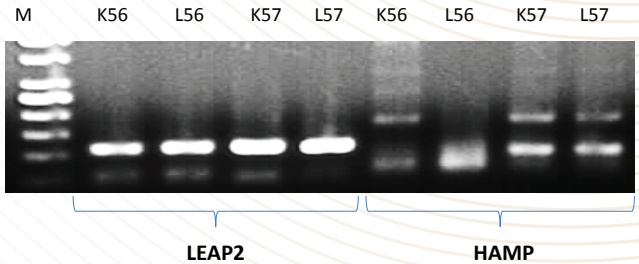

Fig. 10. Partial amplification of selected AMPs. M: 50 bp molecular marker, K: Kidney, L: Liver, 56,57: Annealing temperature.

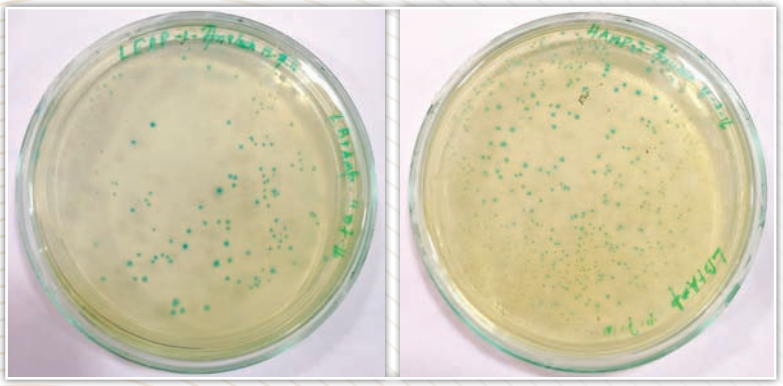

Fig. 11. Blue-white selection for identifying the positive clones of LEAP-2 and Hepcidin/HAMP.

>*P. hypophthalmus* LEAP-2
CCTGCAGATTCCTGTGGAACACTCATAGTTATTCTGGCAGTATGC
CCCATGGGGTTTAGTACCCATGATTCTCCAAAGGGGCGTCATACG
GGCCATTCTTCTAAGTGAC

Fig. 12. *Pangasianodon hypophthalmus* LEAP -2 partial sequence

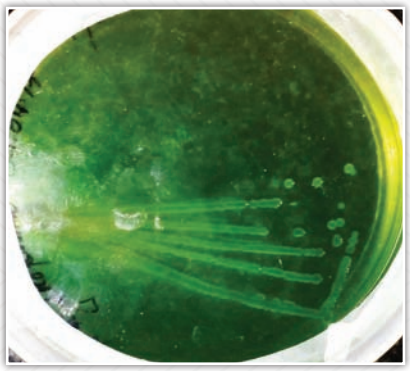

Fig. 13. Pathogenic strain of *Aeromonas hydrophila* grown in Aeromonas isolation medium

IIAB-FHM-01-04: Identification and characterization of genes responsible for immune responses in *Labeo rohita*

Labeo rohita fingerlings were procured locally from State fisheries department, (Doranda, Ranchi, Jharkhand) with an average weight of 3.45 ± 0.48 g. The fish were quarantined with prophylactic dip in salt solution (1 %) for 5 minute and then acclimatized in the fiber reinforced plastic (FRP) tanks (Circular, 1000 L) for a period of 20 days prior to experiment. Aeration was provided throughout the experiment with compressed air pump. The animals were fed with practical diet (30% crude protein) @ of 3 % of their body weight twice daily.

Ninety fingerlings of *L. rohita* were randomly distributed in two treatment groups each with three replicates following a completely randomized design (CRD). The fingerlings were fed to satiation and the feeding trial was conducted for 60 days. The uneaten feed and faecal matters were removed by siphoning out about 50% of the tank water on alternate days with care to avoid stress to the test organisms (Fig. 14). All water quality parameters (dissolved oxygen: 6.18–6.82 mg l^{-1}; pH: 7.26–7.62; temperature: 23.8–26.8°C) were found to be within the normal range for rearing of *L. rohita*.

Fig. 14 Monitoring of the fish health

Fig. 15. Challenge study with *A. hydrophila*

FEED AND FEEDING

Two experimental diets were prepared with microbial levan and without microbial levan (control). Dry ingredients such as soybean meal, fish meal (Protein source) wheat flour, maize flour (carbohydrate source) were weighed and mixed with water to make dough followed by cooking in an autoclave at 15 psi for 20 min. After cooling, vitamins and minerals were added. Required quantities of microbial levan, dissolved in oil (sunflower oil and cod liver oil as lipid sources) were also added. Finally, the dough was pressed through a hand pelletizer to gain uniform size pellets, which were spread over a sheet of paper for sun drying. After drying for 4h, the pellets were kept in a hot air oven overnight for complete drying at 50–60°C (Fig. 16). The pellets were packed in polythene bags and kept at 4°C throughout the experimental period. Feeding of fingerlings was @3.0% of the body weight initially and the feeding rate was adjusted according to the biomass gain over a period of 15 days. The daily ration was divided into two equal parts and was fed to the fish at 10 am and 5.00 pm.

Fig. 16 : Experimental feed prepared for trial

Challenge study with *A. hydrophila*

After 60 days of feeding, 15 fish from each group were challenged with virulent *A. hydrophila* strain (ATCC 7966, Hi-media, Mumbai, India). *A. hydrophila* was grown on nutrient broth for 24 h at 30°C in a BOD incubator and harvested by centrifuging the culture broth at 10,000 rpm for 10 min at 4°C. The cells were then washed three times in sterile PBS (pH 7.4) and the final concentration was maintained at

1.8 X 10^8 CFU ml^{-1} by serial dilution. The fish in each experimental group were intraperitoneal injected with 0.2 ml of bacterial suspension (Fig. 15). Tissues were taken from dead fish for bacteriological culture to confirm *A. hydrophila* as the cause of death after 7 days (Fig. 17).

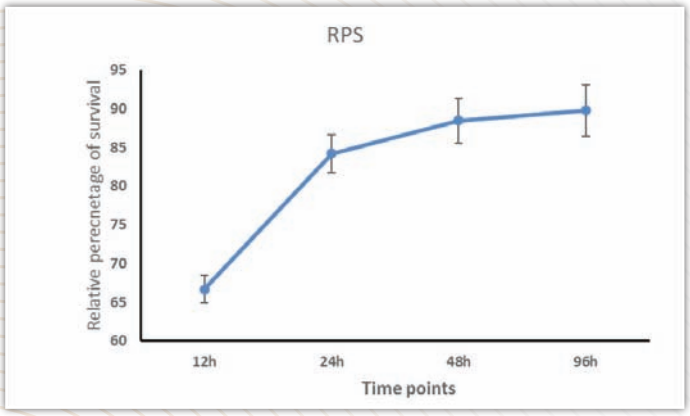

Fig. 17 Relative percentage of survival post feeding trial

SAMPLE COLLECTION FOR GENE EXPRESSION STUDIES

After injecting the fish with virulent *A. hydrophila*, tissue samples were collected at different time points viz., 6h, 12h, 24h, 48h, and 96h. For tissue collection, 3 fish from each replicate were dissected and intestine, liver, gill and kidney tissues were collected in 1.5 ml tube containing trizol reagent (Fig. 18).

Fig. 18 Tissue sample collection from experimental fish

IXX12919: Development and evaluation of the efficacy of novel nanoparticles for enhancing yield in rice and Indian major carp

Synthesis of silver nanoparticle (AgNPs) using guar gum and starch as stabilizer

Silver nitrate ($AgNO_3$) 1mM (25 ml) solution was mixed drop wise with 20ml of 2mM freshly prepared sodium borohydride ($NaBH_4$) under magnetic stirrer at 10°C. The colour of the solution changes gradually from light yellow to dark yellow indicating the formation of silver nanoparticle. After that, 50ml of 1% of starch solution was prepared and added slowly to the reaction mixture (Fig 19a). The resultant solution was stirred for another one hour, kept overnight and washed for further study. In case of Guar gum, 50ml of 0.2% of Guar gum solution

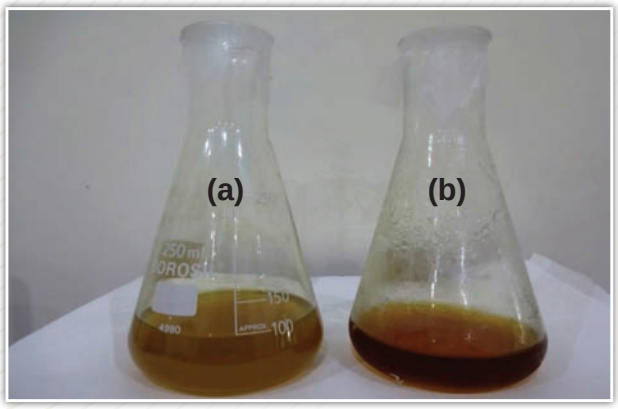

Fig. 19: Colour variation of the synthesized silver nanoparticles using (a) starch and (b) guar gum

was prepared in deionized water and added slowly to the reaction mixture. During addition of the guar gum, the colour of the reaction mixture changed to dark brown (Fig 19b). The resultant solution was stirred for another one hour, kept overnight and washed for further study.

The stability of synthesized silver nanoparticles using guar gum and starch as stabilizer was tested up to forty two days through UV-Visible spectrophotometer and it was found that guar gum elicited higher stability than starch at ambient temperature (Fig. 20). The FT-IR spectra of Guar gum and Ag nano particles (AgNPs) in Guar gum (GG) exhibited characteristics bands at 3426 and 2926 cm^{-1} because of the O–H and C–H stretching vibrations of the polymer associated. Additional characteristics absorption bands of GG appeared at 1418 and 1026 cm^{-1} because of C–H and O–H bending vibrations, respectively. As shown in Figure 21, the band at 3426 cm^{-1} shifted to 3457 cm^{-1} in the presence of Ag and the band was broader in Ag/GG compared to GG. These observations clearly indicate the interaction of Ag with the –OH group of GG. As stability is a major problem in commercial and field based application of silver nanoparticle, guar stabilized silver nanoparticle formulation will be a viable alternative and can be applied in field application.

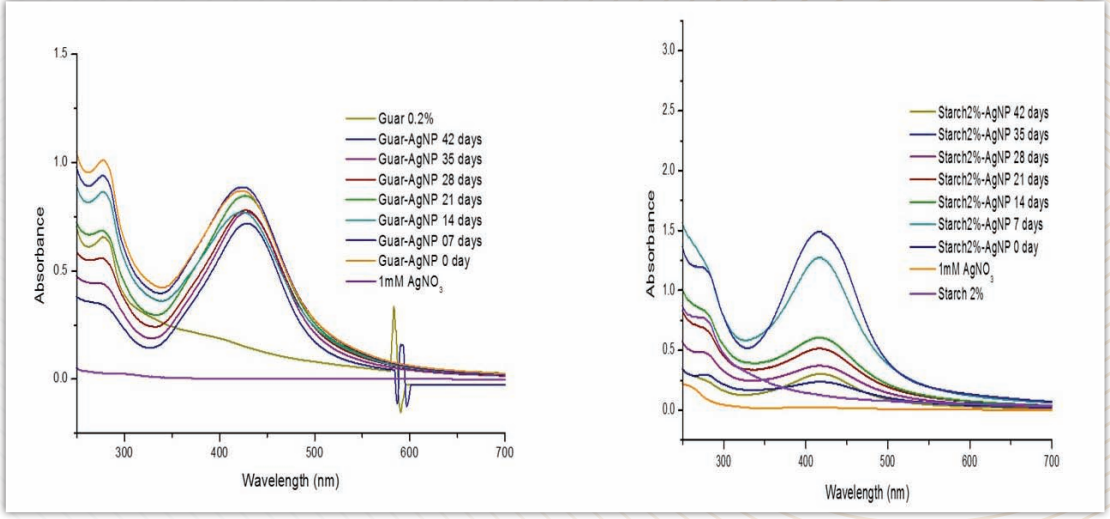

Fig 20. UV-Vis spectroscopy-based evaluation of the variations in stability of silver nanoparticles synthesized using guar gum and starch as stabilizer during a 42 days study period

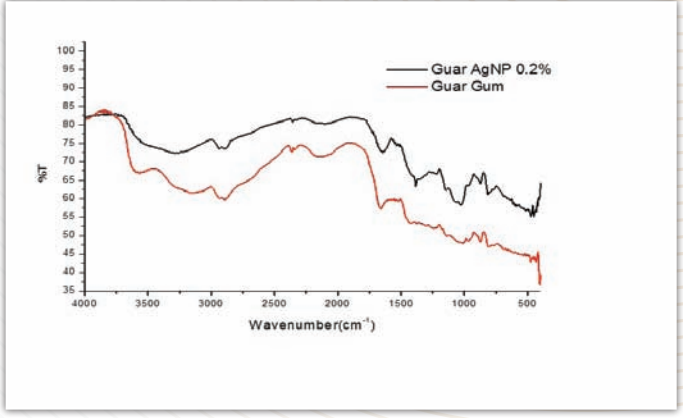

Fig 21. FT-IR spectra of silver nanoparticle synthesized using guar gum

II. Synthesis of silver nanoparticle (AgNPs) using rice leaves and evaluation of its antibacterial activity against rice pathogen, *Xanthomonas oryzae*

Fresh leaves of rice were collected, washed thoroughly before preparing leaf broth by taking 5g of leaf in 50ml of distilled water. Leaf extract was collected by filtration and decantation of the broth. The prepared rice leaf extract was mixed with 1mM silver nitrate ($AgNO_3$) solution in different ratios (0.5%, 1.0%, 2.0% and 5.0%). The mixture was kept at ambient temperature till the colour of the mixture changes to yellow-brown confirming the formation of silver nanoparticle (Fig. 22). The mixture was centrifuged and washed for further characterization.

During characterization, silver nanoparticles showed 128 nm size as analyzed by particle size analyzer and zeta potential as -36.6mV analyzed by zetasizer which confirms stability of the silver nanoparticles. The UV-Visible spectrophotometric analysis showed surface plasmonic resonance (SPR) at the prescribed range of silver nanoparticle (Fig. 23 - 25).

This silver nanoparticle synthesized from rice leaves exhibited anti-bacterial activity (elicited an inhibition zone of 3 cm) when tested against important rice pathogen, Xanthomonas oryzae which was cultured and evaluated through standard microbiological methods. These nanoparticle formulations will be applied in field condition to evaluate its efficacy as viable therapeutic tools against bacterial disease in rice (Fig. 26).

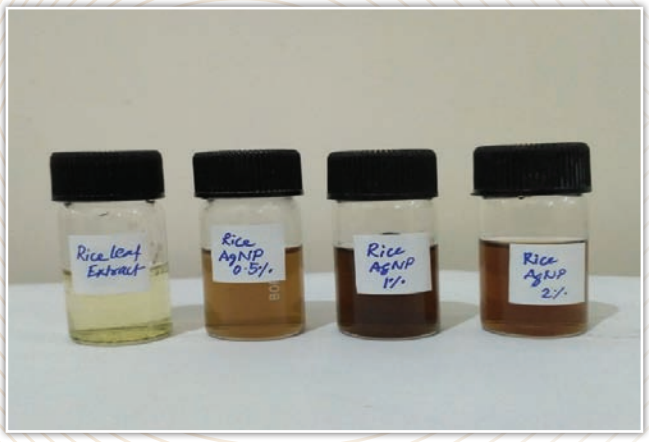

Fig 22. Colour variations during the synthesis of silver nanoparticle using rice leaf extract

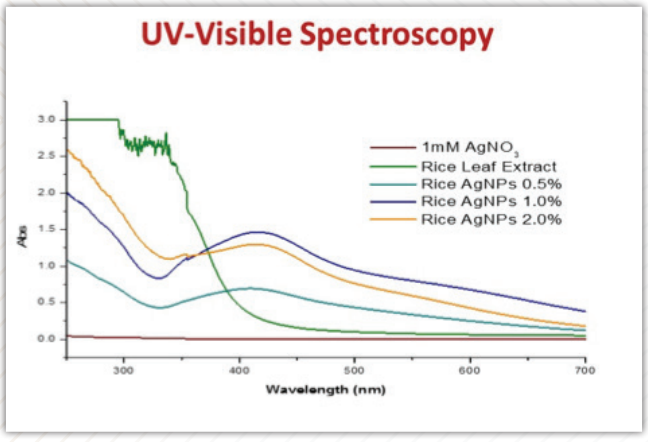

Fig 23. UV-visible spectroscopy-based evaluation of the synthesis of silver nanoparticle using rice leaves extract

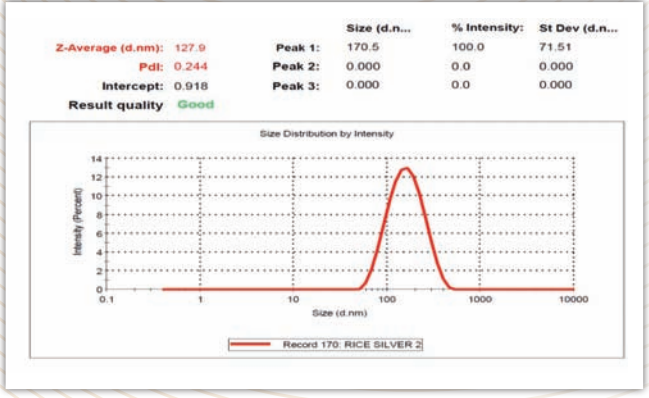

Fig 24. Particle size analyzer based evaluation of the synthesized silver nanoparticle using rice leave extract

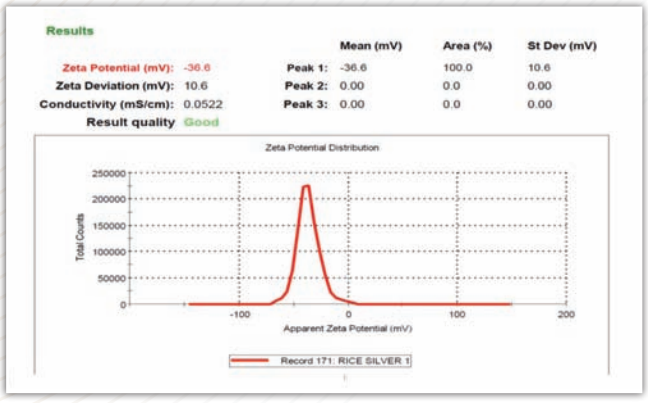

Fig 25. Zeta sizer based profiling of synthesized silver nanoparticle using rice leaf extract

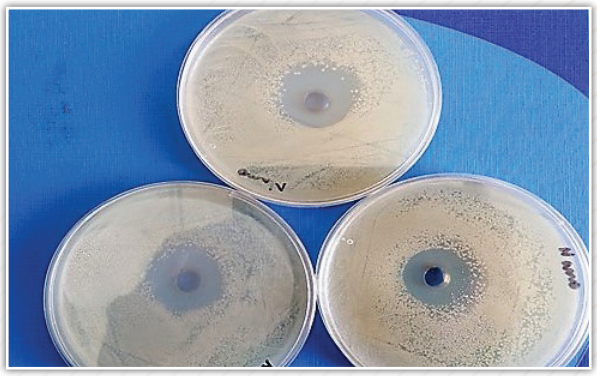

Fig 26. Antimicrobial assay of rice leaf induced silver nanoparticle

III.Synthesis and characterization of Copper (Cu) and Zinc Oxide (ZnO) nanoparticle for biological application

50 ml Copper (II) sulfate pentahydrate (0.1 M) solution was mixed with 120 ml starch solution (1.2%) with vigorous stirring for 30 min. After that, 50ml 0.2M Ascorbic acid solution was added slowly into the reaction mixture under continuous stirring. Subsequently, 30 ml of 1M Sodium hydroxide solution was added dropwise into the mixture and heated at 80°C for 2 h under this stirring condition. The colour of the solution turned yellow to ocher. Reaction mixture was washed and processed for further characterization (Fig. 27).

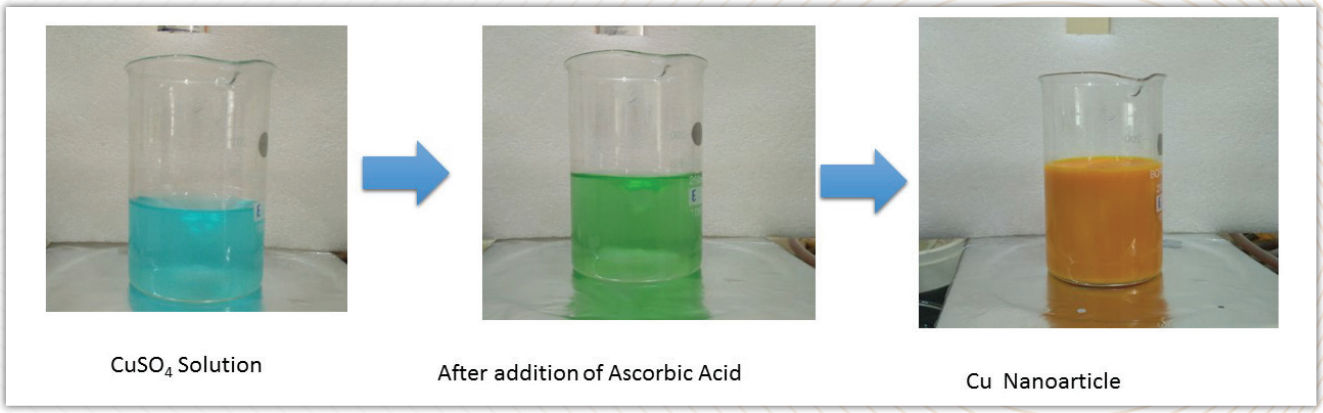

Fig 27. Colour variations during the synthesis of copper nanoparticle

The synthesized Cu nanoparticles were characterized by X-Ray Diffraction (XRD) analysis and FT-IR spectroscopy. The crystal structure and size of the Cu nanoparticles were verified by XRD analysis. Fig 28 exhibits the XRD pattern of the ascorbic acid-synthesized nanoparticles. Peaks observed at 2θ values of 43.39, 50.49 and 74.18 correspond to (111),(200) and (220) planes of metallic Cu. These three peaks were quite consistent with those of the standard JCPDS Card No. 04-0836 for the standard spectrum of the pure fcc (face centered cubic) metallic Cu.

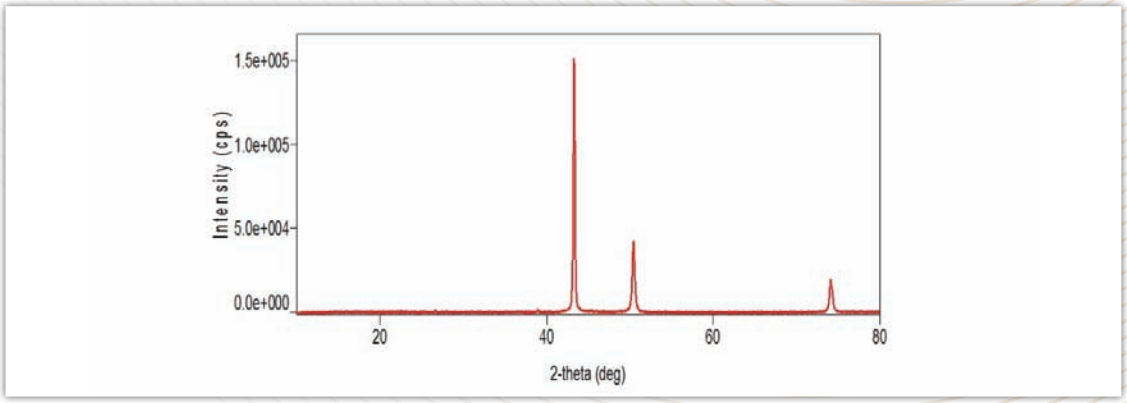

Fig. 28 : X-Ray diffraction (XRD) based profiling of copper nanoparticle synthesized using ascorbic acid

FT-IR spectroscopy was used to investigate the interactions between different species and changes in chemical compositions of the mixtures. The stretching vibration of the carbon-carbon double bond and the peak of enol hydroxyl were observed at 1674 cm^{-1} and 1322 cm^{-1}, respectively. These peaks disappeared after the reaction and new peaks were observed at 1504 cm^{-1}, 1153 cm^{-1}, and 1029 cm^{-1} (Fig. 29). These peaks correspond to the hydroxyl, oxidated ester carbonyl groups, and conjugated carbonyl groups, respectively. These results indicate the presence of the polyhydroxyl structure on the surface of copper nanoparticles. The polyhydroxyl structure has an excellent dispersion effect on copper nanoparticle.

For the synthesis, zinc oxide nanoparticle and zinc acetate dihydrate (20 mM) solution of 50 ml was mixed with magnetic stirrer. Sodium hydroxide (1 M) solution was added drop by drop to zinc acetate solution until pH became 10. Then, solution was stirred at 800-1000 rpm for 2 hours and a white colored precipitate of zinc hydroxide was developed. Synthesized zinc oxide (ZnO) nanoparticle was characterized through UV-Vis and FT-IR spectroscopy. UV-Vis spectroscopy was widely used to characterize the optical properties of nanosized zinc. UV-Vis absorption spectrum of ZnO and its precursor was shown in Fig 30. A strong absorption band was observed at 355 nm which confirms the formation of ZnO nanoparticles.

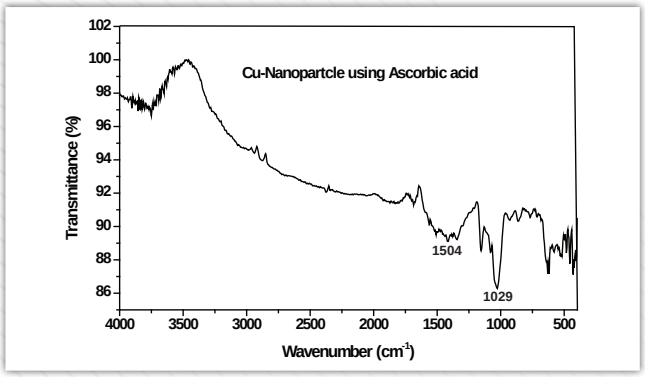

Fig. 29: FT-IR spectra of Copper nanoparticle synthesized using ascorbic acid

FT-IR spectroscopy is performed in order to quickly establish the presence or absence of various vibrational modes present in synthesized particles. The Fig 31 shows the FT-IR spectrum of the ZnO nanoparticles synthesized from Zinc acetate acquired in the range of 400-4000 cm^{-1}. Various modes of vibration are observed at different regions of FT-IR spectrum. The peaks observed in the spectrum indicate the presence of –OH and C=O residues which may be due to precursors used in reaction. The spectrum of interference pattern obtained in FTIR images clearly shows that the characteristic absorption peaks of Zn-O are nearer to 493 cm^{-1} and also authenticates presence of ZnO. The peaks at 1793, 1635 and 1481cm^{-1} diminish gradually for the sample synthesized from Zinc acetate. Synthesized copper and zinc oxide nanoparticles will be tested for evaluating its role as antimicrobial component as well as nutritional supplement in rice and fish.

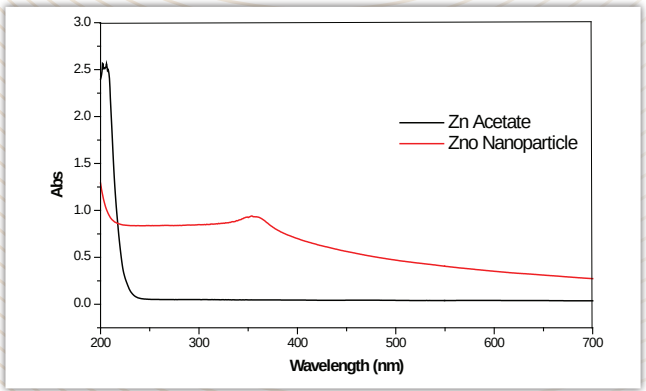

Fig. 30. UV-Vis spectra of synthesized ZnO nanoparticle and its precursor Zn acetate

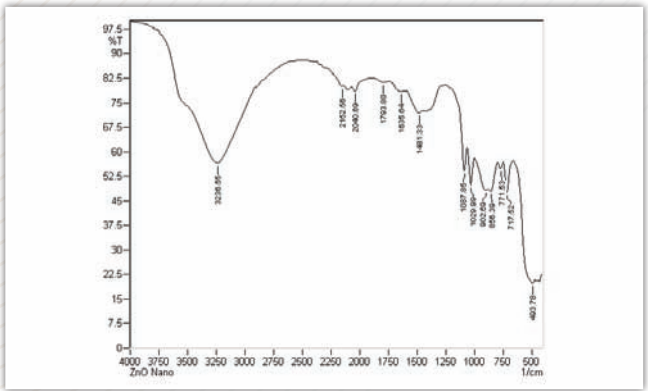

Fig. 31. FT-IR spectra of zinc oxide nanoparticle synthesized in alkaline medium

OTHER PROJECTS

IXX11598: Enhancing pure germinating seed yield of *Flemingia semialata* by physiological approaches

Flemingia semialata is a shrub and very good host plant for lac cultivation, However, it is poor seed setter resulting in poor seed with high seed cost. This project was conceived with major objective of reducing seed cost by increasing yield with application of plant growth regulators (PGRs). Different levels of thiourea, NAA and salicylic acid were sprayed at pre-flowering and anthesis stages of *Flemingia semialata*. The PGRs at different levels (Control (water); Thiourea 500 ppm, Thiourea 1000 ppm, Thiourea 1500 ppm, NAA 15 ppm, NAA 30 ppm, NAA 45 ppm, Salicylic acid 100 ppm, Salicylic acid 200 ppm, Salicylic acid 300 ppm) were sprayed at pre flowering and anthesis stage and their effects were studied on different morpho-physiological, physiological, physiochemical and biochemical characters of *Flemingia semialata*.

Morpho-physiological Study

The different morpho-physiological characters were studied at 15 days' interval. Perusal of Table 4, indicates that thiourea1000 ppm recorded highest plant height (2.41 m), stem diameter (17.46 mm), leaf area (80.50 cm^2), leaf number (19.20), number of raceme/bush (12.0), floret number/raceme (161.60), number of pods/ raceme (129.1), seed set % (65.0), 1000 seed weight (22.10 g) and seed yield (14.67 g/ plant), whereas sturdiness % was recorded highest (0.862) in Thiourea 500 ppm. The per cent seed set and pure seed yield was also improved by the application of different levels of PGRs over control.

Seed set and seed yield

Seed set (%) was recorded highest in the plants treated with Thiourea @ 1000 ppm and NAA @ 30 ppm (65.0 %) followed by NAA @ 45 ppm and salicylic acid @ 200 ppm (64.0 %), in comparison to control (61.2 %). Further, maximum seed yield (15.67 g/plant) was recorded in the plants sprayed with Thiourea @ 1000 ppm followed by NAA @ 30 ppm (12.63 g/plant).

Physiological study

Application of different PGRs maintained higher relative water content (RWC) of leaves (52.51-39.41 %), and lower water saturation deficit (41.16-59.44 %) as compared to control (32.12 and 63.12, respectively; Table 5). Application of thiourea @ 1000 ppm recorded highest RWC (52.51 %) followed by NAA @ 30 ppm (51.44 %) and salicylic acid @ 200 ppm (46.25 %) as compared to control (32.12%). The value of water saturation deficit (WSD) was observed lowest in the Thiourea @ 1000 ppm (41.16) followed by NAA @ 30 ppm (44.22), salicylic acid @ 100 ppm (45.47) with respect to control (63.12). Lowering the WSD and increasing the relative water content due to the application of PGRs resulted in higher seed set (65.0- 62.0 %) than that of control (60.20 %).

The net photosynthesis rate (13.55 µmol CO_2 m^{-2} sec^{-1}) and stomatal conductance (139.65 mmol CO_2 m^{-2} sec^{-1}) were found to be highest after spraying of thiourea @ 1000 ppm as compared to control (Table 5).

Biochemical study

The application of PGRs increased the chlorophyll content and carotenoid (Table 6) and highest values were recorded with Thiourea 1000 ppm (2.91 µg/g fw and 0.46 µg/g fw, respectively) followed by NAA 30 ppm (2.90 µg/g fw and 0.44 µg/g fw, respectively). Foliar spray of thiourea 1000 ppm observed highest content of total sugar (31.0 mg/g fw), protein (83.5 mg/g fw) and free phenol (15.3 mg/g fw).

Thus the present study revealed that the application of PGRs improved the seed set and seed yield which may be because of high relative water content and low water saturation deficit. Among different PGRs and their levels, Thiourea 1000 ppm was found more effective.

Table4: Effect of plant growth regulators on yield and yield attributes in *F. semialata*

Treatment	Plant height (m)	Stem diameter (mm)	Sturdiness % (Stem diameter/ height)	Leaf number /plant	Leaf area (cm2)	No. of raceme / bush	Floret number/ raceme	Raceme length (cm)	Raceme width (mm)	Pod number/ raceme	Seed set (%)	1000 Seed weight (g)	Seed yield (g/plant)
Control	1.84	14.55	0.788	12.40	57.01	8.00	145.80	6.30	3.20	135.80	60.20	20.63	11.40
Thiourea @500ppm	2.05	16.66	0.862	18.80	75.12	11.80	158.00	6.40	4.20	158.00	64.00	21.77	13.00
Thiourea @1000ppm	2.41	17.46	0.824	19.20	80.50	12.00	161.60	6.60	4.00	161.60	65.00	22.10	15.67
Thiourea @1500ppm	2.13	13.11	0.798	13.00	66.61	8.50	98.60	6.60	4.20	114.80	62.00	21.17	8.93
NAA @15ppm	2.11	15.35	0.774	17.20	56.39	9.00	147.00	6.60	4.20	131.00	64.00	20.60	6.70
NAA @30ppm	2.05	15.81	0.704	13.60	62.62	8.20	206.60	6.40	4.20	152.60	65.00	21.33	12.63
NAA @45ppm	2.33	15.36	0.734	15.60	60.80	8.80	192.80	6.80	4.21	140.40	64.00	21.12	11.30
Salicylic acid @100ppm	1.94	17.36	0.796	15.40	69.31	10.40	132.00	5.80	4.20	133.40	62.00	20.60	11.93
Salicylic acid @200ppm	1.98	16.59	0.772	13.00	71.62	9.00	233.40	6.40	4.40	152.20	64.00	21.43	12.20
Salicylic acid @300ppm	2.18	17.18	0.772	14.00	76.30	9.20	177.60	6.78	3.60	157.60	64.00	20.83	11.27
SEm±	0.09	0.79	0.04	1.54	2.42	0.81	12.41	0.08	0.21	7.04	0.16	0.17	0.53
CD (0.05)	0.27	2.29	0.12	4.43	6.67	2.32	35.73	0.23	0.59	20.43	0.47	0.49	1.58

Table 5: Effect of plant growth regulators on physiochemical and physiological attributes of *F. semialata*

Treatment	Net Photosynthesis ($\mu mol/m^2/s$)	Leaf stomatal conductance ($mmol/m^2/s$)	Relative water content (%)	Water saturation deficit (%)
Control	9.77	91.48	32.12	63.12
Thiourea @500ppm	10.95	111.52	39.41	59.44
Thiourea @1000ppm	13.55	139.65	52.51	41.16
Thiourea @1500ppm	10.86	96.26	43.14	48.76
NAA @15ppm	11.05	110.52	44.21	49.88
NAA @30ppm	12.49	136.28	51.44	44.22
NAA @45ppm	12.21	111.41	44.35	50.11
Salicylic acid @100ppm	12.41	127.71	50.25	45.47
Salicylic acid @200ppm	11.36	106.22	46.95	48.82
Salicylic acid @300ppm	10.82	101.14	41.41	50.32
SEm±	0.08	1.75	0.11	2.10
CD (0.05)	0.23	5.17	0.32	6.15

Table 6: Effect of plant growth regulators on biochemical attributes in *F. semialata*

Treatment	Total sugar mg/g fresh weight	Total protein mg/g fresh weight	Free phenol mg/g fresh weight	Chlorophyll a (µg/ml)	Chlorophyll b (µg/ml))	Chlorophyll total (µg/ml)	Caretenoids (µg/ml)
Control	16.9	59.1	13.8	1.75	0.62	2.37	0.40
Thiourea @500ppm	16.8	78.8	13.8	2.17	0.35	2.52	0.48
Thiourea @1000ppm	31.0	83.5	15.3	2.32	0.59	2.91	0.52
Thiourea @1500ppm	25.9	62.7	13.0	2.05	0.51	2.56	0.44
NAA @15ppm	28.4	66.7	14.3	2.04	0.52	2.89	0.46
NAA @30ppm	28.6	72.6	15.5	1.95	0.95	2.56	0.49
NAA @45ppm	14.2	53.5	13.0	1.82	0.36	2.18	0.45
Salicylic acid @100ppm	29.3	68.5	13.1	1.91	0.36	2.27	0.45
Salicylic acid @200ppm	23.4	57.9	13.6	2.08	0.32	2.41	0.48
Salicylic acid @300ppm	22.1	73.9	15.4	2.02	0.56	2.58	0.44
SEm±	2.19	1.78	0.67	0.22	0.58	0.89	0.11
CD (0.05)	6.54	5.32	N/A	0.62	0.19	2.66	0.04

IXX12950: Molecular characterization of Major Histocompatibility Complex (MHC) genes of indigenous pig (*Sus scrofa*)

The project aims to characterize the major constitutively expressed classical MHC genes of indigenous pig (*Sus scrofa*), decipher the allelic architecture of the Swine Leukocyte Antigen (SLA) system, and develop PCR-based assay for following the SLA types.

During the current year, biological samples of Purnia local pigs (Bihar) were collected, and DNA of Doom (Assam), Ghungroo (West Bengal), Mali (Tripura), Niang Megha (Meghalaya) and Tenyi Vo (Nagaland) pigs were collected.

IXX12951: Understanding host-pathogen interactions and identification of novel blast and false smut resistance gene(s) in rice

An exploration of six major rice growing districts of Bihar (Aurangabad, Rohtas, Kaimur, Buxar, Bhojpur and Patna) was conducted during the preceding *Kharif* season. During the study, an epidemic of false smut disease leading to severe loss in yield as well as human and animal health problems was observed (Fig. 32a,b). Interaction meetings with the farmers of these areas were also conducted during the exploration study. In the meetings, it was observed that the incidences of false smut disease have increased during the last 5-6 years. A total of 54 samples of rice panicles heavily infested with false smut along with their GPS location tags were collected during the study (Fig. 32c). These samples were stored in freezer before isolation of the pathogen. For pure culture of the false smut pathogen, yellow coloured smut balls were surface sterilized with 1.0% sodium hypochlorite solution for two minutes, subsequently washed three times with sterile distilled water under aseptic conditions. Spore balls were crushed in 1 ml sterile water and streaked on the Potato Sucrose Agar (PSA) medium (Potato peeled 200 g, Sucrose: 20 g, Agar: 20 g for one-liter media) plates. These plates were kept for incubation at 27±1°C. Small white fungal colonies of false smut appeared after 10 days of incubation which produced yellowish pigmentation at the bottom of the culture plate (Fig. 32d). Fungal colonies were stored in the freezer which will be used for research work.

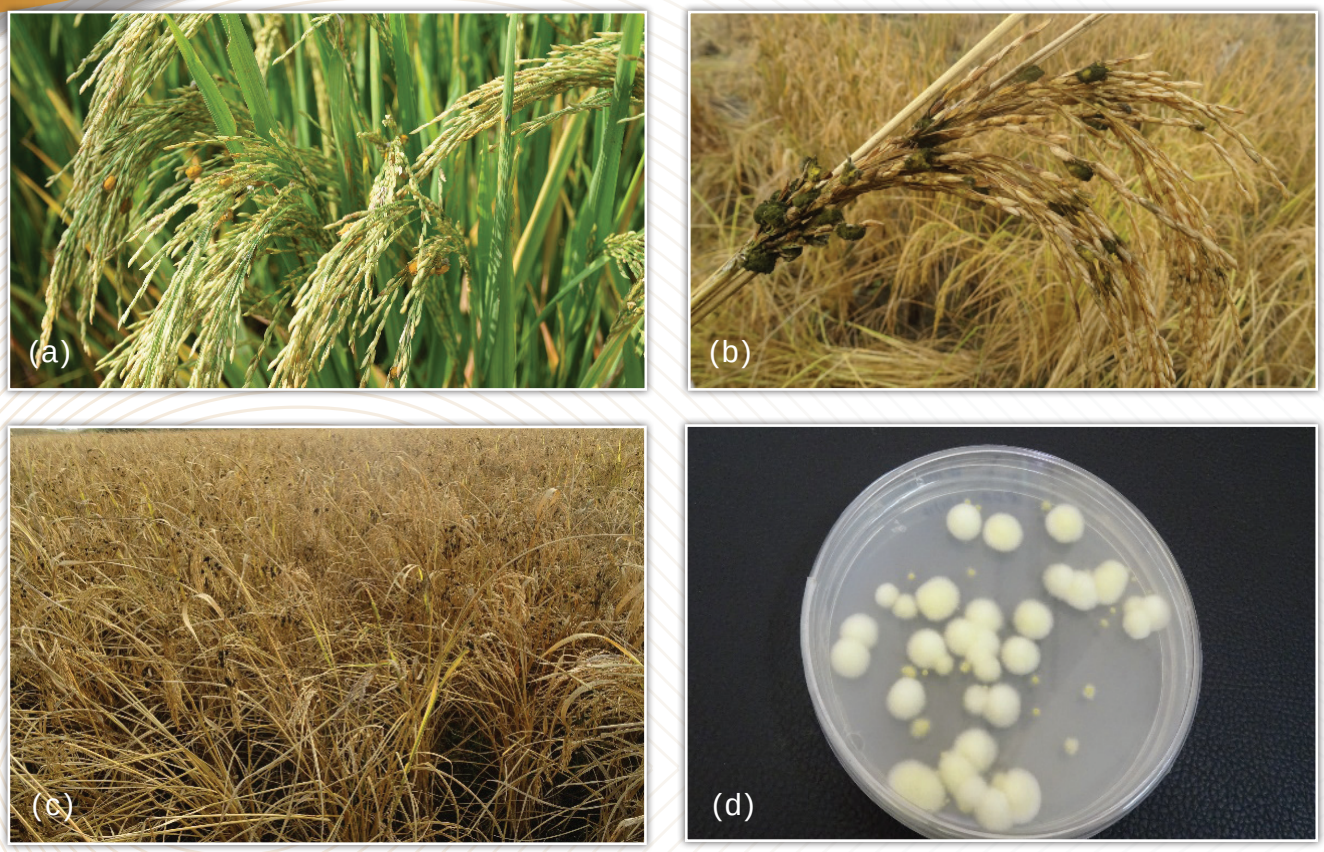

Fig 32 : False smut disease in rice, (a) infestation at early stage of crop, (b) close view of rice panicle heavily infested with false smut at the stage of crop maturity, (c) field view infestation of false smut at the stage of crop maturity, and (d) pure culture of false smut pathogen

INSTITUTIONAL RESEARCH PROJECT ON "PEOPLES' UNDERSTANDING OF AGRICULTURAL BIOTECHNOLOGY IN JHARKHAND"

Objective 1 : To identify agricultural problems of the state which can be solved through agricultural biotechnology intervention

Major agricultural problems of Jharkhand were identified through focussed group discussion organized among farmers and schedules/ questionnaires used among experts. Acidic soil, water scarcity and run off, monocropping, low soil fertility, heavy metal contaminated irrigation water, post harvest losses of crops, pest infestation in crops, drying of fish pond in summer season, non-availability of improved seed, quality fertilizer, quality animal breeds, green fodder, etc are the major agricultural problems of Jharkhand which require attention. Some of these problems could be tackled with biotechnological intervention.

Objective 2: To study the level of knowledge of respondents about agricultural biotechnology

A. Development of Knowledge Test : Major steps followed were as follows:

i. Collection of items (statements): 45 statements about Agricultural Biotechnology were collected.

ii. Jury Opinion: Based on opinion of judges, 34 statements were selected for item analysis

iii. Item analysis: The statements with Item

Difficulty Index (P) values ranging from 30.00 to 83.33 and Discrimination Index (E 1/3) values ranging from 0.40 to 0.80 were considered for final selection in knowledge test. Thus, 20 statements were finally selected for knowledge test.

B. Reliability : All the 20 selected statements were randomly arranged and then divided into two equal halves, one containing the odd items and the other one containing the even items. Then, coefficient of correlation between two sets of scores was computed using the " r " value of 0.870, which indicated that the knowledge test is highly reliable. Spearman Brown Prophecy formula was used for assessing reliability coefficient.

C. Validity : Content validity of the test was ensured initially by administering every item to different experts for evaluating the representation of universe by the test, its relevance and appropriateness.

D. Knowledge Test : The final Knowledge Test had 20 statements related to agricultural biotechnology. The respondents put √ mark in Correct/ wrong/ Not Known responses against each statement. This test may be used for assessing knowledge level of respondents about agricultural biotechnology/ GM crops.

E. Measurement of level of knowledge : For correct answer 1 score and for wrong answer 0 score were awarded. Scoring was reversed in case of negative statements.

Knowledge Index = $(X_1 + X_2 + \text{--------} + Xn)\ 100/n$

Where, X_1, X_2------, Xn are score of statements and n is number of statements.

The levels of knowledge of farmers and scientists about agricultural biotechnology in Jharkhand are mentioned below:

Table. 7 Knowledge level of farmers and scientists about agricultural biotechnology in Jharkhand.

Farmers (N=50)			Scientists (N=50)		
Mean Score	**Category**	**Frequency (%)**	**Mean Score**	**Category**	**Frequency (%)**
5.00	Low (<1.16)	11 (22.00)	9.05	Low (<9.05)	06 (12.00)
	Medium (1.16-8.84)	29 (58.00)		Medium (9.05-17.83)	33 (66.00)
	High (>8.84)	10 (20.00)		High (>17.83)	11 (22.00)

Table 7 and Fig.33 indicated that knowledge level of scientists about agricultural biotechnology was better in comparison to farmers. Table 1 further indicated that majority of farmers (58%) had average awareness followed by low and high level of awareness, respectively. However, majority of the scientists (66%) had medium level of knowledge followed by high and low level, respectively.

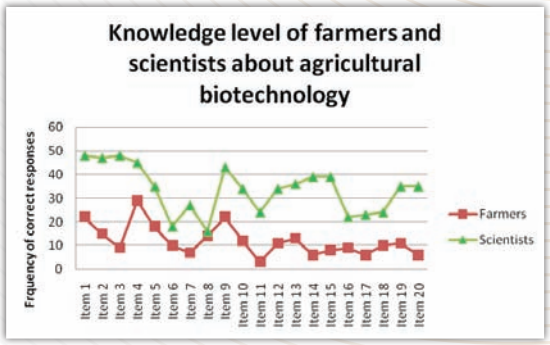

Fig. 33: Knowledge level of farmers and scientists about agricultural biotechnology

Objective 3: To assess attitude of respondents towards agricultural biotechnology

A. Development of Attitude Scale : The method of summated rating suggested by Likert (1932) was followed. Major steps followed were as follows:

i. Collection of attitude stimuli: 50 statements about agricultural biotechnology were collected.

ii. Editing the statements: Based on the jury opinion, 32 statements were found relevant.

iii. Item analysis : The 't' value for 32 statements was calculated by using formula given by Edwards (1969). Statements having higher 't' value than mean 't' value were selected. In this way, a total of 20 statements (having 10 positive and 10 negative statements) were selected for final attitude scale.

B. Reliability : 20 statements (items) were divided into two equal halves with 10 odd number statements in one group and 10 even number statements in the other group. These two groups of statements were administered on five- point continuum to group of 30 farmers which were not included in the actual sample. Reliability coefficient (Spearman Brown Coefficient) between the two sets of scores was calculated, which was found to be highly significant (0.870). Thus Attitude Scale is reliable.

C. Validity : Content validity of the scale was found satisfactory since it was based on various literature, experts advice, judges opinion, etc.

D. Attitude Scale : The final scale consists of 20 statements. The responses against each statement are recorded on a five point continuum representing strongly agree, agree, undecided, disagree and strongly disagree. This scale may be used for assessing attitude of respondents about agricultural biotechnology/ GM crops.

E. Attitude Measurement : Strongly agree, agree, undecided, disagree and strongly disagree responses were assigned with scores of 5, 4, 3, 2 and 1 for positive statements and vice-versa for negative statements. The attitude score of each individual in different categories of respondents was calculated by summing the scores obtained by him/ her on all the items. The attitude scores on this scale ranges from 20 to 100. The higher score indicated that respondent had more favourable attitude about agricultural biotechnology.

The attitude of farmers and scientists about agricultural biotechnology in Jharkhand are mentioned below:

Table 8, Fig. 34 & 35 showed that majority of farmers (48%) had neutral attitude about agricultural biotechnology, followed by favourable (18%) and unfavourable (8%) attitude. However, majority of scientists (68%) had favourable attitude, followed by neutral (10%) and unfavourable (6%) attitude respectively.

Table. 8 Attitude of farmers and scientists about agricultural biotechnology in Jharkhand

Farmers (N=50)		Scientists (N=50)	
Category	Frequency (%)	Category	Frequency (%)
Unfavourable (20-59)	8 (16.00)	Unfavourable (20-59)	06 (12.00)
Neutral (60)	24 (48.00)	Neutral (60)	10 (20.00)
Favourable (61-100)	18 (36.00)	Favourable (61-100)	34 (68.00)

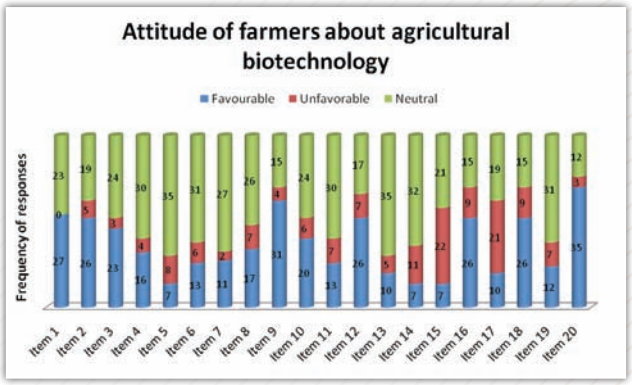

Fig. 34: Attitude of farmers about agricultural biotechnology

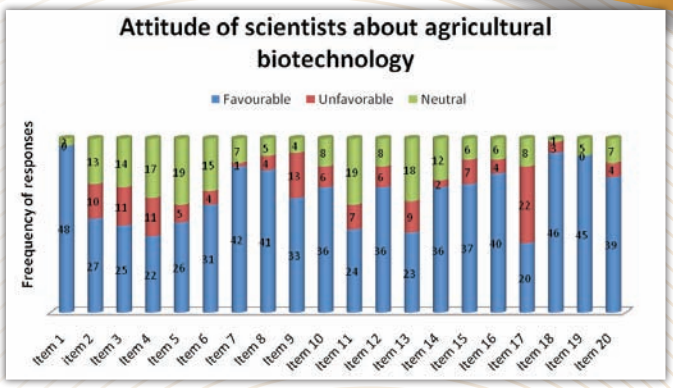

Fig. 35: Attitude of scientists about agricultural biotechnology

Fig. 36 & 37 indicated that majority of scientists (50%) and farmers (46%) are in favour that Government should allow cultivation of GM crops at farmers' field for increasing production and productivity.

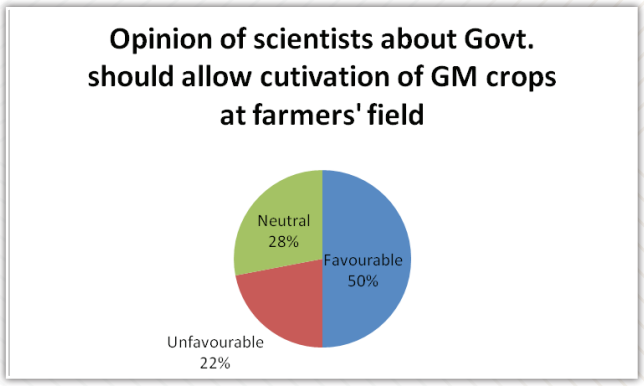

Fig. 36: Opinion of scientists about Govt. should allow cultivation of GM crops at farmer's field

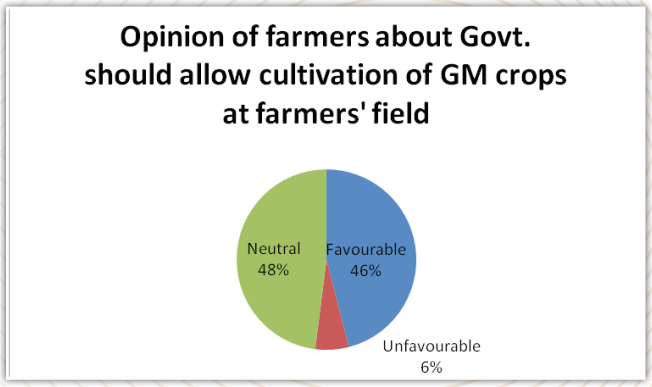

Fig. 37: Opinion of farmer's about Govt. should allow cultivation of GM crops at farmer's field

Objective 4: To assess the extent of utilization of agricultural biotechnology products/ output

Based on survey, agricultural biotechnological products/ output available in Jharkhand are i) Varieties of Banana produced through Tissue Culture (G 9, Robusta and Behula) ii) Tissue culture plant in Bamboo, Sugarcane, Jerbera, Orchids and Agrobacterium iii) Bio-fungicide (Blaster, Trico, Floris, Crobiotic, etc.) iv) Bio-insecticides (Sungen, Pestcon, Plantox, Secure, etc.) v) 4th generation bio plant nutrients manufactured with Nano technology (organic NPK, bio-phos, bio-potash, organic megacal, bio-zinc, new suryamin, etc.) vi) organic plant growth promoter and harmone (plantozyme, planto-horti, PSTIM, plantohume, planto-drip, agrona, etc.) vii) Biofertilizer (plantozyme 'G', endomyco, arisil, bio-phos, bio-potash, bio-NPK, etc.).

EXTERNALLY FUNDED PROJECTS

OXX03650: Identification and characterization of multiple stress responsive WRKY transcription factors in potato (*Solanum tuberosum* L.) (SERB, DST, Govt. of India funded)

The HMM search was performed to identify WRKY transcription factors (TFs) using the HMM profile of WRKY domain (PF03106), which resulted in identification of 128 proteins, encoded by 84 genes. All 128 proteins were subjected to Pfam analysis, which confirmed the presence of WRKY domain. The chromosomal locations of 82 StWRKY genes were identified, while two genes could not be anchored on any of the chromosomes (Fig. 38). During evolution, gene duplication has contributed to the expansion of gene families and establishment of new gene functions underlying the origins of evolutionary novelty. The WGD analysis resulted in identification of 4242 collinear and 25493 tandemly arrayed genes out of 51472 gene models in potato genome. In case of StWRKY family, 30 and 66 genes were found to be segmentally and tandemly duplicated, respectively (Fig. 39).

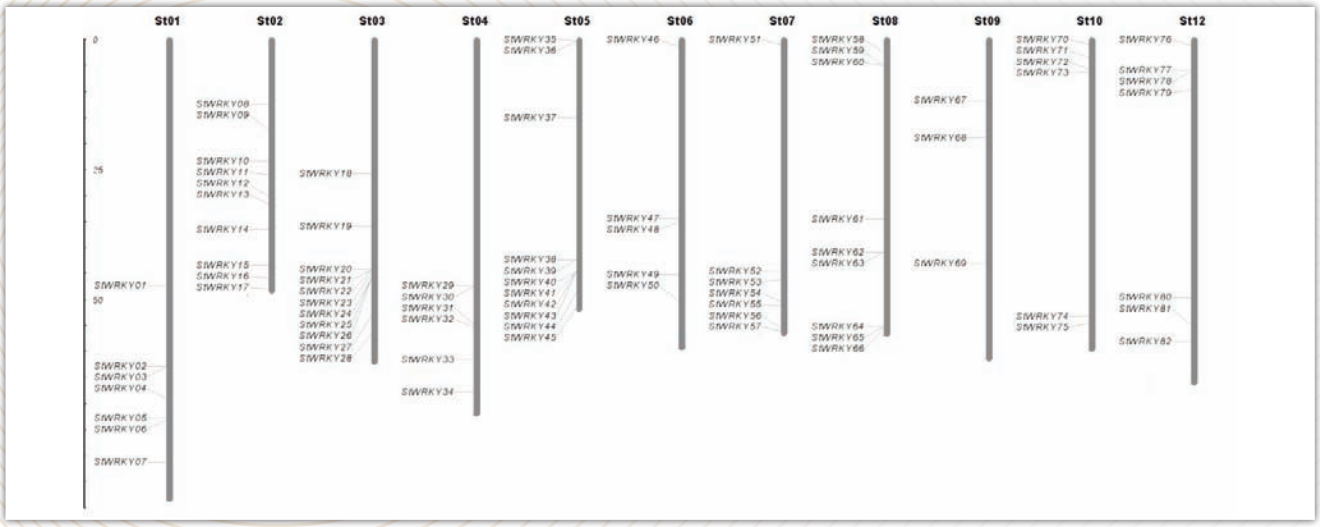

Fig. 38: Chromosomal localization of potato WRKY genes.

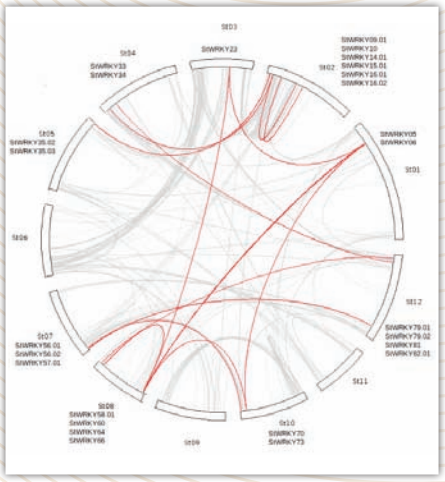

Fig. 39: Depiction of segmentally duplicated StWRKY genes

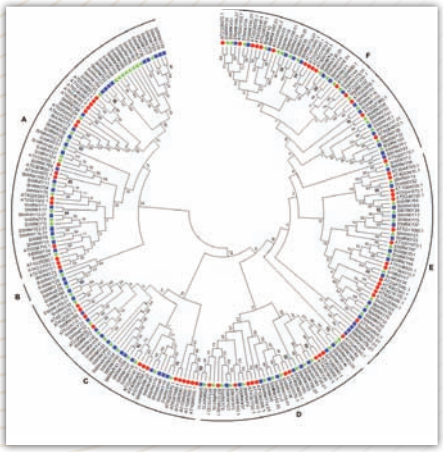

Fig. 40: Phylogenetic analysis of StWRKY proteins along with Arabidopsis and tomato WRKY proteins.

WRKY TF family is one of the largest transcription factor families in plants and has been characterized in various species. The full length protein sequence of WRKY TF in Arabidopsis and tomato were aligned with StWRKY protein sequences and phylogenetic tree was constructed to analyse the evolutionary relationship with these two dicots (Fig. 40). All these proteins were divided into six distinct clades.

Relative expression ratio calculated using available RNA-seq data was used to make the heat-maps. Careful analysis of these heat-maps has identified StWRKY58 and StWRKY68 as multiple stress-responsive genes (Fig. 41). The expression of both the genes has been validated under various abiotic, biotic stresses and phytohormone treatments using qRT-PCR. Both, StWRKY58 and StWRKY68 were found to be upregulated under all the conditions as compared to their respective controls (Fig. 42). Interestingly, both the genes were found to be early responsive to most of the conditions as compared to their respective controls. These observations suggest that these genes could be potential candidates for engineering multiple stress tolerance in plants.

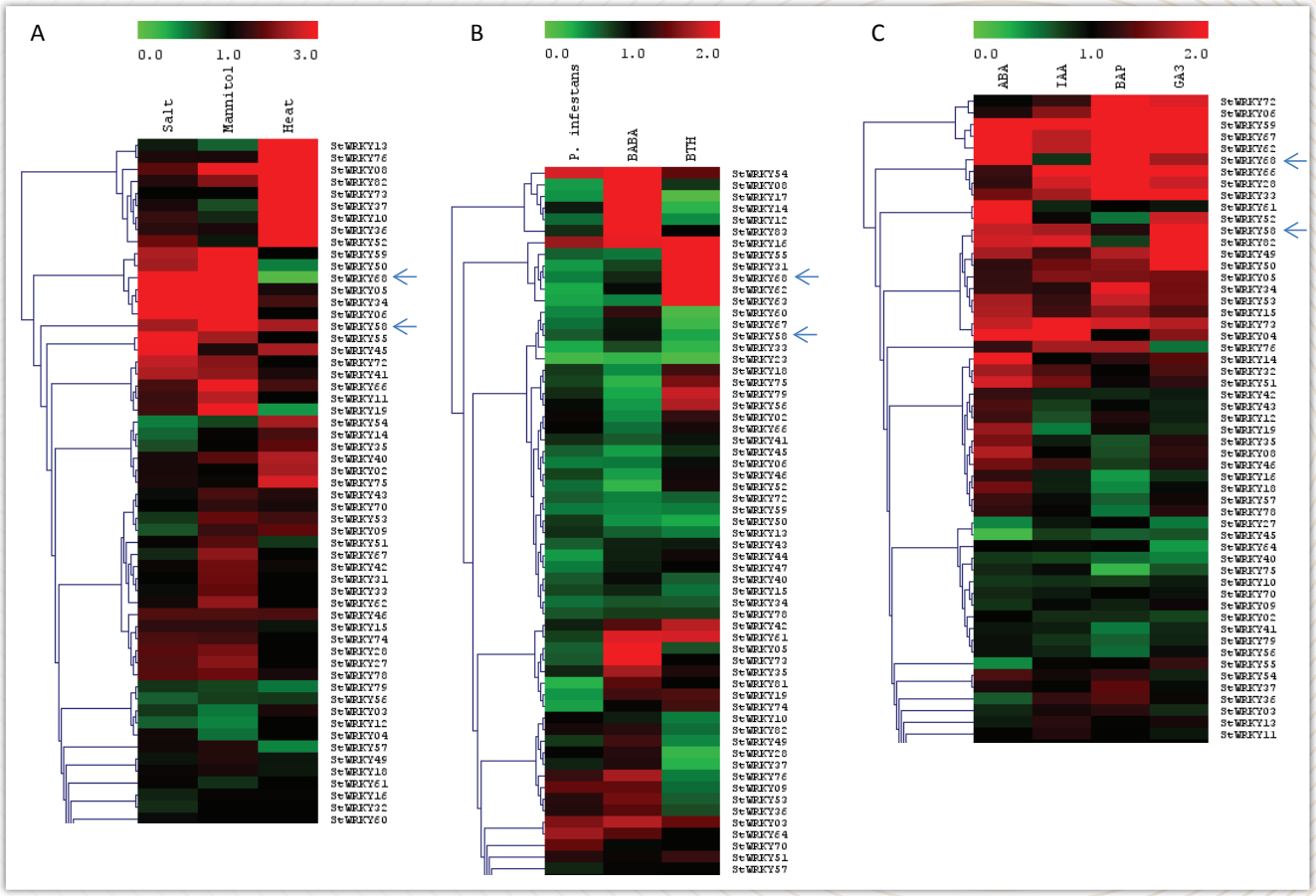

Fig. 41 Expression profiling of StWRKY genes under (A) abiotic, (B) biotic stresses and (C) hormone treatments

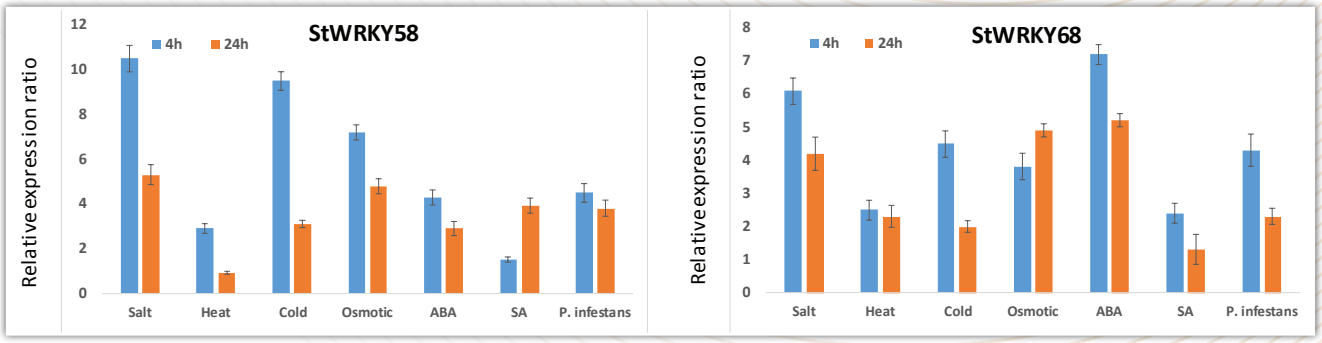

Fig. 42: Relative expression ratio of StWRKY58 and StWRKY68 under various abiotic and biotic stresses and phytohormone treatments as compared to their respective controls as determined using qRT-PCR.

The full-length cDNAs of both, StWRKY58 and StWRKY68 were amplified through PCR using potato cDNA as template (Fig. 43A). The amplified fragments were cloned in pGEM-T easy vector and the nucleotide sequencing was performed to confirm the sequence of both the cDNAs. The StWRKY58 was found to contain an open reading frame of 1005 bp, while, StWRKY68 was found to contain an open reading frame of 882 bp. The cDNA of StWRKY58 was cloned in plant expression vector, pRT101 on EcoRI and BamHI sites (Fig. 43B). The StWRKY58:pRT101 construct was digested with PstI to obtain cassette comprising of CaMV35S promoter: StWRKY58: terminator, which resulted into a fallout of ~1.7 Kb (Fig. 43B). The fallout containing whole cassette was excised from the gel and purified and cloned in pCAMBIA1302 vector at PstI site. The colonies were screened for the presence of StWRKY58 using colony PCR. In colony PCR, most of the colonies were found to be positive (Fig. 43C). Plasmids of two colonies 3 and 5 were isolated and digested with PstI to confirm the insertion of the cassette. The restriction digestion of plasmids from both the colonies yielded fallout of ~1.7Kb, which confirmed the presence of whole cassette in both the plasmids (Fig. 43D).

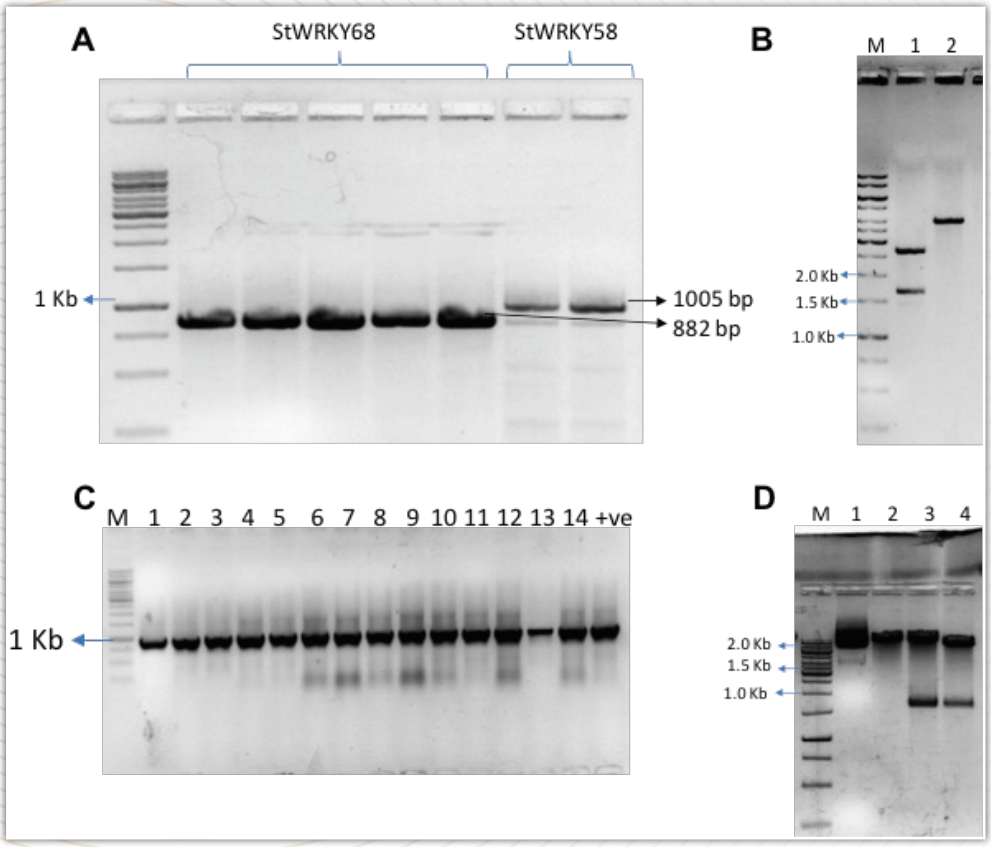

Fig. 43: (A) PCR amplification of StWRKY58 and StWRKY68 (B) Confirmation of cloning of StWRKY58 in pRT101 vector (C) Colony PCR for the confirmation of presence of StWRKY58 in pCAMBIA1302 vector. (D) Confirmation of presence of StWRKY58 cassette in pCAMBIA1302 vector.

The plasmid from colony no. 3 was transformed to *Agrobacterium tumefaciens* (GV3101) using biparental mating method. The resulting colonies were screened through colony PCR (Fig. 44). *In vitro* grown healthy shoots of potato are being used to take the intermodal explants for transformation. At present, internodal explants are being transformed with *Agrobacterium tumefaciens* as per the standardized protocol.

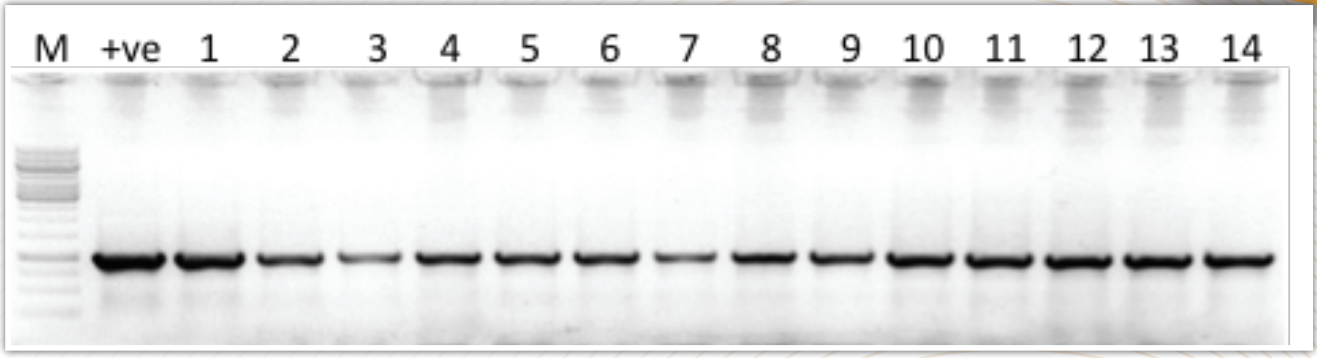

Fig. 44: Colony PCR for the confirmation of presence of StWRKY58: pCAMBIA1302 construct in Agrobacterium tumefaciens.

Screening of various lentil (*Lens culinaris L.*) genotypes for drought tolerance using physiological and molecular approaches (SERB, DST, Govt of India funded under N-PDF scheme)

A project has been initiated to perform screening of lentil genotypes for drought tolerance using various physiological and molecular approaches. The understanding of effect of drought on physiological parameters and associated genes will help in developing drought tolerant lentil cultivars. Twenty six local varieties (genotypes) of lentil having varied characteristics were procured from BAU, Sabour. These were subjected to drought stress by watering them with PEG8000 (Fig. 45).

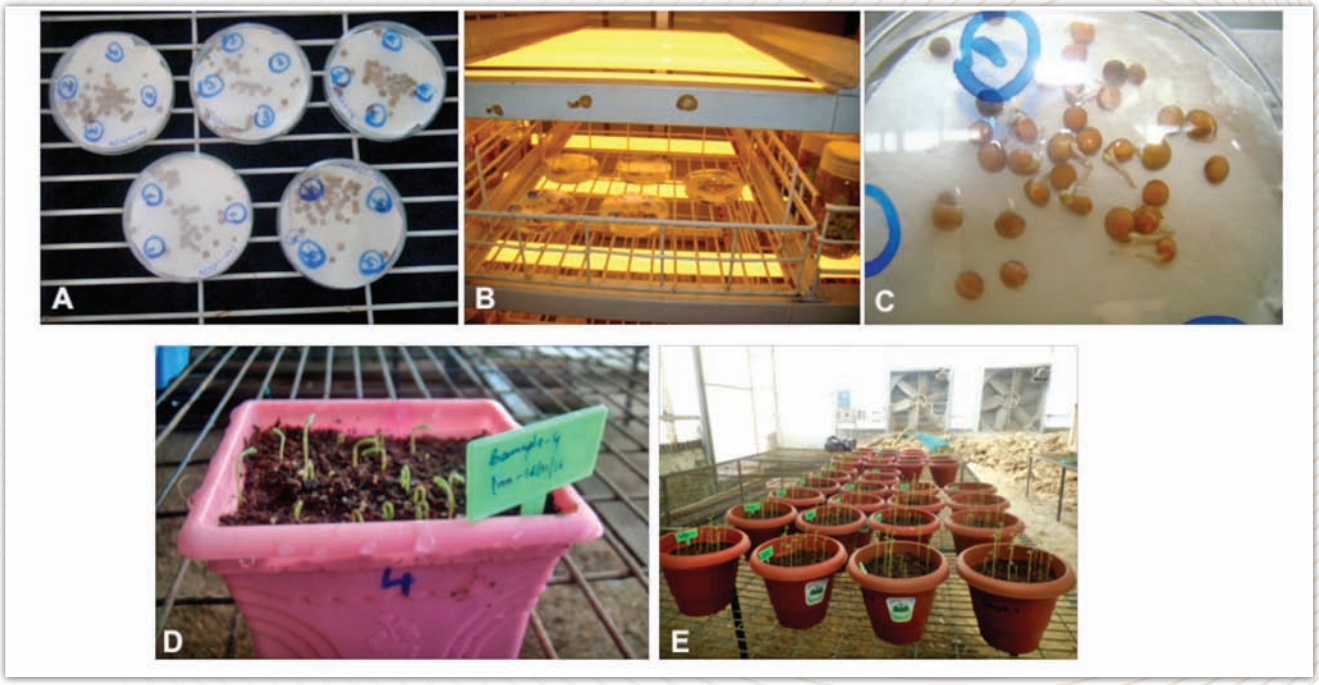

Fig. 45: (A) Seeds inoculated in sterile distilled water, (B) Seed incubation in tissue culture room, (C) Radical emergence, (D) Transferred to pots (Vermiculite: cocopeat; 2:1) (E) Pots maintained in green house conditions. Control seedlings were watered with water, while seedlings were watered with 13.5 % PEG-8000 for imposition of drought stress

Various physiological parameters, viz., stomatal density, relative water content, total chlorophyll, anthocyanin, proline and sugar contents were estimated (Fig. 46 & 47). Tissue samples for RNA isolation were collected and stored in liquid Nitrogen for further use.

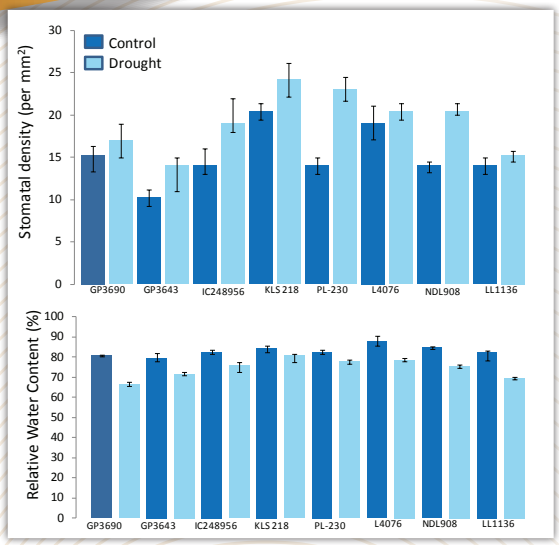

Fig 46: Stomatal density and relative water content in various genotypes of lentil under control and drought stress conditions.

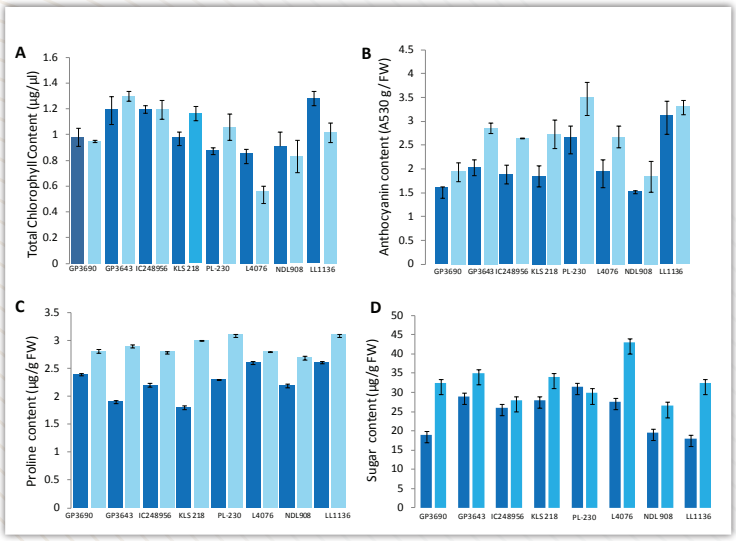

Fig. 47: (A) Total chlorophyll, (B) Anthocyanin, (C) proline and (D) sugar contents in various genotypes of lentil under control and drought stress conditions.

After physiological and biochemical analysis, four genotypes were found to exhibit contrasting response under drought stress. Total RNA was isolated from four genotypes and first strand cDNA was synthesized. Primers for various genes related to biotic /abiotic stresses, metabolism related and flowering related genes were synthesized for gene expression analysis (Fig. 48).

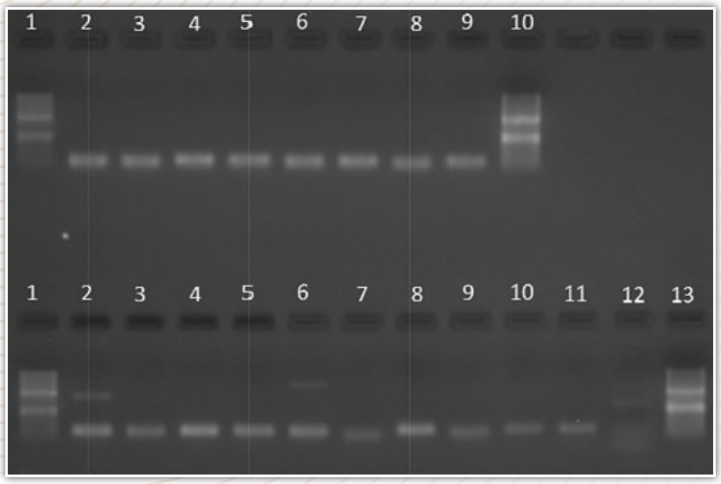

Fig. 48: Agarose gel electrophoresis of RT-PCR products.

IXX13280: Enhancing Food, Nutritional and Livelihood Security of Marginal and Small Farmers in Jharkhand through Need Based Agricultural Technologies (ICAR-funded Farmers FIRST project)

An ICAR funded Farmers FIRST project (FFP) on "Enhancing Food, Nutritional and Livelihood Security of Marginal and Small Farmers in Jharkhand through Need Based Agricultural Technologies" during 2016-17 was granted to ICAR-IIAB, Ranchi. A two-days workshop was organized on 25-26 March, 2017. About 200 farmers and agri-entrepreneurs from four project villages, namely Kutiatu, Pindarkom, Tetri and Malti under Namkum block of Ranchi district, were oriented and trained

on technical interventions to be carried out under different approved modules, viz. crop, livestock/ fish, enterprise, natural resource management (NRM) and integrated farming system (IFS), of the farmer FIRST project. Scientists and faculties from different organizations, namely ICAR-IIAB, Ranchi; ICAR-Indian Institute of Natural Resins and Gums, Ranchi; ICAR Research Complex for Eastern Region (ICAR-RCER), Research Centre Ranchi and Birsa Agricultural University, Ranchi, acted as resource persons in the workshop.

Shri Sudarshan Bhagat Ji, Hon'ble Minister of State, Ministry of Agriculture & Farmers Welfare, Govt. of India, graced the workshop as chief guest in the farmers-scientist interface on the second day (26 March, 2017). Shri Subrata Mandal, Chief General Manager, NABARD, Ranchi was present as Guest of Honour in the interface.

TRIBAL SUB PLAN (OXX03856)

A) Training Programmes:

S. No.	Date of trainings	Venue of training	Topic of training	No. of beneficiary farmers	Outcome
1	14.06.2016	Panchayat Bhavan, Lalkhatanga, Namkum, Ranchi	Cultivation of crops and Pisciculture	99	Participating farmers expressed satisfaction over gain in knowledge and skill related to scientific cultivation of crops, fishery, poultry, piggery, goatry, etc.
2	01.07.2016	Tetri village, Namkum, Ranchi	Crop Cultivation and Fishery	129	
3	04.11.2016	PanchayatBhavan, Lalkhatanga, Namkum, Ranchi	Integrated Farming System	150	
4	16.11.2016	Tetri village, Namkum, Ranchi	Integrated Farming System	106	
5	18.11.2016	Karge village of Mander Block in Ranchi	Integrated Farming System	100	
Total				**584**	

B) Demonstrations:

- Demonstration of IR 64 Drt1 (developed through Marker Assisted Selection) and Sahbhagi varieties of paddy was conducted in 20 acres and HQPM 1 hybrid of maize in 2 acres of land in Tetri and Garhkhatanga villages of Namkum block under TSP during *Kharif* 2016. Seed, herbicide, lime, urea, monocrotophos, etc. were provided to the farmers. Farmers were happy from the bumper harvest of crop. Few farmers kept grain as seed.
- Demonstration of G 9 variety of banana was conducted in Lalkhatanga and Tetri villages during *Kharif* 2016. One hundred plantlets, lime, neemkhali, urea, DAP, MOP, Monocrotophos, etc were provided to the beneficiary farmers.
- Mixed Carp Culture was demonstrated in two ponds in Lalkhatanga and Kharsidag villages during 2016-17. Fish fingerlings, lime, FYM, Urea, DAP, Fish feed, etc were






provided to the beneficiary farmers. 50 Kg Fish were harvested in each pond and sold in the market @ Rs 240/- per Kg.

- Demonstration of Lentil was conducted in 2 acres, Pea in 1 acre, and French bean in 1 acre in project villages during *Rabi* 2016-17. Seedlings of tomato and brinjal were also distributed in training programmes.
- Demonstration of tomato and brinjal was conducted in one acre land in Lalkhatanga panchayat of Namkum block during *Rabi* 2016-17.
- Ninety-one nos. of chicks, poultry feed and prophylactic medicines were provided to 18 tribal farmers families in four villages namely, Lalkhatanga, Garhkhatanga, Tetri and Kharsidag in Namkum block of Ranchi district during 2016-17.

C) Field Day :

Farmers' Field Day was organized in Lalkhatanga village of Namkum block of Ranchi district on 25th September 2016 in which around 150 villagers including members and secretary of panchayat, Krishi Mitra, farmers from four villages namely, Lalkhatanga, Garhkhatanga, Tetri and Kutiyatu participated. Dr. Tilak Raj Sharma (Officer on special duty, ICAR-IIAB and Director, ICAR-NRCPB, New Delhi) was the Chief Guest of the function. He along with the scientists and farmers visited the demonstrations of IR 64 Drt1 variety of paddy, G-9 variety of tissue cultured banana plant and mixed fish farming at farmers' field. He also distributed organic NPK and insecticide to the farmers conducting demonstrations. The beneficiary farmers expressed satisfaction of the performance of paddy varieties.

D) Exposure Visit :

Exposure visit of tribal farmers from Tetri and Kutiyatu villages of Namkum block was organized on the occasion of Exhibition –cum- Kisan Mela on 10.02.2017 at ICAR-IINRG, Ranchi.

FRONTLINE DEMONSTRATION (FLD) ON PADDY

Demonstration of IR 64 Drt1 variety of paddy was laid in 25 acres of land in Karge village of Mander block, 15 acres in Kutiyatu and 15 acres in Lalkhatanga villages of Namkum block under Frontline Demonstration (FLD) programme during *Kharif* 2016. Seed of IR 64 Drt1 variety, pendimethylene (herbicide), organic NPK and monocrotophos (insecticide) were provided to the farmers, and sowing was done in the presence of experts. Monitoring of demonstration plots was done. Farmers expressed satisfaction over performance of paddy.

Institutional ACTIVITIES

PERSONNEL

Name, Designation & E. mail ID	Area of Research
Dr. K.K. Sharma, Director, ICAR-IIAB, Ranchi	
School of Genomics and Molecular Breeding	
Dr. Vijai Pal Bhadana Pr. Scientist (Genetics & Plant Breeding) bhadanavijai@gmail.com	Molecular Breeding in Rice
Dr. Binay Kumar Singh Sr. Scientist (Agril. Biotechnology) binaybio@gmail.com	Genomics and Molecular Breeding for Enhancing Nutrient Use Efficiency in Rice
Dr. Anil Kumar Singh Sr. Scientist (Agril. Biotechnology) anils13@gmail.com	Genomics and Stress Physiology of Crops
Dr. Soumen Naskar Sr. Scientist (Agril. Biotechnology) snrana@gmail.com	Major Histocompatibility Complex (MHC); Assisted Reproductive Technology (ART) in Livestock Species
Sh. Kishor U. Tribhuvan Scientist (Agril. Biotechnology) kish.tribhuwan@gmail.com	Genomics and Molecular Breeding for Abiotic Stress Tolerance in Pulse Crops
Sh. Shambhu Krishan Lal Scientist (Agril. Biotechnology) shambhumku@gmail.com	Genomics and Molecular Breeding for Enhancing Nutrient Use Efficiency in Rice
School of Molecular Diagnostics and Prophylactics	
Dr. Biplab Sarkar Sr. Scientist (Nanobiotechnology) biplab_puru@yahoo.co.in	Development, and Application of Nanoparticles in Disease Control, Environmental Remediation and Micronutrient Induced Fortification
Dr. Sanjay Kumar Gupta Scientist (Fish and Fisheries) sanfish111@gmail.com	*Fish Nutrigenomics*

Name, Designation & E. mail ID	Area of Research
Dr. Vinay T.N. Scientist (Fish Genetics & Breeding) vinaytn56@gmail.com	Fish Immunogenetics and Vaccinology
Sh. Tanmoy Gon Choudhury Scientist (Fish Health) tanmoygc@gmail.com	Fish Disease Prophylaxis and Therapeutics
Sh. Anutosh Paria Scientist (Fish Health) anu.cife@gmail.com	Molecular Immunology in Fish and Shellfish
Sh. Rishikesh Kumar Scientist (Plant Pathology) rishiiari2011@gmail.com	Host-Pathogen Interactions in Plant Disease
School of Basic and Social Sciences	
Dr. Nirmal Kumar Pr. Scientist (Agril. Extension) niraldr04@yahoo.com	Transfer of Technology and Impact Studies
Dr. Nawalesh Kumar Sinha Sr. Scientist (Seed Science & Technology) nksinha.cazri@gmail.com	Seed and Environmental Physiology
Dr. Virendra Kumar Yadav Sr. Scientist (Agril. Extension) totdmr@gmail.com	Popularization of Agricultural Biotechnology
Dr. Seeta Ram Meena Scientist (Agronomy) sr.iari2010@gmail.com	Nutrient Management in Food Crops
Administration and Finance	
Sh. Y. Prabhakar prabhakarctri@gmail.com	Assistant Administrative Officer
Sh. Rishi Kant Singh singh.rishikant4@gmail.com	Assistant Finance & Accounts Officer

TRAINING AND CAPACITY BUILDING

Details of training attended by the ICAR-IIAB staff during 2016-17

S. No.	Name	Subject Area	Duration	Host Institute
1	Sh. Rishikesh Kumar	Professional Attachment Training	90 days (May 27 to Aug. 27, 2016)	ICAR-IIRR, Hyderabad
2	Dr. Anutosh Paria	DBT-Sponsored National Training in Molecular Biology & Biotechnology for Fisheries Professionals	3 months (May 02 to Jul. 30, 2017)	ICAR-CIFE, Mumbai
3	Sh. S.K. Lal	Genomics and Phenomics in Enhancement of Crop Nutrient Use Efficiency	21 days (Sep. 01-21, 2016)	ICAR-NRCPB, New Delhi
4	Dr. Vinay T.N.	Designing Breeding Plans and Genetic Analysis of Complex Traits	10 days (Sep. 13 - 22, 2016)	ICAR-CIFE, Mumbai
5	Dr. Biplab Sarkar	11th Refresher Course on Agricultural Research Management	12 days (Nov. 15 - 26, 2016)	ICAR-NAARM, Hyderabad
6	Dr. Anil K. Singh	Molecular Breeding with Emphasis on Developing Climate Resilient Rice Varieties	21 days (Nov. 2 - 22, 2016)	ICAR-NRRI, Cuttack
7	Dr. V.P. Bhadana	Management Development Programme on Leadership Development	12 days (Dec. 19 - 30, 2016)	ICAR-NAARM, Hyderabad
8	Dr. V.P. Bhadana	Competency Enhancement Programme for Effective Implementation of Training Functions by HRD Nodal Officers	3 days (Feb. 23 - 25, 2017)	ICAR-NAARM, Hyderabad
9	Dr. Soumen Naskar	Hands-on Training cum Workshop on CRISPR/Cas9 – A Robust Tool for Genome Editing	7 days (Feb. 19 - 25, 2017)	KIIT University, Bhubaneswar
10	Sh. Rishi Kant Singh	PFMS	2 days (Feb. 22 - 23, 2017)	Patna

IMPORTANT MEETINGS

IRC, RAC AND IMC MEETINGS

Institute Research Council (IRC) Meeting

ICAR-IIAB organised its 8th and 9th IRC Meetings on June 25 and Sept. 24, 2016. Both the meetings were held under the Chairmanship of Dr. T.R. Sharma, OSD, IIAB, Ranchi to review the progress of Institutional Research Projects and consideration of new project proposals. During the IRC Meeting held on June 25, 2016, the Chairman opined that all the projects should be in line of the mandate and proposed Schools of the Institute and addressing important national and local problems.

Research Advisory Committee (RAC) Meeting

The 4th RAC meeting of ICAR- IIAB was held on July 30-31, 2016 under the Chairmanship of Dr. C.D. Mayee, Former Chairman, ASRB, New Delhi. The RAC members who were present in the meeting were Dr. N.K. Singh, National Professor, ICAR-NRCPB, New Delhi; Dr. George John, Vice Chancellor, BAU, Ranchi; Prof. A.N. Lahiri Majumder, Raja Ramanna Fellow, Division of Plant Biology, Bose Institute, Calcutta; Dr. J.S. Chauhan, ADG (Seed), ICAR-New Delhi and Dr. T.R. Sharma, OSD, IIAB, Ranchi and Director, NRCPB, New Delhi. Dr. T. R. Sharma cordially welcomed the Chairman and all the members of the RAC. After introduction of all the participants and RAC members, Annual Report 2015-16 of ICAR-IIAB was released by the RAC. The newly developed website of IIAB was also launched by the Chairman during the Meeting.

In his opening remarks, Chairman emphasized the need of application of Molecular Biology and Biotechnology (MBB) for increased agricultural production to achieve 2nd Green Revolution. He also suggested to start the M.Sc. Degree Programmes in MBB and Fish Biotechnology in collaboration with ICAR-IARI and ICAR-CIFE, respectively.

Subsequently, progress made on establishment of IIAB during the last year was presented by Dr. T.R. Sharma, OSD, IIAB. Action Taken Report (ATR) on the recommendations of previous RAC was presented by Dr. Nirmal Kumar, Member Secretary, RAC. After an elaborate discussion on the OSD's Report and ATR, Principal Investigators of different

thematic research areas under different Schools of IIAB presented the objectives, milestone activities, materials to be used and expected outcomes in respect of the approved projects during last one year.

Chairman and members of the RAC complemented the OSD and Scientists of IIAB for the progress made during past one year on developmental front and especially for coming out with much focused research programmes of the Institute. In the concluding session, Dr T.R. Sharma, OSD, IIAB expressed his gratitude to the RAC for their valuable suggestions. The meeting ended with vote of thanks to the Chair and members by Dr. V.P. Bhadana. On July 31, RAC members visited Institute's sites at Garhkhatanga to see the progress of farm development. Later, they visited the newly developed laboratories and other facilities at Camp office of IIAB. The meeting ended with a vote of thanks to the Chair and members of RAC.

Institute Biosafety Committee (IBSC) Meeting

The first meeting of IBSC was held on Sep. 23, 2016 in the Committee room of ICAR-IIAB, Ranchi. The meeting started with welcome of all the members of the committee by Dr. T.R. Sharma, OSD, IIAB & Chairman of the committee. This was followed by remarks by Dr. Alok Sinha, DBT Nominee in the committee who emphasized the role of IBSC in implementing biosafety guidelines in research. The committee reviewed all the five proposals which were submitted for consideration of IBSC. Three proposals were approved by the committee while the remaining two were not considered for approval as they did not involve any recombinant DNA work. The meeting of the committee was concluded with Vote of thanks to the Chairman and all the members by Dr. A.K. Singh, Member Secretary, IBSC.

OTHER ACTIVITIES

ORGANIZATION OF HINDI PAKHWADA

Hindi Pakhwada was organized from Sept. 09 - 23, 2016. Various competitions such as debate, extempore, translation, dictation, etc. were organized during the Pakhwada. All the staffs of IIAB participated in the Pakhwada. Hindi Day was celebrated on 14th September, 2016 and all the winners were awarded.

ORGANIZATION OF HINDI WORKSHOPS

Four quarterly Hindi Workshops were organized on June 22, 2016; Sept. 14, 2016; Dec. 23, 2016 and March, 01, 2017, respectively. During the Workshops various lectures were delivered by resource persons. Different topics covered during the Workshops were (i) Swasth jeevan ka amogh mantra: Yoga (ii) Rajbhasha Hindi: chunautiyan ewam sambhavnayen (iii) Hindi ki sthiti ewam karyalaya men iska upyog, and (iv) Rajya me bhugarbh jal ki sthiti ewam jal chhajan. All the staff of IIAB participated in the Workshops.

RAJBHASHA IMPLEMENTATION COMMITTEE MEETINGS

Four quarterly Rajbhasha Implementation Committee meetings on June 22, 2016; Sept. 14, 2016; Dec. 23, 2016 and Feb., 25, 2017, respectively. All the members of the committee participated in the meetings and discussions were made to enhance the use of Hindi in all official files, trainings, demonstrations, etc.

FARMERS' AWARENESS CUM TRAINING PROGRAMME

A Farmers' Awareness cum Training was organized under Mera Gaon Mera Gaurav programme in Karge village of Mander block in Ranchi district on June 23, 2016.

SWACHH BHARAT ABHIYAAN

ICAR-IIAB organized Swachhta Pakhwada under Swachh Bharat Mission during Oct. 16-31, 2016. During the Pakhwara, cleaniness drives were organized to clean the campus premises by removing weeds, collection of garbage, cutting and cleaning of grasses, and other waste materials. The programme of 'Swachhta Pakhwada' started with pledge taking ceremony, wherein Director, IIAB emphasized the importance of cleanliness in scientific and public life to all the staffs. The programme of 'Swachhta Pakhwada' started with cleaning of administrative premises as well as scientific blocks of IIAB campus and continued to different locations of IIAB farms at Garhkhtanga IINRG campus as well as nearby villages of Namkum Block. During Pakhwara cleanliness drive were carried out in the afternoon for about one and half hours every day.

Fig : Cleanliness campaign of ICAR-IIAB under Swachh Bharat Abhiyaan

PARTICIPATION IN CONFERENCES, MEETINGS, SEMINARS, SYMPOSIA AND WORKSHOPS

S. No.	Event	Venue	Period	Participants
1	51st All India Rice Workers Group Meetings	Raipur	April 2 - 5, 2016	Dr. V.P. Bhadana Dr. B.K. Singh
2	National Conference on Agricultural and Rural Innovations for Sustainable Empowerment	Kakatiya University, Warangal	May 21 - 22, 2016	Dr. V.P. Bhadana
3	First Steering Committee Meeting of Second Green Revolution	Patna	June 27, 2016	Dr. Nirmal Kumar Dr. V.P. Bhadana
4	29th Extension Education Council Meeting of BAU, Ranchi	Ranchi	July 20, 2017	Dr. V.P. Bhadana
5	2nd International Conference on Plant Genetics and Genomics, AgriGenomics India 2016	Radison Blue, New Delhi	Aug. 19 - 20, 2016.	Dr. A.K. Singh
6	XXIII Meeting of ICAR Regional Committee No. IV	Patna	Aug. 26 - 27, 2016	Dr. V.P. Bhadana
7	Interaction Meeting with Adl. Secretary, DARE & Secretary, ICAR and Adl. Secretary & FA, DARE	Kolkata	August 31, 2016	Dr. V.P. Bhadana Sh. Rishi Kant Singh
8	National Conference on Emerging Challenges and Opportunities in Agriculture, Social, Plant, Environment, Co-Operatives & Technology ECOASPECT-2016.	ICAR-IIRR, Hyderabad, Telangana	Sep. 10 - 11, 2016	Dr. N.K. Sinha
9	4th Annual South Asia Biosafety Conference	Taj Krishna, Hyderabad	Sep. 19 - 21, 2016	Dr. A.K. Singh
10	Workshop on Intellectual Property Rights (IPRs) in Agricultural Biotechnology	ICAR-IIAB, Ranchi	Sep. 24, 2016	Dr. Nirmal Kumar Dr. V.P. Bhadana Dr. N.K. Sinha Dr. B.K. Singh Dr. Biplab Sarkar Dr. A.K. Singh Dr. S. Naskar Dr. S.K. Gupta Sh. S.K. Lal Sh. Rishikesh Kumar

S. No.	Event	Venue	Period	Participants
11	National Conference on Nanoscience, Nanotechnology and Advanced Materials	BIT, Mesra,	Sep. 26 - 27, 2016	Dr. Biplab Sarkar
12	Review Meeting by Hon'ble Minister of Agriculture & Farmers' Welfare, Government of India	Ranchi	Sep. 27, 2017	Dr. V.P. Bhadana Dr. A.K. Singh Dr. S. Naskar
13	1st International Apple Symposium	Yangling, Shaanxi Province, China	Oct. 10 - 16, 2016.	Dr. A.K. Singh
14	Farmers Fair cum Exhibition & Seminar	Hazaribag	Oct. 26, 2017	Dr. V.P. Bhadana Dr. B.K. Singh
15	International Seminar on Recent Advances in Aquaculture	Andhra University	Dec. 16 - 17, 2017	Dr. S.K. Gupta
16	International Conference on Advances in Nanotechnology	Assam Don Bosco University, Guwahati	Jan. 9 - 13, 2017	Dr. Biplab Sarkar
17	ICAR Directors' Conference	New Delhi	February 14 - 15, 2107	Dr. V.P. Bhadana
18	National Symposium on Recent Trends in Biopolymers	ICAR-IINRG, Ranchi, Jharkhand	Feb. 17 - 18, 2017	Dr. N.K. Sinha Dr. A.K. Singh Dr. Biplab Sarkar Dr. Anutosh Paria
19	International Symposium on 'Genome Editing Technologies and Their Applications in Biology, Medicine and Agriculture	KIIT University, Bhubaneswar	Feb. 16 - 18, 2017	Dr. S. Naskar
20	International Conference InterDrought-V	Hyderabad International Convention Centre, Hyderabad	Feb. 21 - 25, 2017	Dr. A.K. Singh
21	National Symposium on Plant Biotechnology: Current Perspectives on Medicinal & Crop plants	CSIR-IICB, Kolkata	March 3 - 5, 2017.	Dr. A.K. Singh
22	International Conference on Environment and Ecology (ICEE 2017)	St. Xavier's College, Ranchi	Mar. 27 - 29, 2017	Dr. Biplab Sarkar

JOINING OF NEW STAFF

LIST OF NEW STAFF JOINING AT ICAR-IIAB, RANCHI

Name of the Staff	Designation	Date of Joining
Sh. Rishikesh Kumar	Scientist (Plant Pathology)	11 April, 2016
Dr. Soumen Naskar	Sr. Scientist (Agril. Biotechnology)	08 August, 2016

TRANSFER OF IIAB STAFF

Name of the Staff	Designation	Place of Transfer
Dr. S.R. Meena	Scientist (Agronomy)	ICAR-CAZRI, Jodhpur
Dr. Vinay T.N.	Scientist (Fish Genetics and Breeding)	ICAR-CIBA, Chennai
Dr. V.K. Yadav	Principal Scientist	ICAR-RCER, Patna

INSTITUTIONAL PROJECTS

Project Title	Date of Start	Principal Investigator	Co- Principal Investigator(s)
IIAB-CBB-01: Genomics and Bioinformatics			
IXX12585: Identification and characterization of drought-responsive genes of wild chickpea (Cicer microphyllum)	April 2016	Dr. A.K. Singh	Sh. Kishor U. Tribhuvan Dr. V.P. Bhadana
IXX12644: Identification of genes/QTLs for heat tolerance in lentil	April 2016	Dr. A.K. Singh	Dr. B.K. Singh Dr. V.P. Bhadana Sh. S.K. Lal
IXX12950: Molecular characterization of the Major Histocompatibility Complex (MHC) genes of indigenous pig (Sus scrofa)	September 2016	Dr. Soumen Naskar	Dr. A.K. Singh Dr. V.P. Bhadana Dr. S. Banik
IIAB-TRCI-01: Translational Research for Crop Improvement			
IXX12649: Introgression of genes/ QTLs for drought tolerance and efficient phosphorus uptake in rice using MAS	April 2016	Dr. V.P. Bhadana	Dr. B.K. Singh Dr. N.K. Sinha Dr. A.K. Singh Sh. S.K. Lal Sh. Kishor U. Tribhuvan

Project Title	Date of Start	Principal Investigator	Co- Principal Investigator(s)
IXX12645: Identification and functional characterization of genes/QTLs responsible for Zinc homeostasis in rice	April 2016	Sh. S.K. Lal	Sh. Kishor U. Tribhuvan Dr. B.K. Singh Dr. V.P. Bhadana
IXX12651: Identification and mapping of novel genes/QTLs for phosphorus uptake and use efficiency in rice	April 2016	Dr. B.K. Singh	Dr. V.P. Bhadana Sh. S.K. Lal Sh. Kishor U. Tribhuvan
IXX12951: Understanding host-pathogen interactions and identification of novel blast and false smut resistance gene(s) in rice	September 2016	Sh. Rishikesh Kumar	Dr. B.K. Singh Dr. V.P. Bhadana Dr. N.K. Sinha
IIAB-FHM-01: Biotechnological Interventions for Fish Health Management			
IXX12177: Development of nanoparticle based recombinant protein oral vaccine for Indian major carps against Aeromonas hydrophila	October 2015	Dr. Vinay T.N.	Sh. Tanmoy Gon Choudhury Sh. Anutosh Paria Sh. Kishor U. Tribhuvan Dr. S.K. Gupta
IXX12178: Molecular characterization and functional analysis of antimicrobial peptides in response to pathogenic bacteria in striped catfish Pangasianodon hypophthalmus	October 2015	Sh. Anutosh Paria	Sh. Tanmoy Gon Choudhury Dr. Vinay T.N. Sh. Kishor U. Tribhuvan Dr. S.K. Gupta
IIAB-FHM-01-03: Isolation and characterization of novel bacteriophage for biocontrol of bacterial diseases in fish	October 2015	Sh. Tanmoy Gon Choudhury	Sh. Anutosh Paria Dr. Vinay T.N. Sh. Kishor U. Tribhuvan Dr. S.K. Gupta
IXX12206: Identification and characterization of genes responsible for immune response in *Labeo rohita* fingerlings	November 2015	Dr. S.K. Gupta	Sh. Tanmoy Gon Choudhury Sh. Anutosh Paria Dr. Vinay T.N.
IXX12919: Development and evaluation of the efficacy of novel nanoparticles for enhancing yield in rice and Indian major carp	June 2016	Dr. Biplab Sarkar	Sh. S.K. Lal Sh. Rishikesh Kumar Dr. S.K. Gupta Dr. B.K. Singh Dr. V.P. Bhadana Dr. A.K. Singh Dr. A. Roy Choudhury

Project Title	Date of Start	Principal Investigator	Co- Principal Investigator(s)
Other Projects			
IXX11598: Isolation and characterization of root nodule bacteria from *Flemingia* sp.	January 2014	Sh. Kishor U. Tribhuvan	Dr. Thamilarasi K. (ICAR-IINRG) Dr. V.D. Lohot (ICAR-IINRG)
1.5.001: Enhancing pure germinating seed yield of Flemingia semialata by physiological approaches	July 2014	Dr. N.K. Sinha	Dr. J. Ghosh (ICAR-IINRG) Dr. Md. Monobrullah (ICAR-IINRG) Dr. V.D. Lohot (ICAR-IINRG)
1.5.002: Peoples' understanding of agricultural biotechnology in Jharkhand	July 2014	Dr. V.K. Yadav	Dr. Nirmal Kumar
1.5.003: Zinc solubilizing *rhizobacteria* and *arbuscular mycorrhizal* fungi for bio fortification in direct seeded rice	August 2014	Dr. S.R. Meena	Dr. Thamilarasi K. (ICAR-IINRG) Sh. Kishor U. Tribhuvan Sh. S.K. Lal Dr. S.K. Naik (ICAR-RCER, Ranchi)
Externally Funded Projects			
OXX03650: Identification and characterization of multiple stress responsive WRKY transcription factors in potato (Solanum tuberosum L.) (SERB, DST, Govt. of India funded)	May, 2014	Dr. Anil K. Singh	
Screening of various lentil (Lens culinaris L.) genotypes for drought tolerance using physiological and molecular approaches (SERB, DST, Govt of India funded under N-PDF scheme)	July, 2016	Dr. Ragini Sinha (PI)	Dr. Anil K. Singh (mentor)

AWARDS AND HONOURS

- Dr. Biplab Sarkar, Sr. Scientist received 'Scientist of the Year - 2016' award by 'International Foundation of Environment and Ecology', 42, Station Road, Rahara, Kolkata – 700 118, West Bengal.
- Dr. A.K. Singh, Sr. Scientist has been selected as Member of the National Academy of Sciences, India
- Dr. A.K. Singh, Sr. Scientist was invited to deliver talk in 1st International Apple Symposium held at Yangling, Shaanxi, China during Oct. 10-16, 2016, with full funding support.
- Dr. A.K. Singh, Sr. Scientist joined as Review Editor of "Frontiers in Plant Science" specialty section "Plant Abiotic Stress".
- Dr. N.K. Sinha, Sr. Scientist received best Oral Presentation award on the occasion of National Conference on Emerging Challenges and Opportunities in Agriculture, Social, Plant, Environment, Co-Operatives & Technology (ECOASPECT-2016) held at ICAR-IIRR, Hyderabad, Telangana during Sep. 10 -11, 2016.
- Dr. N.K. Sinha, Sr. Scientist received Distinguished Scientist Award for outstanding contribution in the field of Seed Science on the occasion of National Conference on Emerging Challenges and Opportunities in Agriculture, Social, Plant, Environment, Co-Operatives & Technology (ECOASPECT-2016) held at ICAR-IIRR, Hyderabad, Telangana during Sep. 10 -11, 2016.
- Dr. N.K. Sinha, Sr. Scientist Co-Chaired a technical session on Advancing Frontiers in Biotechnology, Plants and Allied Sciences in National Conference on Emerging Challenges and Opportunities in Agriculture, Social, Plant, Environment, Co-Operatives & Technology (ECOASPECT-2016) held at ICAR-IIRR, Hyderabad, Telangana during Sep. 10-11, 2016.
- Dr. N.K. Sinha, Sr. Scientist Chaired a technical session on Harmonization of Plant Health Management (Plant Physiology) in National Conference on Emerging Challenges and Opportunities in Agriculture, Social, Plant, Environment, Co-Operatives & Technology (ECOASPECT-2016) held at ICAR-IIRR, Hyderabad, Telangana during Sep. 10-11, 2016.
- Dr. S.K. Gupta, Scientist honoured as Editorial Board Member of the Journal of Fisheries and Aquaculture for the year 2016-17.
- Dr. S.K. Gupta, Scientist received Certificate of Appreciation on June 30, 2016 by the Editor-in-Chief, Nusantara Bioscience Journal of Biological Science, published from Surakarta, Indonesia.
- Dr. S.K. Gupta, Scientist has been awarded Certificate of Outstanding Contribution in Reviewing from the editors in recognition made to the quality of Journal Fish and Shell Fish Immunology, Elsevier, Amsterdam, Netherlands in June 2016.
- Dr. S.K. Gupta, Scientist received Certificate of Reviewing from the editors, in recognition to the review made for Journal Fish and Shell Fish Immunology, Elsevier, Amsterdam, Netherlands in June 2016.
- Dr. Vinay T.N., Scientist awarded Early Career Research Award from Science and Engineering Research Board (SERB), Department of Science and Technology (DST). Award includes research

grant of Rs. 49, 93,056.0 (Rupees forty-nine lakh ninety-three thousand and fifty-six only) for a duration of three years.

- Sh. S.K. Lal, Scientist received Young Scientist Award for outstanding contribution in Biotechnology on the occasion of National Conference on Agriculture and Rural Innovations for Sustainable Empowerment during May 21-22, 2016 held at Kakaitya University, Bala Vikasa, Warangal, Telangana.
- Dr. B.K. Singh, Sr. Scientist received Distinguished Scientist Award for outstanding contribution in Biotechnology on the occasion of National Conference on Agriculture and Rural Innovations for Sustainable Empowerment during May 21-22, 2016 held at Kakaitya University, Bala Vikasa, Warangal, Telangana.
- Dr. A.K. Singh, Sr. Scientist awarded mentorship for a research project proposal entitled "Screening of various lentil (*Lens culinaris* L.) genotypes for drought tolerance using physiological and molecular approaches", granted to Dr. Ragini Sinha under SERB-National Post-Doctoral Fellowship (N-PDF) by SERB, Department of Science & Technology (DST), Government of India with ICAR-IIAB as host institution.
- Dr. S. Naskar, Sr. Scientist awarded mentorship for a research project entitled "Characterization of molecular marker(s) associated with X- and/or Y-chromosome bearing spermatozoa in cattle", granted to Dr. Laxmi Vandana Rongala under SERB-National Post-Doctoral Fellowship (N-PDF) by SERB, Department of Science & Technology (DST), Government of India with ICAR-IIAB as host institution.

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BUDGET ALLOCATION AND UTILIZATION DURING 2015-16

(Rs. In Lakhs)

S. No.	Head	Plan			Non-Plan		
		B.E. 2015-16	R.E. 2015-16	Total Expenditure	B.E. 2015-16	R.E. 2015-16	Total Expenditure
1	2	3	4	5	6	7	8
Grants for Creation of Capital Assets (CAPITAL)							
1	Works	0.00	0.00	0.00	0.00	0.00	0.00
	A. Land	0.00	0.00	0.00	0.00	0.00	0.00
	B. Building	0.00	0.00	0.00	0.00	0.00	0.00
	i. Office building	1888.00	45.00	44.43	0.00	0.00	0.00
	ii. Residential building	0.00	0.00	0.00	0.00	0.00	0.00
	iii. Minor works	0.00	0.00	0.00	0.00	0.00	0.00
2	Equipment	3.00	28.00	25.84	0.00	0.00	0.00
3	Information Technology	5.00	3.00	1.55	0.00	0.00	0.00
4	Library Books and Journals	0.00	3.00	2.23	0.00	1.00	0.00
5	Vehicles & Vessels	0.00	12.00	0.00	0.00	0.00	0.00
6	Livestock	0.00	0.00	0.00	0.00	0.00	0.00
7	Furniture & Fixtures	4.00	9.00	8.58	0.00	0.00	0.00
8	Others	0.00	0.00	0.00	0.00	0.00	0.00
	Total-CAPITAL (Grants for creation of Capital Assets)	1900.00	100.00	82.63	0.00	1.00	0.00
Grants in Aid - Salaries (REVENUE)							
1	Establishment Expenses	0.00	0.00	0.00	0.00	0.00	0.00
	A. Salaries	0.00	0.00	0.00	90.00	122.50	121.46
	i. Establishment Charges	0.00	0.00	0.00	0.00	0.00	0.00
	ii. Wages	0.00	0.00	0.00	0.00	0.00	0.00
	iii. Overtime Allowances	0.00	0.00	0.00	0.00	0.00	0.00
	B. Loans and Advances	0.00	0.00	0.00	0.00	2.00	0.00
	Total-Establishment Expenses (Grants in Aid - Salaries)	0.00	0.00	0.00	90.00	124.50	121.46
Grants in Aid - General (REVENUE)							
1	Pension & Other Retirement Benefits	0.00	0.00	0.00	0.00	0.00	0.00

S. No.	Head	Plan			Non-Plan		
2	Travelling Allowance						
	A. Domestic TA/ Transfer TA	6.00	13.00	12.95	0.00	1.50	0.35
	B. Foreign TA	0.00	0.00	0.00	0.00	0.00	0.00
	Total - Traveling Allowance	6.00	13.00	12.95	0.00	1.50	0.35
3	Research & Operational Exp.						
	A. Research Expenses	0.00	34.45	34.41	0.00	0.00	0.00
	B. Operational Expenses	25.00	9.00	9.00	0.00	0.00	0.00
	Total - Res. & Operational Exp.	25.00	43.45	43.41	0.00	0.00	0.00
4	Administrative Expenses						
	A. Infrastructure	18.00	23.20	23.12	0.00	0.00	0.00
	B. Communication	0.00	0.80	0.80	0.00	0.00	0.00
	C. Repair & Maintenance	0.00	0.00	0.00	0.00	0.00	0.00
	i. Equipment, Vehicle & Others	0.00	0.00	0.00	0.00	0.00	0.00
	ii. Office building	0.00	0.00	0.00	0.00	0.00	0.00
	iii. Residential building	0.00	0.00	0.00	0.00	0.00	0.00
	iv. Minor Works	0.00	3.75	3.71	0.00	0.00	0.00
	D. Other (excluding TA)	15.00	13.80	13.80	0.00	0.00	0.00
	Total - Administrative Expenses	33.00	41.55	41.43	0.00	0.00	0.00
5	Miscellaneous Expenses						
	A. HRD	1.00	1.00	0.93	0.00	0.00	0.00
	C. Other items (Fellowships, Scholarships etc.)	0.00	0.00	0.00	0.00	0.00	0.00
	D. Publicity & Exhibitions	0.00	0.00	0.00	0.00	0.00	0.00
	E. Guest House - Maintenance	0.00	0.00	0.00	0.00	0.00	0.00
	F. Other Miscellaneous	5.00	1.00	0.98	0.00	0.00	0.00
	Total - Miscellaneous Expenses	6.00	2.00	1.91	0.00	0.00	0.00
	Total Grants in Aid - General	70.00	100.00	99.70	0.00	1.50	0.35
	Total Revenue (Grants in Aid - Salaries + Grants in Aid - General)	70.00	100.00	99.70	90.00	126.00	121.81

S. No.	Head	Plan			Non-Plan		
	Grand Total (Capital + Revenue)	1970.00	200.00	182.33	90.00	127.00	121.81
*	Tribal Sub-Plan Expenditure	0.00	0.00	0.00	0.00	0.00	0.00
*	NEH Expenditure	0.00	0.00	0.00	0.00	0.00	0.00
*	Non-Plan Scheme Expenditure with name	0.00	0.00	0.00	0.00	0.00	0.00

Name of Plan Scheme/AICRP/Network Project etc.	B.E. 2015-16	R.E. 2015-16	Expenditure
1	2	3	4
National Agriculture Innovation Fund (NIAF)	6.00	6.00	1.83

IMPORTANT COMMITTEES

RESEARCH ADVISORY COMMITTEE (RAC)

Prof. V.L. Chopra, Former Secretary, DARE & DG, ICAR, New Delhi	Chairman
Prof. K. Veluthambi, Former Head, Department of Plant Biotechnology, School of Biotechnology, Madurai Kamraj University, Madurai	Member
Prof. K. R. Koundal, Former Joint Director (IARI), Scientist Emeritus, ICAR-NRCPB, New Delhi	Member
Dr. W.S. Lakra, Former Director, ICAR-Central Institute of Fisheries Education, Mumbai	Member
Dr. B.P. Mishra, Joint Director (Research), ICAR-Indian Veterinary Research Institute, Izzatnagar, Bareilly	Member
Prof. H.S. Dhaliwal, Former Professor of Biotechnology, IIT, Roorkee Vice Chancellor, Eternal University, Baru Sahib, Sirmour, Himachal Pradesh	Member
Director, IIAB, Ranchi	Member
ADG (Seed), ICAR, New Delhi	Member
Two persons representing agricultural/rural interests on the management committee of the Institute in terms of Rule 66(a)(5)	Member
Dr. V.P. Bhadana, Principal Scientist, IIAB, Ranchi	Member Secretary

INSTITUTE MANAGEMENT COMMITTEE (IMC)

Dr. K.K. Sharma, Director, ICAR-IIAB & Director, ICAR-IINRG, Ranchi	Chairman
Dr. Kishor Gaikwad, Principal Scientist, NRCPB, New Delhi	Member
Dr. J.C. Rana, Head, Division of Germplasm Evaluation. NBPGR, New Delhi	Member
Dr. Vindhya Mohindra, Head, Fish Conservation Division, NBFGR, Lucknow	Member
Dr. Anil Rai, Head, IASRI, New Delhi	Member
ADG (Seeds) ICAR, New Delhi	Member Secretary

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Dr. K.K. Sharma, Director, ICAR-IIAB & Director, ICAR-IINRG, Ranchi	Chairman
All Scientific Staff of ICAR-IIAB, Ranchi	Members
Dr. N.K. Sinha, Senior Scientist, ICAR-IIAB, Ranchi	Member Secretary

DISTINGUISHED VISITORS

S. No.	Name	Designation	Date of Visit
1	Smt. Droupadi Murmu,	Hon'ble Governor of Jharkhand	Feb. 10, 2017
2	Shri Sudarshan Bhagat,	Hon'ble Minister of State, Ministry of Agriculture & Farmers Welfare, Govt. of India,	Mar. 26, 2017
3	Shri Subrata Mandal	Chief General Manager, NABARD, Ranchi	Mar. 26, 2017
4	Dr. C.D. Mayee	Former Chairman, ASRB, ICAR, New Delhi	Jul 30-31, 2016
5	Dr. N.K. Singh	National Professor, ICAR-NRCPB, New Delhi	Jul 30-31, 2016
6	Dr. J.S. Chauhan	ADG (Seed), ICAR, New Delhi	Jul 30-31, 2016
7	Dr. George John	Vice Chancellor, BAU, Ranchi	Jul 30-31, 2016
8	Dr. Alok K. Sinha	Scientist VI, NIPGR, New Delhi	Sep. 23, 2016
9	Dr. Manoj Prasad	Scientist VI, NIPGR, New Delhi	Oct. 20, 2016

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