# वार्षिक प्रतिवेदन
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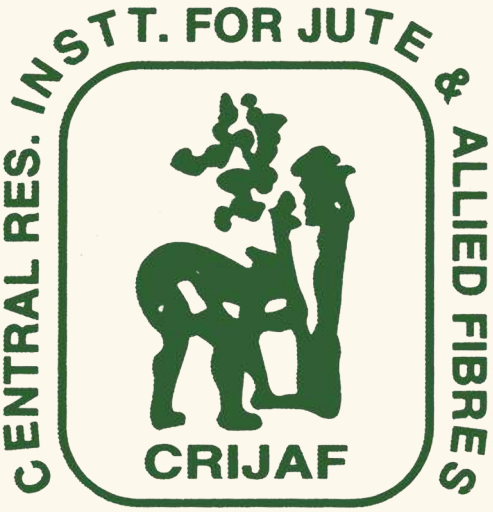


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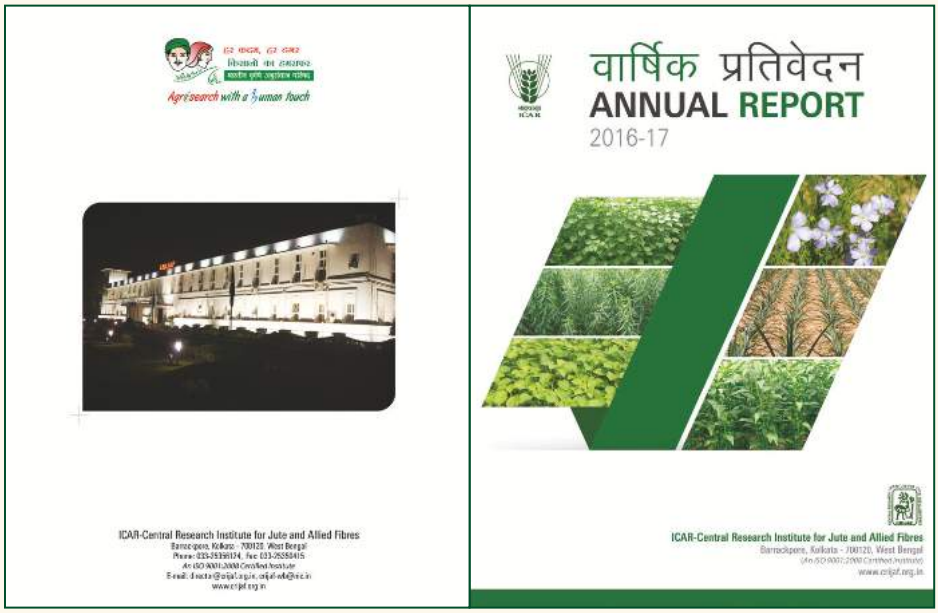


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# Contents

# Preface

The jute acreage in the country always witnesses fluctuation mostly due to the extent and time of onset of summer rain, trend of raw jute price in the previous season and the returns realized from competing crops. The real challenges in jute research are to make its cultivation a competitive venture with other crops. In recent years development and promotion of new varieties, small farm implements and the microbe-mediated retting technology have made a mark in improving the productivity of raw jute. The share of new varieties of JAF developed by ICAR-CRIJAF in the seed chain has increased considerably indicating significant varietal replacement. This year five varieties of jute and allied fibre crops viz., JRO 2407 (Samapti) of tossa jute, JRC 9057 (Ishani) of white jute, JRKM 9 1 (Satyen) and Central Kenaf JBMP 2 of kenaf and CRIJAFR 5 (Roselle Ratna) of roselle have been released and notified by the Central Sub-Committee on Crop Standard, Notification and Release of varieties for commercial cultivation.

Major milestone achieved in jute genomic research is the sequencing of the draft genome of Corchorus olitorious cv. JRO-524 (Navin) which identified a total of 57,087 protein-coding genes and a large number of disease resistance-like and defence response genes in the jute genome. This work coupled with hypocotyl transcriptome analyses have improved understanding of the molecular basis of major biosynthetic pathways in jute, viz., hemicellulose biosynthesis, starch and sucrose metabolic pathway, amino-sugar and nucleotide-sugar metabolism pathways. This has not only helped our understanding about bast fibre biogenesis, but also provides the platform for application of genomic technologies for improvement of fibre. New set of polymorphic molecular markers have been developed in allied fibres like flax and sunnhemp, and analyses of population structure and genetic polymorphisms with these markers are expected to provide the much required boost in application of molecular breeding in these two crops.

Technological interventions to reduce the cost of cultivation is still a challenge in jute cultivation. Experimental model of power operated seed drill for line sowing of jute and other small-seeded crops with field capacity of 0.28-0.30 ha/hr has been standardized. CRIJAF-single wheel jute weeder has been designed for the mechanical weeding of young composite weed flora in line-sown jute and other similar crops. These developments will certainly deliver applied technologies having direct impact on productivity and reduction in cost of cultivation.

In chemical profiling of jute stem weevil, Apion corchori, hairy caterpillar, Spilosoma obliqua and semilooper, Anomis sabulifera pheromones, altogether 7 compounds of diverse chemical characteristics and molecular weight with specific beahaviour modifying properties have been identified. Fungicidal activity of ZnO, CuO and silver nanoparticles against stem rot in jute seedlings was established. However, ZnO nanoparticles (10 nm) were most effective which could completely suppress the pathogen even at 0.01 ppm concentration. Such information will form the basis for applied research in pheromone and nanotechnology for monitoring and formulating advance pest and disease management technologies in jute.

Jute column based vegetable cultivation technology has established as the means for crop diversification and enhancing the cropping intensity in jute based cropping system. Besides, the green gram-jute intercropping has proved to be very economical in weed suppression and increasing the system productivity. Both the technologies are very simple, cost effective and quite climate resilient.

Realizing the higher adoption and future requirement of 'CRIJAF SONA', the institute emphasized to commercialize the microbial retting consortium to meet the demand from Assam. Institutional strengthening for promotional activities for jute cultivation got big boost as the new KVK North 24 Parganas became functional in the North Farm campus of CRIJAF. The ambitious target for dissemination of CRIJAF technologies through jute- ICARE may touch one lakh farm families this year. The scientists groups have implemented the MGMG programme in designated villages and also highlighted the flagship programmes of the Government for the farmers.

I acknowledge the efforts of the scientists of ICAR-CRIJAF who have done a commendable job to accomplish the volume of research and documentation work successfully. I am grateful to Dr. Trilochan Mohapatra, Hon'ble Director General, ICAR for his leadership and direction. I express my sincere gratitude and thanks to Dr. J.S. Sandhu, Deputy Director General (Crop Science) and Dr. R.K. Singh, Assistant Director General (Commercial Crops), ICAR, New Delhi for their constant encouragement and support.

Place: Barrackpore
Date: 25.06.2017

(Jiban Mitra)
Director, ICAR-CRIJAF

# Executive Summary

## Crop Improvement

A total of 2268 germplasm accessions (*Corchorus* spp., 2042; *Hibiscus* spp., 78; *Crotalaria* spp., 148) have been regenerated. The genepool of ramie was enriched with 10 germplasm accessions of *Boehmeria* spp. collected from Assam, Meghalaya and Nagaland. Significant genotype X environment interaction for disease response was revealed in 1227 *C. olitorius* accessions. A population has been developed by crossing a natural flowering mutant PIN with JRO 524, JRO 204 and 46 $F_3$ families were selected for delayed flowering trait. During 4 year evaluation of 130 flax accessions, a delayed flowering flax accession (LIN 056) with early pod maturity was identified and population structure analysis of flax accessions was done using qualitative traits and SSR markers.

In tossa jute, 192 F5:6 inter-specific populations derived from *C. olitorius x C. aestuans* exhibited high variability for fibre fineness and 18 lines resistant to pre-mature flowering were selected. A total of 43 superior lines were developed from progenies of four inter-specific cross-combinations, JRO 8432 x *C. pseudo-capsularis*, S 19 x *C. trilocularis*, S 19 x JRC 212, Chinsura Green x CIJ 143 and JRO 8432 x *C. trilocularis*. The average fibre yield of the selected lines ranged from 30.5-33.3 q/ha.

Morphological, histological and molecular characterisation was done for 588 pedigreed mutant population of tossa jute. Registration proposal was submitted to ICAR-NBPGR for five unique mutants having qualitative and quantitative traits of agronomic importance. Out of 158 $F_3$ *C. olitorius* genotypes evaluated for morphological and fibre anatomy characters, three mutant genotypes have been registered with NBPGR for different superior fibre anatomy characters.

An interspecific hybrid was derived between stem rot resistant accession WCIN-136 (*Corchorus aestuans* L.) and susceptible accession OIJ-248 (*Corchorus olitorius* L.). $F_1$ hybridity was confirmed with morphological and molecular markers. Out of 217 $F_2$ plants screened for stem rot resistance, 42 $F_2$ plants were identified as resistant and 175 F2 plants as susceptible. Chi square test indicated single recessive gene responsible for disease resistance.

Two years evaluation against stem rot and hairy caterpillar categorised *C. capsularis* accessions CIM-13, CIM-50, CIN-348 and CIN-429 as resistant to hairy caterpillar and CIN-109, WCIN-136 as resistant and CIN-002, CMU-002 as moderately resistant to stem rot disease.

During 2016-17, two new white jute varieties viz., KJC 7, JRCM-2, five *tossa* jute varieties viz., JROM-1, NJ 7055, NJ 7010, NJ 7005, NJ 7050 and two farmer's varieties viz., Cheka Pat and Kamra Pat were tested under DUS testing. The candidate varieties KJC 7, NJ 7055 were not found to be distinct from two reference varieties and another candidate variety NJ 7050, two farmer's varieties were not characterised for DUS descriptors.

For DNA finger printing of jute varieties, out of 75 jute EST-SSR markers, only 21 were found to be polymorphic in *C. olitorius* varieties and 27 in *C. capsularis* varieties. All the capsularis varieties were differentiated with polymorphic markers but among olitorius varieties, JRO 204, JRO 2407, S 19, JROG 1, Tarun, IRA, TJ 40 and Chinsura Green could not be differentiated with polymorphic markers.

In kenaf, a bulked population derived from interspecific hybridization has been advanced to F7 generation with directional selection for cultivated plant type and tall plant height. Deep red with tall stem and green stem with tall phenotype were selected. For induction of mutation and estimation of $LD_{50}$ dose, three genotypes of kenaf were irradiated to 7 different doses of gamma ray. A dose of 65 kRAD was considered as the $LD_{50}$ dose for kenaf.

In kenaf, out of 75 lines evaluated, nine accessions namely, KIN-085, KIN-147, KIN-148, KIN-149, KIN-154, KIN-156, KIN-168, KIN-170 and KIN-175 were found superior to check varieties. Further a 10 x 10 half diallele crossing was attempted using these nine germplasm lines and cultivated variety MT 150.

In roselle, seven accessions namely AR-23, AR-13A, AS-80-1, AS-80-3, ER-79, REX-5 and REX-62) were found exceeding best check variety HS 4288 (6.88%) for fibre recovery percentage. Based on plant height and basal diameter, 50 promising progenies from 17 $F_6$ and 45 single plants from 14 $F_2$ populations of roselle were selected.

In roselle, three lines suitable for leafy vegetable purpose and three for calyx purpose were selected and nominated for IET of AINPJAF for 2017-18. Besides, three elite lines of roselle (Extra-long calyx 2014-1, HSLC-2-1, HSLC-3-3) were found consistently superior in calyx length over check HS-4288 across four growing seasons.

In sunnhemp, 44 accessions were characterised for eleven agro-morphological traits and three early-flowering (day neutral) accessions SIN 01, SIN 26 & SIN 30 were identified, which can flower in 32-33 days under short day conditions and 42-45 days under long day conditions.

## Seed Science and Technology

In *tossa* jute, seed coating with Lite fleck red polymer @ 16 g/kg seed had no adverse effect on seed germination. Further seed coating with polymer+insecticide+fungicide increased seedling vigour significantly and also enhanced fibre yield. In mesta, crop sown in mid-September with a fertilizer

dose of NPK 80:40:40 kg/ha and foliar spray of fungicide i.e. carbendazim at pod maturation stage effectively increased healthy disease free seed yield.

A total of 13.04 q breeder seed of 11 varieties of jute, 2 varieties of mesta and 1 variety of sunnhemp were produced. Besides, 3.59 q nucleus seeds of released varieties of jute, mesta and sunnhemp were also produced. Under mega seed project, 827.6 q seeds of different crops were produced. In addition, planting materials of sisal and ramie were also produced and distributed to the farmers.

## Biotechnology

Unigenes identified from hypocotyl transcriptomes were mapped to major biosynthetic pathways in jute, viz. hemicellulose biosynthesis, starch and sucrose metabolic pathway, amino-sugar and nucleotide-sugar metabolism. A total of 200 and 232 unigenes were mapped to starch and sucrose metabolic pathway in *C. capsularis* cv. JRC-212 and its mutant dlpf respectively.

Twelve isoforms of β-galactosidase (BGAL) were identified in hypocotyl tissues of *C. capsularis* cv. JRC-212 and its mutant dlpf. Phylogenetic analyses of BGAL isoforms showed sequence homologies to those of *Linum usitatissimum*, *Vitis vinifera*, *Arabidopsis thaliana*, *Ricinus communis* and *T. cacao*.

RNA-seq analysis was carried out in Sunnhemp for marker discovery and self-incompatibility gene identifications. 3,591 non-redundant SSR primers consisting of di, tri and tetranucleotide repeats from 10,199 SSR loci and 4,769 putative Intron Linked Polymorphism (ILP) markers were discovered for validations. A non-redundant set of 6,037 intron-linked polymorphism markers were mined from 34,163 jute unigene sequences.

Functional gene derived simple sequence repeat (SSR) markers from transcription factor coding genes and long non coding RNA sequences were developed in flax. A non-redundant set of 580 SSR markers were used to analyze population structure and genetic polymorphisms among the 93 fibre flax accessions and two clusters were obtained.

An in-vitro shoot and root regeneration systems was developed in tossa jute (*Corchorus olitorius*) for transformation with genes conferring herbicide tolerance. Jute EPSPS genes were characterized and potential targets for mutation and genome editing were identified. An efficient in-vitro plantlet regeneration and in-planta floral-dip transformation protocol was developed in flax (*Linum usitatissimum*).

Clonal fidelity test of ramie mericlones of in vitro micropropagated plantlets was done using RAPD & ISSR primers and polypeptide profiling to confirm true to type nature. DNA fingerprinting for roselle varieties was done using EST SSR and SRAP markers.

## Soil and Nutrient Management

Study on long-term effect of continuous fertilizer application alone or in combination with FYM significantly increased the yield of jute, rice and wheat. The 150%NPK treatment was at par with the application of 100%NPK+FYM in all three crops. NPK uptake by jute, rice and wheat increased with increasing dose of fertilizer. Integrated use of organic manure and chemical fertilizers resulted in a positive influx of nutrients thereby increased OC, available nitrogen, available phosphorus and available potassium in the soil.

Simulation of 40 years data for study on carbon sequestration under jute based agro-ecosystem indicates that the SOC content increases slightly at the first 20 years and then it decreases gradually under NPK fertilizer application alone. SOC contents were slightly increased from its initial value and maintained the increased value under NPK100+FYM treatment. The result shows that fertilizer management systems, which include FYM, have more capacity to recover the soil carbon. The initial SOC content had a large effect on the SOC recovery capacity.

Study on depletion/build-up of S in the mesta and jute growing soil revealed that sulphur build-up was more in surface soils as compared to lower soil depths. Sulphur utilisation was higher in mesta as compared to jute crop.

Field experimentation on conservation tillage with or without residue under selective jute based cropping systems indicates maximum SOC content under jute-rice-lentil followed by jute-rice-wheat and jute-rice-potato. SOC was the major contributor to soil aggregate formation. However, the crop yield in conventional tillage was higher over conservation tillage.

Study of soil health characterization and carbon sequestration potential of ramie based cropping system indicates that SOC and nutrient content decreased with increase in depth.

In controlled condition, maximum shoot and root length was recorded with OIJ 008 germplasm both at low nitrogen and optimum nitrogen levels. Under field condition, olitorius germplasm OMU 008 recorded maximum plant height, basal diameter, yield and total dry weight at highest N level as well in absence of applied N.

## Crop Husbandry

Jute-rice-baby corn cropping system recorded higher system productivity (205q/ha). Whereas, higher carbon management index (60.8) was recorded in jute-rice-mustard and mung bean cropping system. Application of 100% recommended dose of fertilizer and incorporation of crop residue recorded higher system productivity, labile and non-labile carbon and carbon management index (57.11) as compared to lower doses of nutrient with and without crop residue incorporation.

Furrow sown jute crop with application N:$P_2O_5$:$K_2O$::60:30:30 kg/ha and one irrigation recorded higher yield (26.0 q jute fibre/ha) and water productivity (1492 litre water/kg fibre). Line sown crop and application of single irrigation followed by one nail weeding at 5 days after crop emergence (DAE) for soil mulching with RDF (N:$P_2O_5$:$K_2O$::60:30:30) produced 32.30 q jute fibre/ha. Application of N:$P_2O_5$:$K_2O$::60:30:30 kg/ha with one irrigation and mung waste @ 2 t/ha produced 37.4 q fibre yield/ha and water productivity was 1035 litre water/kg fibre.

Rice (*kharif*) field was diversified with intercrop of vegetables and pulses sown in reinforced soil columns. An yield of about 3.0 tonnes of rice, 173 q pumpkin, 210.5 q bottle gourd, 24.8 q bitter gourd, 125 q brinjal, 18.8 q arhar, 24 q radish, 26 q kharif spinach, 78.42 q white amaranth, 9.9 q ginger was recorded in unit of 1 ha. Highest return per unit cost was obtained from cucurbits followed by arhar and other green vegetables. This system in summer produced 4.5 t/ha rice, along with cabbage (51q/ha), carrot (28.3 q/ha), brinjal (152 q/ha), tomato (69 q/ha) coriander (9.3 q/ha), onion (12.3 q/ha), summer radish (33 q/ha) and chilli (11.8q/ha).

Among different MAPs cropping sequences, maximum jute equivalent yield (86.24 q/ha) was recorded in jute-kharif rice-asalio followed by jute-kharif rice-menthol mint (74.5 q/ha). Fertilizer treatment i.e. RDF+5t FYM recorded 14.02% higher yield than only with RDF. Asalio in jute based cropping system jute-kharif rice-asalio recorded highest net return of Rs 1,48,151 per ha.

## Biotic and Abiotic Stresses

In chemical profiling of jute stem weevil, *Apion corchori*, hairy caterpillar, *Spilosoma obliqua* and semilooper, *Anomis sabulifera* pheromones, altogether 7 compounds of diverse chemical characteristics and molecular weight have been identified through Gas Chromatography - Mass Spectrometry (GC-MS) studies. The compounds showed specific behavior-modifying effect on these pests (3 for stem weevil, 2 for hairy caterpillar and 2 for semilooper). GC-MS analysis of headspace volatile organic compounds (VOCs) extracted from 5 wild and 1 cultivated jute species confirmed the presence of 12 compounds with specific behaviour modifying property imparting resistance/susceptibility to insect pests.

Endophytism of entomopathogenic *Lecanicillium lecanii* isolates in jute plant caused due to seed treatment was detected by PCR with *L. lecanii*-specific primers and fluorescence microscopy. Molecular identification of new *Beauveria bassiana* (Bb) isolate obtained from dead mealy bug confirms its distinctness from other existing Bb strains. A multiplex PCR assay was optimized to identify different fungal strains from dead mealy bug sample.

On the basis of mite population, egg density and mite days the jute varieties JRO 524, JRO 204 and JBO 1c were identified to be less susceptible whereas JROM 1 and JRO 2407 were highly susceptible with higher expression of damage symptoms. The mite on the jute plants grown in soil treated with sulphur had relatively less mite compared to the plants grown in untreated soil. The mite population on leaves was significantly less in higher dosages of S application in soil.

The impact of variable temperature i.e., at 25, 30 and 35$^{O}$C on mealybug, *Phenacoccus solenopsis* indicated significant reduction in nymphal duration with increase in temperature. Although the fecundity was high in higher temperature, the overall population growth may not be proportional as the female longevity was significantly reduced at this temperature.

Among the talc based formulation of 3 entomopathogens i.e., *Lecanicillium lecanii* (Ll), *Paecilomyces fumosoroseus* (Pf) and *Beauveria bassiana* (Bb) at 4X10$^8$ CFU/l and 6X10$^8$ CFU/l concentrations, the infectivity of Pf was significantly high on yellow mite under laboratory condition.

Five different types of symptoms of stem rot based on lesion characteristics were observed in the field collected diseased plants. As per the colony characteristics, fungi associated were broadly grouped into six categories. Based on RFLP, similarity between the fungi of second and third groups and those from fourth and fifth group was confirmed. Most of the groups were highly sensitive to Tebuconazole.

The nanoparticles of ZnO, CuO and silver with average diameters of 10 nm, 30 nm and 6.5 nm, respectively evaluated against stem rot in jute seedlings indicated absolute check on disease incidence through CuO nanoparticles is possible @ 0.5 ppm. Whereas, the nanoparticles of ZnO were most effective which could completely suppress the pathogen even at 0.01 ppm concentration.

In co-inoculation study of stem rot pathogen and bio-agent, the *Trichoderma viride* strain, TVC 1 inhibited the lesion size up to 47% till 30 days after inoculation exhibiting significantly highest disease control potential. On the basis of in vitro growth inhibition of *Trichoderma* strains by different fungicides at different period of incubation, tricyclazole was identified to be the best compatible fungicides with *Trichoderma* followed by copper oxychloride and moximate.

ST with carbendazim 50WP followed by one foliar spray at 45 DAS in jute crop was most effective in preventing the stem rot disease. However, pre-sowing soil application of bleaching powder performed better than two modes of application of fungicides.

The incidence of zebra disease in sisal plantations of Jharsugura, Sambalpur and Sundargarh district of Odisha was 14.9 to 37.3% in *Agave sisalana* and 25.5 to 50.3% in Bamra Hybrid-1. In nursery stage, disease severity ranged from 3.4 to 47.1% in *Agave sisalana* and 3.0 to 50.6% in Bamra Hybrid-1. Fosetyl–Al @2.5g/l exhibited the best control of the disease.

Weed density and diversity was highly correlated with soil N, P and soil organic carbon. Higher weed density was recorded in 100% NPK + FYM compared to control and 100% NPK. Economic threshold of *Cyperus rotundus* in jute was calculated to be 14/m$^2$ at about 3% of fibre loss. Critical period of weed control (CPWC) was estimated under different sowing method of jute. CPWC for broadcasted , line sown, furrow sown and paired row sown was 9- 42 DAS, 10-34 DAS, 11-24 days and 10-24 DAE, respectively, at 5% fibre loss.

Ipfencarbazone as pre-emergence herbicide recorded 77, 95 and 72 % lower grass, broad leaved and sedges density, respectively. Among the post-emergence herbicides, application of quizalofop ethyl 10 EC @ 38 g/ha with one manual weeding was best in suppressing the weeds and enhancing the yield.

The dominant weeds in flax crop were *Cyperus rotundus* L., *Chenopodium album* L., *Coronopus squamatus*, *Convolvulus arvensis* L., *Anagalis arvensis* L., *Vicia sativa* L. etc. Significantly lowest weed density was observed with the pre-emergence application of pendimethalin 30 EC @ 1.00 kg a.i./ha being at par with 0.75 kg a.i./ha dose.

As per rainfall and temperature data of 30 years (1982-2012), there was a rainfall variability of 1.53%, 80% and 86% during summer, kharif and rabi season, respectively. The jute yield shows an increasing trend of summer rainfall and increase in temperature (+0.3 ℃) after the year 1992, whereas wheat productivity decreased due to decline in rainfall and increase in temperature (+1.3 to +3.4 ℃) during rabi season. Rice production shows insignificant correlation with monsoon rainfall.

## Farm Mechanization and Post-Harvest Technology

Experimental model of power operated seed drill for line sowing of jute and other small seeded crops with field capacity of 0.28-0.3 ha/hr has been standardized. CRIJAF-single wheel jute weeder has been designed for the mechanical weeding of young composite weed flora in line sown jute and other similar crops. Weeding with this tool reduces drudgery and labour cost.

Fibre from the ribbons extracted with manual jute extractor exhibited 10-20% more strength than other machines for both jute and mesta. The fibre strength of vertically retted ribbon was declined by 7% and 40% for jute and mesta, respectively compared to horizontal retted ribbons. The average fibre fineness of 2.8 to 3.4 tex was obtained with ribbon retting. Retting of raw jute with bacterial endospores reduced the retting duration to10 days, improved the fibre strength and fibre fineness.

The consortium of the alkalophillic strains (MTCC 5891 and MTCC 5892) has degumming efficiency comparable to chemical method. Other parameters of microbial degumming like residual gum, pectin content and the tensile strength were also comparable to chemical degumming.

## Jute and Allied Fibre Informatics

A web-based database management system (DBMS)-cum-agroadvisory system has been developed for storing, updating, retrieving, and analysing the long-term temporal and spatial climatic data for agricultural advisory services to the farmers with special emphasis on jute growers.

JAFexpert is a web-based three-tier expert system introduced and developed by ICAR-CRIJAF containing information on jute and allied fibre crops growing practices. The website is now available at URL: http://jafexpert.crijaf.icar.gov.in/. The database of expert system for jute and allied fibre crops has been updated on the basis of recent developments in technologies.

Large number of unigene-driven SSR markers have been developed from the existing jute genomic resources and integrated in a user-friendly database, named "JuteMarkerdb" along with detailed information on these markers. The jute breeders, biotechnologists and students can easily access the freely available database for characterization of jute germplasm and varieties, and molecular breeding.

## Technology Assessment and Transfer

The FLDs on different improved technologies exhibited the highest fibre yield of jute in the variety JRO 204 (30.35 q/ ha) followed by JRO 524 (26.53 q/ha) irrespective of the locations. Mechanical weeding by nail weeder improved the yield by 2.48-3.15 q/ha over farmers' practice (25.94-26.12 q/ha). This practice was also effective in soil mulching and reducing the adverse effect of drought. Application of CRIJAF Sona for retting could improve the quality of fibres (TD 3 & 4), reduced retting duration (6-10 days) and compatible to their production system. All these technologies reduced the cost of cultivation, increased the fibre yield, quality and net return. Line sowing through manual 4 row seed drill improved the fibre yield by 1.60-2.63 q/ha and saved the cost of human labour to the extent of Rs. 5,107-6,066/ha over farmers practice.

Adoption of CRIJAF technologies had positive impact on jute cultivation as evidenced from increase in average productivity (20.5%), fibre grade improvement (1–2 grade), additional return (350-500/q) due to better grade and thereby increased farmers' income.

In agro-economic studies of tribal farmers, it was recoded that the improved production technologies increased the jute yield by 39.4%, in lentil by 30.7% with higher net return per rupee investment (1.33), better than jute (1.16). The goat rearing activity by the tribal farm women was the most beneficial venture with maximum NRPRI of 3.84.

Balanced fertilizer application (95%) and weed management using herbicide (67%) was adopted by majority of jute growers followed by line sowing through Multi Row Seed Drill (28.3%). The major constraints for non-adoption of technologies were non-availability of improved CRIJAF varieties (89.2 %), Nail Weeder (85.3%) and Multi Row Seed Drill (80%) in local market.

## Tribal Sub Plan

Under Tribal Sub Plan (TSP) programme, a series of activities were undertaken with the objective to enhance livelihood security of tribal farm families through integration of jute and allied fibres based cropping system, livestock, poultry & duckery farming, and fishery in West Bengal, Odisha and Assam. In total 1416 tribal farm families were benefited through such activities.

Under All India Network Project on Jute and Allied Fibres the TSP programme were also taken up by AINP units of BCKV Kalyani, UBKV Coochbehar, JRS Kendrapara and RARS Nagaon in 9 villages belong to 5 districts of West Bengal, Assam and Odisha covering 59 ha area of 288 tribal farm families. FLD and training on paddy and jute seed production were undertaken under TSP in Choubata and Ranjitpur village of district Bankura.

## AINP on J&AF

Nine varieties of jute and allied fibre crops viz., JRO 2407 (Samapti), KRO 4 and BCCO 6 (Kisan Pat) of *tossa* jute, KJC 7 (Shresthaa), JRC 9057 (Ishani) and AAUCJ 2 (Kkhyati) of white jute, JRKM 9 1 (Satyen) and Central Kenaf JBMP 2 of kenaf and CRIJAFR 5 (Roselle Ratna) of roselle have been released and notified by the Central Sub-Committee on Crop Standard, Notification and Release of varieties for commercial cultivation. Beside, one variety each in *tossa* jute (NJ-7010), kenaf (JBMP-3) and roselle (JRR-17) have been identified for central release during the 29$^{th}$ Annual Workshop of AINP on Jute and Allied Fibres.

Seventy-five accessions each of *tossa* jute, white jute and roselle and 51 germplasm of kenaf were evaluated with respective check varieties at various locations of JAF growing states. Hybridization programme at different centres was attempted and evaluation of crosses, selection of individual plants in various segregating generations and their seeds were done for further evaluation. Elite entries of jute and allied fibre crops were also evaluated under multi-location experiments comprising of IETs, AVT-Is, AVT-IIs and adaptive trials.

ST-TY based fertilizer & FYM application improved the B.C. ratio and achieved the targeted yield of mesta and rice with slight yield deviation. Application of pretilachlor 50 EC or butachlor with one hand weeding effectively reduced the weed biomass and recorded higher mesta fibre yield compared to unweeded control at Coochbehar, Nagaon, Amadalavalasa and Aduthurai. Jute + green gram intercropping system recorded the highest weed control efficiency (74.7 %).

Maximum seed yield of sunnhemp (19.6 q/ha) was recorded with spacing of 30 cm x 10 cm along with 20:40:40 kg NPK/ha at Rahuri, and with spacing of 60 cm x 15 cm with 20:60:60 kg NPK/ha at Aduthurai and Rahuri.

Survey and surveillance of insect pests and diseases revealed that yellow mite, semilooper, Bihar hairy caterpillar and stem weevil were the most common insect pests in jute. Infestation of indigo caterpillar and grey weevil was specific to Nagaon and Barrackpore centre, respectively. Stem weevil infestation was noticed in all the centers except Bahraich and Coochbehar, whereas jute semilooper infestation was observed at Barrackpore, Nagaon, Kendrapara and Coochbehar centre. Foliar application of Spiromesifen 240 SC at 35 DAS + Neem at 50 DAS or Spiromesifen 240 SC at 35 DAS and 50 DAS was found most effective for management of yellow mite in jute.

The maximum incidence of stem rot was observed from mid-June to September. Seed treatment with azoxystrobin + difenoconazole 325 SC + spraying of azoxystrobin + difenoconazole 325 SC at 45 DAS of crop age was most effective against stem rot disease. Mid–June sown seed crop of jute with fungicidal spray either at pod setting or pod maturation stage yielded maximum healthy seeds. Seed treatment with azoxystrobin (25% SC) @ 1.0 ml/kg was found to be effective against flax wilt. In mesta, foliar spray of profenophos @ 2ml/l at 35, 50 and 65 DAS was most effective against sucking pests at Amadalavalasa.

## Krishi Vigyan Kendra

OFTs on improved technologies for jute, pulses, paddy and fish production were conducted. Improved variety of jute (cv. JRO 204), onion (cv. Agrifound Red), brinjal (cv. Bhangar), oat (cv. JHO-822), berseem (cv. Mascavi) were demonstrated under FLD. Under NFSM and NMOOP programme, 97 FLDs on lentil and 153 demonstrations on green gram, 175 FLDs on mustard, 59 FLDs on groundnut and 281 FLDs on sesame were conducted. Altogether 190 trainings were conducted for farmers, farm women, rural youth and extension personnel including 2 vocational and 34 sponsored programmes. Under TSP, about 1250 tribal farmers and farm women were trained by the KVK. Skill development training (200 hrs.) was also organized for rural youth under Pradhan Mantri Kaushal Vikas Yojana (PMKVY).

# कार्यकारी सारांश

## फसल सुधार

पूर्व में संग्रहित 2268 जननद्रव्यों जिसमें पटसन के 2042, मेस्ता के 78 तथा सनई के 148 प्रभेद शामिल थे का पुनर्उद्भवन किया गया। असम, मेघालय व नागालैंड के इलाकों से संग्रहित किये गये 10 नये अनुवृद्धियों द्वारा रेमी के जीनपूल को समृद्ध किया गया। पश्चिम बंगाल व असम में पटसन के रोगों के प्रति उनकी प्रतिक्रिया जानने के लिए 1227 अनुवृद्धियों का मूल्यांकन करने पर ये देखा गया कि उनके जीनोटाइप व पर्यावण के बीच पारस्परिक क्रिया काफी महत्वपूर्ण था। विलंबित पुष्पन हेतु उत्परिवर्ति पी.आई.एन. को जे.आरओ.–524 तथा जे.आर.ओ.–204 से संकरण करा कर 46 एफ3 संततियों को चयनित किया गया। फ्लैक्स के 130 अनुवृद्धियों के चार वर्षों तक मूल्यांकन के उपरान्त एक अनुवृद्धि एल.आई.एन.–56 का चयन विलंबित पुष्पन हेतु किया गया जिसमें शीघ्र फली परिपक्वता देखा गया। ऐसे अनुवृद्धि का एस. एस.आर. तथा इ.एस.एस.आर. मार्कर द्वारा संरचनात्मक विश्लेषण किया गया है।

*सी. ऑलीटोरियस* तथा *सी. एस्टुएनस* के अंतर्जातीय संकरण से उद्भवित 192 एफ5:6 समुदायों में रेशा महीनता के प्रति काफी विविधता देखी गयी साथ ही ऐसे 18 वंशक्रमों को चयनित किया गया जिन्होंने पूर्व–पुष्पन रोधी लक्षण दिखाया था। पाँच अंतर्जातीय संकरणों (जे.आर.ओ. 8432 x *सी. स्युडोकैपसुलरिस*, एस 19 x *सी. ट्राइलोकुलेरिस*, एस.–19 x जे.आर.सी.–212, चिन्सुरा ग्रीन x सी.आई. जे.–143 एवं जे.आर.ओ.–8432 x *सी. ट्राइलोकुलेरिस*) के संततियों से विकसित 43 श्रेष्ठ लाइन्सों का चयन किया गया जिनका औसत रेशा उत्पादकता 30.5–33.3 कु./है. था।

तोषा पटसन के 588 उत्परिवर्ती संततियों के वाह्यसंरचना, उत्तकीय संरचना तथा आण्विक संरचना का विश्लेषण किया गया। शस्य महत्व वाले पाँच अनूठे उत्परिवर्तियों को पंजीकृत करने हेतु भाकृअनुप–एन.बी.पी.जी.आर. भेजा गया।

रेशा संरचना गुण के आधार पर *सी. ऑलीटोरियस* के 158 एफ3 जीनोटाइप्स में से तीन उत्परिवर्तियों को पंजीकरण करने हेतु भाकृअनुप–एन.बी.पी.जी.आर. को भेजा गया है।

तना सड़न रोधी जननद्रव्य डब्ल्यू.सी.आई.एन.–136 को तना सड़न ग्रहणीय जननद्रव्य ओ.आई.जे.–248 के साथ अंतर्जातीय संकरण द्वारा एक संकर विकसित कर उसे वाह्य संरचनात्मक एवं आण्विक मार्कर्स द्वारा पुष्टि किया गया। तना सड़न के प्रति 217 एफ2 पौधों को जाँच करने पर 42 एफ2 पौधे इसके प्रतिरोधी थे जबकि बाकि 175 एफ2 पौधे इसके प्रति ग्रहणीय पाये गये। सांख्यिकी विश्लेषणों से ज्ञात हुआ कि रोग प्रतिरोधता हेतु एकल रेसेशिव जीम उत्तदायी था।

*कैपसुलरिस* जननद्रव्यों का बिहार रोमिल सूंडी तथा तना सड़न रोग के प्रति दो वर्ष तक जाँच करने पर पाया गया कि सी.आई. एम.–13, सी.आई.एम–50, सी.आई.एन–348 तथा सी.आई.एन.–429 प्रभेद बिहार रोमिल सूंड़ी के प्रति रोधी थे जबकि सी.आई.एन.–109 तथा डब्ल्यू.बी.सी.आई.एन.–136 तना सड़न के प्रतिरोधी एवं सी.आई. एन.–002 और सी.एम.यू.–002 प्रभेद तना सड़न के प्रति सामान्य रोधी पाये गये।

वर्ष 2016–17 के दौरान क्रिजैफ मुख्यालय बैरकपुर तथा केन्द्रीय पटसन एवं समवर्गीय रेशा बीज अनुसंधान केन्द्र, बुद बुद में डी.यू. एस. परीक्षण के तहत सादा पटसन की दो (के.जे.सी. 7, जे.आर. सी.एम.–2), तोषा पटसन के पाँच (जे.आर.ओ.एम.–1, एन.जे. 7055, एन.जे.–7010, एन.जे. 7005, एन.जे.–7050) तथा कृषकों की दो प्रजातियों (चेका पाट, कामरा पाट) का उनके संदर्भित प्रजातियों के साथ परीक्षण किया गया। के.जे.सी.–7 व एन.जे.–7055 के सभी गुण उनके संदर्भित प्रजाति के समान ही थे तथा उनमें कोई भिन्नता नहीं देखी गयी।

केनाफ में अंतर्जातीय संकरण के पश्चात्, पौध लंबाई तथा कृषित क्षमता के आधार पर चयनित एक समुच्य को एफ$_7$ संतति में अग्रेसित किया गया। साथ–ही एक–एक जनसंख्या को क्रमशः लंबाई+लाल तना तथा लंबाई+हरा तना के आधार पर विकसित किया गया। केनॉफ के 3 जीनोटाइप में उत्परिवर्तन उत्पन्न करने तथा एल.डी.50 डोज के आक्कलन हेतु गामा किरणों के 7 डोज से उपचारित किया गया। केनॉफ के लिए 65 के आर.ए.डी. के एक डोज को एल.डी.50 डोज माना गया।

पटसन के प्रजातियों का डी.एन.ए. फिंगर प्रिंटिंग इ.एस.टी.–एस. एस. आर. मार्कर्स से करने पर देखा गया कि तोषा पटसन के 21 व सादा पटसन के केवल 27 प्रजातियाँ बहुरूपी गुणों वाली थी। सादा पटसन के सभी प्रजातियों में भिन्नता थी परंतु तोषा पटसन के जे. आर.ओ.–204, जे.आर.ओ.–2407, एस.–19, जे.आर.ओ.जी.–1, तरूण, ईरा, टी.जे.–40 तथा चिन्सुरा ग्रीन में कोई भिन्नता नहीं पायी गयी।

रोज़ेल के चेक प्रजाति एच.एस.–4288 की तुलना में सात अनुवृद्धियों का रेशा प्रतिशत बेहतर था। पौधा ऊँचाई (लंबाई) तथा बेसल आधारिय व्यास के आधार पर 17 एफ2 संततियों से 50 एफ6 तथा 14 एफ2 संततियों से 14 एकल पौध को चयनित किया गया। केनॉफ में चेक प्रजाति की तुलना में नौ अनुवृद्धियों का रेशा प्रतिशत तथा उत्पादकता बेहतर पाया गया जिन्हें 10 x 10 डायएलील संकरण हेतु प्रयुक्त किया गया।

रोजेल के 20 उन्नत लाईन्स में से तीन को साक–भाजी तथा तीन

को कैलिक्स प्रयोजन के उपयुक्त पाया गया। इन्हें अखिल भारतीय नेटवर्क परियोजना के आई.ई.टी. परीक्षण में शामिल किया गया है। इसके अलावा कैलिक्स लंबाई में बेहतर पाये जाने वाले तीन लाइन्स चार सीजन तक परीक्षण के दौरान लगातार उत्कृष्ठ प्रदर्शन किये।

सनई के 44 प्रभेदों में से 11 को कृषि संबंधी गुणों तथा 3 को पूर्व–पुष्पन गुण के लिए वर्गीकृत किया गया। लघु दिवस अवस्था में एस.आई.एन.–01, एस.आई.एन.–26 तथा एस.आई.एन.–30 लगभग 32–33 दिनों के अंदर पुष्पित होते हैं जबकि दीर्घ दिवस अवस्था में ये 42–45 दिनों के बाद पुष्पित होते हैं।

## बीज विज्ञान एवं प्रौद्योगिकी

तोषा पटसन के बीज को जब लाईट फ्लेक रेड पॉलीमर (16 कि.ग्रा./किलो बीज की दर से) की परत चढ़ायी गयी तो इसके अंकुरण पर कोई प्रतिकूल प्रभाव नहीं पड़ा। जब बीज पर पॉलीमार+कीटनाशक+कवकनाशी की परत चढ़ायी गयी तो इसके पौध ओज़ तथा रेशा उपज में सार्थक वृद्धि हुयी। मध्य सितम्बर में मेस्ता के बीज फसल की बुआई में 80:40:40 कि.ग्रा. एन.पी.के. प्रति है. की दर से रासायनिक उर्वरक प्रयोग करने से बीज उपज में वृद्धि होती है। यह वृद्धि कार्बेन्डाजीम के पर्णीय छिड़काव के कारण भी हुई।

पटसन के 11, मेस्ता के दो तथा सनई के एक प्रजातियों से कुल 13.04 कु. जनक बीज का उत्पादन हुआ। इसके अलावा उपर्युक्त फसलों के विमोचित प्रजातियों का 3.59 कुं केन्द्रक बीज का उत्पादन भी किया गया। बृहद बीज परियोजना के तहत विभिन्न फसलों के कुल 827.60 कु. बीज का उत्पादन किया गया। इसके अतिरिक्त सीसल और रेमी के रोपण सामग्री का उत्पादन व किसानों के बीच वितरण भी किया गया।

## जैव प्रौद्योगिकी

हाईपोकोटाइल ट्रांसकिप्टोम्स से चिन्हित यूनिजीन्स की सहायता से पटसन में संश्लेषित होने वाले प्रमुख जैव रसायनों जैसे मण्ड, सर्करा, एमीनो अम्ल तथा न्यूक्लोपोटाइड–सर्करा संश्लेषण प्रक्रिया का पता लगाया गया है। सादा पटसन की प्रजाति जे.आर.सी.–212 तथा उत्परिवर्ती प्रभेद डी.एल.पी.एफ. में मण्ड तथा सर्करा उपापचय प्रक्रिया से संबद्ध क्रमश 200 तथा 232 यूनिजिन्स चिन्हित किये गये हैं।

सादा पटसन की प्रजाति जे.आर.सी. 212 तथा उत्परिवर्ती प्रभेद डी.एल.पी.एफ. के हाइपोकोटाइल उत्तक में बीटा–गैलेक्ओसाईडेज (बी.जी.ए.एल.) के 12 आईसोफार्म चिन्हित किये गये हैं। बी.जी.ए. एल. आईसोफार्म के वंशावली विश्लेषण में इनकी अनुक्रम समानता अलसी, पान, अरैबीडोप्सीस, अरण्ड तथा कोकोआ पौध के अनुरूप दर्ज की गयी।

सनई में स्व–अनिशेच्य जीन्स तथा मार्कर्स के पहिचान हेतु आर.एन.ए. अनुक्रम का विश्लेषण किया गया। दो, तीन एवं चार न्यूक्लीओटाईड रिपीट्स निर्मित कुल 3591 उपयोगी एस.एस.आर. मार्कर्स जो कि 10,199 एस.एस.आर. तथा 4,769 ज्ञात आई.एल.पी. मार्कर्स से ब्यूत्पन है, का सत्यापन जारी है। पटसन के कुल 34,163 यूनिजेन्स अनुक्रम से 6037 उपयोगी आई.एल.पी. मार्कर्स के एक समुच्य का पता लगाया गया है।

अलसी में क्रियाशील गुणों के जिन्स की मदद से एस.एस.आर. मार्कर्स का विकास किया गया है। 580 उपयोगी एस.एस.आर. मार्कर्स के एक समुच्य से अलसी के कुल 93 जननद्रव्यों के समूह की अनुवांशिक विविधता का पता लगाकर उन्हें दो समूहों में विभक्त किया गया है।

तोषा पटसन में शाकनाशी सहिष्णु गुणों को कृत्रिम ढंग से प्रतिस्थापित करने के उद्देश्य से एक संवर्धन तकनीक का विकास किया गया है जिसमें मूल एवं तने का सफलता पूर्वक उद्दभवन पाया गया। पटसन में ई.पी.एस.पी.एस. जीन्स को वर्गीकृत करके उनके उत्परिवर्ती जिन्स एवं परिवर्तनशील जिनोमिक केन्द्रों की पहचान की गयी। फ्लैक्स में एक दक्ष कृत्रिम उद्भवन तकनीक तथा पौधों के पुष्प अग्र भाग रूपांतरण पद्धति का विकास भी किया गया है।

रेमी के क्लोन की आनुवांशिक शुद्धता को जानने के उद्देश्य से इसके सूक्ष्म वर्द्धित पौध के पोलीपेपटाईड की रूपरेखा, आर.ए.पी. डी. तथा आई.एस.एस.आर. मार्कर्स का प्रयोग किया गया है। रोज़ेल प्रजातियों के डी.एन.ए. फिंगर प्रिंट हेतु ई.एस.टी.–एस.एस.आर. तथा एस.आर.ए.पी. मार्कर्स का प्रयोग किया गया है।

## मृदा एवं पोषक तत्व प्रबंधन

दीर्घकालीन उर्वरक के प्रयोग के प्रभाव के अध्ययन से यह ज्ञात हुआ है कि निरंतर उर्वरक के प्रयोग अथवा उर्वरक के साथ गोबर की खाद के उपयोग करने से पटसन, धान एवं गेहूँ फसलों की उपज में वृद्धि हुई। इन तीनों फसलों की उपज, संस्तुत उर्वरकों की 150 प्रतिशत तथा संस्तुत उर्वरक की 100 प्रतिशत मात्रा के साथ गोबर की खाद प्रयोग के समतुल्य प्राप्त हुआ। उर्वरकों की मात्रा में वृद्धि से पौधों में नत्रजन, फॉस्फोरस एवं पोटाश के ग्रहण की मात्रा में भी वृद्धि दर्ज की गयी। जैव खाद के साथ रासायनिक उर्वरकों के प्रयोग के कारण मृदा के पोषण तत्वों में सकारात्मक अन्तःप्रवाह पाया गया जिसके कारण मिट्टी में जैव कार्बन, नत्रजन, फॉस्फोरस एवं पोटाशियम में वृद्धि दर्ज की गयी।

कार्बन अधिग्रहण के अध्ययन के लिए पटसन–धान–गेहूँ फसल पद्धति के अन्तर्गत मृदा में चालीस वर्षों में प्राप्त तथ्यों के सिमुलेशन से यह ज्ञात हुआ कि प्रथम बीस वर्ष में मृदा में कार्बन की वृद्धि हुई, उसके बाद इसमें निरंतर कमी दर्ज की गयी। हालांकि नत्रजन, पोटाश एवं फॉस्फोरस उर्वरक के साथ गोबर की खाद के उपयोग से मृदा कार्बन

में निरंतर वृद्धि कायम रहा। इस परिणाम से यह ज्ञात हुआ कि उर्वरक प्रबंधन में गोबर की खाद डालने से मृदा कार्बन की बरामदगी की दक्षता बढ़ती है। प्रारम्भिक मृदा में उपस्थित कार्बन भी मृदा में कार्बन की बरामदगी में अत्यधिक प्रभाव डालता है।

सल्फर ह्रास या वृद्धि के अध्ययन से ज्ञात हुआ कि सल्फर की वृद्धि मृदा की उपरी सतह में निचली सतह की अपेक्षा ज्यादा होती है। सल्फर का अधिग्रहण मेस्ता में पटसन पौधों की अपेक्षा ज्यादा होती है।

पटसन–धान–मसूर फसल पद्धति में संरक्षित जुताई के साथ फसल अवशेष या बिना अवशेष के उपयोग में अधिकतम मृदा कार्बन की मात्रा दर्ज की गयी। मृदा कार्बन का मृदा संग्रहण में महत्वपूर्ण योगदान रहा। हालांकि पारम्परिक जुताई में अधिकतम उपज की प्राप्ति हुई है।

रेमी फसल पद्धति में मृदा कार्बन के निरूपण से ज्ञात हुआ कि कार्बन की मात्रा मृदा की गहराई के साथ घटती जाती है।

नियंत्रित स्थिति में पटसन के जननद्रव्यों पर नत्रजन के विभिन्न मात्राओं का पौधों के विकास एवं क्रियाओं पर प्रभाव के अध्ययन से ज्ञात हुआ कि ओ.आई.जे.–008 जननद्रव्य में तने तथा जड़ों की अधिकतम लंबाई दोनों, अल्प अथवा सामान्य नत्रजन के प्रयोग से प्राप्त हुई। हांलांकि प्रक्षेत्र दशा में ओ.एम.यू.–008 की अधिकतम तने की लंबाई, व्यास एवं रेशे की उपज बिना नत्रजन के उपयोग में भी प्राप्त हुई।

## फसल प्रबंधन

पटसन–धान बेबी कॉर्न फसल पद्धति में अधिकतम उत्पादकता (205 कु./है.) प्राप्त हुई जबकि अधिकतम कार्बन प्रबंधन सूचकांक (60.8) पटसन–धान–सरसों–मूँग में दर्ज की गयी। संस्तुत उर्वरकों की शतप्रतिशत मात्रा के साथ फसल अवशेष को मिट्टी में मिलाने से उपज, अस्थिर एवं स्थिर कार्बन तथा कार्बन प्रबंधन सूचकांक में वृद्धि दर्ज की गई।

पटसन की कुंड में बुआई के साथ 60 कि.ग्रा. नत्रजन 30 कि.ग्रा. फॉस्फोरस तथा 30 कि.ग्रा. पोटाश/है. के उपयोग तथा केवल एक सिंचाई देने से 26 कु./है. पटसन रेशे की प्राप्ति हुई। इसमें जल की उत्पादकता 1492 लि./कि.ग्रा. रेशा दर्ज की गयी। पटसन की पंक्तिबद्ध बुआई के साथ क्रिजैफ 'नेल वीडर' के द्वारा बुआई के 5 दिनों बाद मिट्टी का पलवार बनाने से 32.3 कु./है. रेशे की प्राप्ति हुई। संस्तुत उर्वरकों की मात्रा (60:30:30 एन.पी.के.) के साथ 2 टन/है. मूँग का अवशेष के उपयोग तथा एक सिंचाई से 37.4 कु./है . रेशे की प्राप्ति हुई तथा जल की उत्पादकता 1035 लि./कि.ग्रा. रेशा दर्ज की गयी।

पटसन के बोरे द्वारा प्रबलित मिट्टी स्तंभ का उपयोग धान के खेतों में विविधिकरण के लिए किया गया इसमें धान के साथ अन्तः फसल में सब्जिओं और दलहन फसल उगाया गया, जिसमें 3 टन/है. धान के साथ, 24 कु. मुली, 26 कु. पालक साग, 78.42 कु. चुलाई, 24.8 कु. करेला, 125 कु. बैगन, 18.8 कु. अरहर, 9.9 कु. सफेद चौलाई, 17.3 कु. सीताफल, 210.5 कु. लौकी तथा 9.9 कु. अदरख/है. की प्राप्ति हुई। इसी पद्धति को बोरो धान में उपयोग करने से 4.5 टन/है. धान के साथ 51 कु. बंधगोभी, 28.3 कु. गाजर, 152 कु. बैगन, 69 कु. टमाटर, 9.3 कु. धनिया पत्ता, 12.39 कु. प्याज 33 कु. मूली तथा 11.8 कु./है. मिर्च की उपज प्राप्त हुई।

विभिन्न प्रकार के औषधीय एवं सुगंधित फसल चक्र में, पटसन–धान–एसेलियो द्वारा अधिकतम पटसन समकक्ष उपज (62.4 कु./है.) की प्राप्ति हुई। संस्तुत उर्वरक के साथ 5 टन गोबर की खाद के प्रयोग से सिर्फ उर्वरक की तुलना में 14.02 प्रतिशत ज्यादा उपज की प्राप्ति हुई।

## जैविक एवं अजैविक तनाव

पटसन तना छेदक, बिहार रोमिल सूडी, तथा सेमीलूपर फेरोमोन्स के रासायनिक विश्लेषण में विभिन्न अणुभार वाले कुल 7 यौगिक पाये गये। जिनमें से 3 यौगिक तना छेदक, 2 यौगिक बिहार रोमिल सूड़ी तथा 2 यौगिक सेमीलूपर से संबंधित थे जो इन कीटों में विशिष्ट व्यवहार परिवर्तन के लिए उत्तरदायी थे। पटसन के पाँच जंगली तथा एक कृषित प्रजाति से प्राप्त कुल 12 यौगिकों के रासायनिक विश्लेषण में ये कीटों के विशिष्ट व्यवहार में परिवर्तन लाने में सक्षम पाये गये जो कीट प्रतिरोधिता/संवेदनशीलता के लिए उत्तरदायी हो सकते हैं।

कीट रोगजनक *लिकानीसिलियम लेकेनाई* कवक से उपचारित पटसन बीजों से प्राप्त पौधों में इस कवक की स्थापना की पुष्टि आण्विक एवं सूक्ष्मदर्शी विधि से की गयी है। मृत मिलीबग से प्राप्त एक नवीन *बिउवेरिया बैसियाना* प्रभेद की पहचान आण्विक विधि से की गयी जो कि अन्य ज्ञात प्रभेदों से भिन्न था। मृत मीली बग के नमूनों से विभिन्न रोग जनक प्रभेदों की पहचान हेतु एक बहुसंकेती पी.सी.आर. परीक्षण तकनीक का मानकीकरण भी किया गया है।

पटसन फसल में माईट की संख्या, उनके अण्डों का घनत्व तथा फसल अवधि के दौरान माईट्स की पौधों पर उपस्थिति के आधार पर प्रजाति जे.आर.ओ.–524, जे.आर.ओ.–204 तथा जे.बी.ओ.–1 को अल्प संवेदनशील जबकि प्रजाति जे.आर.ओ.एम.–1 तथा जे.आर.ओ.–2407 को अत्यन्त संवेदनशील पाया गया। सल्फर से उपचारित मृदा की तुलना में बिना उपचारित मृदा में बोए गये पटसन फसल में माईट्स का प्रकोप अधिक देखा गया। सल्फर की उच्च मात्रा से उपचारित मृदा में उगे हुए पटसन की पत्तियों में माईट की संख्या सार्थक रूप से कम थी।

मिलीबग के निम्फावस्था पर तापमान में परिवर्तन का सार्थक प्रभाव पाया गया अर्थात निम्फ काल पर बढ़ते हुए तापक्रम का नकारात्मक प्रभाव परिलक्षित हुआ। तापक्रम में वृद्धि से प्रजनन दर में वृद्धि के बावजूद भी कीटों के आबादी में आनुपातिक वृद्धि नहीं हो पायी क्योंकि मादा कीटों के जीवनकाल पर बढ़ते तापक्रम का सार्थक रूप से ऋणात्मक प्रभाव देखा गया।

चूर्ण आधारित तीन प्रकार के कीट रोगजनकों के प्रयोगशाला में परीक्षण से ज्ञात हुआ कि पीली दीमक में *पेसिलोमाइसीटीज फ्यूमोसोरोसस* नामक कीट रोग जनक की संक्रमणशीलता अन्य दो रोग जनकों की तुलना में सार्थक रूप से उच्च थी।

विभिन्न स्थानों से एकत्रित तना सड़न रोग से ग्रस्त पटसन पौधों में पाँच प्रकार के रोग लक्षण परिलक्षित हुए। इन रोग जनकों के प्रयोगशाला परीक्षण के आधार पर कुल छः वर्गों में वर्गीकृत किया गया। इन रोगजनकों के आण्विक स्तर पर अध्ययन से स्पष्ट हुआ कि इन कवक प्रभेदों के दूसरे एवं तीसरे तथा चौथे एवं पांचवें समूह आनुवंशिक रूप से समान थे। लगभग सभी कवक समूह टेबुकोनाजोल नामक कवकनाशी के प्रति अत्यन्त संवेदनशील पाये गये।

जिंक, कॉपर तथा सल्फर के सूक्ष्मकण जिनका आकार क्रमशः 10, 30 तथा 6.5 एन.एम. था, का परीक्षण पटसन में तना सड़न रोग के रोकथाम के लिए किया गया तथा यह पाया गया कि कॉपर सूक्ष्मकणों की 0.5 पी.पी.एम. तथा जिंक की 0.01 पी.पी.एम. सान्द्रता पटसन में तना सड़न रोग के नियंत्रण में अत्यन्त प्रभावी था।

तना सड़न रोग जनक तथा *ट्राईकोडर्मा विरिडी* के प्रभेद टी.वी.सी.–1 जैसे जैव घटक का सह–टीकाकरण अध्ययन के दौरान यह पाया गया कि टीकाकरण के लगभग 30 दिनों तक तना सड़न रोग के लक्षणों में करीब 47 प्रतिशत तक की कमी दर्ज की गयी जो कि रोग नियंत्रण में सार्थक पूर्वक दक्ष साबित हुआ।

पटसन के तना सड़न रोग के रोकथाम हेतु कार्बेन्डाजीम 50 डब्ल्यू. पी. से बीजोपचार तथा बुवाई के 45 दिनों के पश्चात इसका एक बार पर्णीय छिड़काव अत्यन्त प्रभावी पाया गया। बुवाई पूर्व ब्लीचिंग पाउडर से मृदा उपचार पटसन सड़न रोग के नियंत्रण हेतु कवकनाशीयों के इस्तेमाल की तुलना में बेहतर परिणाम दर्ज कराया।

ओडीशा के झाड़सुगुड़ा, सम्बलपुर तथा सुन्दरगढ़ जिलों में सीसल के *अगेव सिसलाना* तथा बामरा हाईब्रीड–1 प्रजातियों में जेब्रा रोग का प्रकोप क्रमशः 14.9–37.3 प्रतिशत तथा 25.5–50.3 प्रतिशत तक दर्ज किया गया। इस रोग की तीव्रता *अगेव सिसलाना* तथा बामरा हाईब्रीड–1 पौधे की नर्सरी अवस्था में क्रमशः 3.4–47.1 प्रतिशत तथा 3.0–50.6 प्रतिशत तक पायी गयी। इस रोग के नियंत्रण हेतु फोसेटाईल–ए.एल. का 2.5 ग्रा./ली. के दर से छिड़काव सर्वोत्तम पाया गया।

खरपतवार की सघनता तथा विविधता का मिट्टी में मौजूद कार्बनिक कार्बन, नत्रजन एवं फोस्फोरस के साथ सकारात्मक सम्बन्ध पाया गया। *साइप्रस रोटन्ड्स* के आर्थिक थ्रेसहोल्ड 14 पौधा प्रति वर्ग मीटर घनत्व से पटसन रेशे में 3 प्रतिशत की क्षति दर्ज की गई। पटसन की विभिन्न बुवाई विधि में खरपतवार तथा फसल की प्रतिस्पर्धा की क्रांतिक अवस्था निर्धारित की गयी जिसमें छिटकावां विधि में क्रांतिक अवस्था 9–42 दिनों तक, पंक्तिबद्ध में 10–34 दिनों तक कुंड में बुआई में 11–25 दिनों तथा युग्मित पंक्ति बुआई में 10–24 दिनों तक निर्धारित की गयी।

इमफेनकरबाजोन शाकनाशी का प्रयोग अंकुरण पूर्व करने से घास, चौड़ा पत्ता एवं मोथा में क्रमशः 77, 95 और 72 प्रतिशत की कमी दर्ज की गयी। बुआई के पश्चात् खरपतवारनाशीयों में क्विीजालोफाप ईथाइल 10 ई.सी. का 38 ग्रा./है. के दर से प्रयोग तथा हाथ की एक निराई खरपतवार प्रबंधन में कारगर साबित हुआ तथा पटसन उत्पादन में भी वृद्धि दर्ज की गई।

अलसी (फ्लैक्स) फसल में मोथा, बथुआ, हिरन खुरी, कृषण नील तथा जंगली मटर आदि खर–पतवारों की प्रधानता थी। अंकुरण पूर्व शाकनाशी पेन्डीमेथीलिन 30 ई.सी. 1.0 कि.ग्रा./है. अथवा 0.75 कि. ग्रा./है. सक्रिय तत्व का प्रयोग इन खर–पतवारों के प्रबंधन में अत्यन्त प्रभावी पाया गया।

तीस वर्षों (1982–2012) के वार्षिक वर्षा एवं तापक्रम के आँकड़ों के विश्लेषण से ग्रीष्म खरीफ तथा रबी मौसम में वर्षा की विविधता क्रमशः 1.53 प्रतिशत, 80 प्रतिशत तथा 66 प्रतिशत देखी गयी। ग्रीष्म कालीन वर्षा तथा तापक्रम (+0.3 डिग्री सेल्सियस) में वृद्धि के कारण वर्ष 1992 के पश्चात् पटसन उपज में वृद्धि दर्ज की गयी जबकि रबी मौसम में वर्षा की कमी तथा तापक्रम में वृद्धि (+1.3 से +3.4 डिग्री सेल्सियस) के कारण गेहूँ की उपज में कमी पायी गयी। खरीफ मौसम में धान की उपज वर्षा से अत्यधिक सह संबधित पाई गई।

## प्रक्षेत्र यंत्रीकरण एवं कटाई उपरांत तकनीकी

पटसन तथा छोटे आकार के बीज वाले फसलों की बुआई के लिए पावर चालित बीज बुआई यंत्र (सीडड्रील) का मानकीकरण किया गया। इसकी कार्य क्षमता 0.28–0.3 है. प्रति घंटा है। क्रिजैफ एकल चक्र जूट वीडर को यांत्रिक खर–पतवार नियंत्रण के लिए परीक्षण किया गया। यह यंत्र छोटे खरपतवारों को नियंत्रित कर, उत्पादन लागत को कम करता है तथा इसमें मानव श्रम में भी कमी आती है।

मानव चालित जूट एक्स्ट्रैक्टर से निकाले गये रेशे की मजबूती दूसरे मशीनों की तुलना में 10–20 प्रतिशत तक ज्यादा दर्ज की गयी। मेस्ता एवं पटसन के बार्क रिबन को लम्बवत स्थिति में सड़न के लिए रखने पर क्षैतीज में रखे गये स्थिति की तुलना में रेशे की मजबूती

में क्रमशः 7 तथा 40 प्रतिशत की कमी दर्ज की गयी। रेशे की महीनता 2.8–3.4 टैक्स दर्ज की गयी। पटसन रेशा के सड़न के लिए जीवाणु का अन्तःबीज का उपयोग किया गया जो वनस्पति कोशिका में अंकुरित होकर पेक्टिनोलाइटिक एवं जाइलेनोलाइटिक एंजाइम का स्राव करता है और यही एंजाइम सड़न की क्रिया को सुगम बनाता है, सड़न की अवधि को कम करता है तथा उत्तम गुणवत्ता वाले रेशा प्रदान करता है। पटसन के सड़न की क्रिया इस जीवाणु अंतःबीज से 10 दिनों में पूर्ण होती है तथा रेशे की मजबूती एवं महीनता में भी सुधार होता है।

एलकेलोफिलिक जीवाणु के उपभेदों (एम.टी.सी.–5891 एवं 5892) के कॉर्न्सोसियम से रेमी रेशों में गोंद निष्कर्षण की क्षमता रासायनिक उपयोग की तुलना से ज्यादा दर्ज की गई। इसके अलावा अन्य मापक, जैसे गोंद का अवशेष, पेक्टिन की मात्रा, रेशे की मजबूती रासायनिक निष्कर्षण के समतुल्य था।

## पटसन एवं समवर्गीय रेशा सूचना विज्ञान

दीर्घकालीन आकाशीय एवं जलवायु आंकड़ों को संरक्षित, पुनर्विचार एवं विश्लेषण कर पटसन उत्पादकों को जानकारी प्रदान करने के लिए वेब डाटा बेस तैयार किया गया है।

क्रिजैफ के द्वारा 'जैफ एक्सपर्ट' एक वेब आधारित एक्सपर्ट पद्ध ति को बनाया गया है। जिसके द्वारा पटसन एवं समवर्गीय रेशे के उत्पादन सम्बन्धी सभी जानकारियां हासिल किया जा सकती है। यह अब संस्थान के वेबसाइट www/http//jafexpert.crijaf.org.in पर उपलब्ध है।

पटसन के उपलब्ध जिनोमिक संसाधनों की सहायता से अनेकों एस.एस.आर. मार्कर्स का विकास किया गया है जिन्हें उपयोगकर्ता के अनुकूल 'जूटमार्करडीबी' नामक डाटाबेस में एकीकृत करके उनका विस्तृत विवरण भी प्रस्तुत कराया गया है। निःशुलक उपलब्ध इन तमाम सूचनाओं की मदद से इच्छुक पटसन प्रजनक, जैवप्रौद्योगिकीविद् तथा छात्रगण पटसन के उपलब्ध जननद्रव्यों तथा प्रजातियो का आण्विक वर्गीकरण करके उनमें अनुवांशिक सुधार ला सकते है।

## तकनीकी आक्कलन एवं हस्तान्तरण

उन्नत तकनीकों के प्रक्षेत्र प्रदर्शन में जे.आर.ओ.–204 किस्म में अधिकतम उपज (30.35 कु./है.) की प्राप्ति हुई जिसके बाद जे. आर.ओ. 524 की उपज (26.53 कु./है.) थी। यांत्रिक विधि द्वारा खरपतवार नियंत्रण के लिए 'नेल वीडर' से 2.48–3.15 कु./है. अधि ाक उपज की प्राप्ति हुई जबकि पारम्परिक कृषक पद्धति में 25. 94–26.12 कु./है. रेशा उपज की प्राप्ति हुई। क्रिजैफ सोना के प्रयोग से रेशे की गुणवत्ता में वृद्धि दर्ज की गयी तथा सड़न की अवधि में 6–10 दिनों की कमी दर्ज की गई। इन सभी उन्नत तकनीकों से उत्पादन लागत में कमी के अलावा रेशे की उपज में तथा रेशे की गुणवत्ता में वृद्धि हुई। चार पंक्ति वाले मानव चालित सीडड्रील से 1.60–2.63 कु./है. रेशे की वृद्धि हुई तथा 5107–6066 रूपये तक की मानव श्रम लागत में कमी दर्ज की गई।

## जनजातीय उपयोजना

जनजातीय उपयोजना के अन्तर्गत पश्चिम बंगाल, ओडीशा तथा असम राज्य के जनजातीय कृषकों के जीवीकोपार्जन एवं खाद्य सुरक्षा में गुणात्मक वृद्धि के उद्देश्य से पटसन एवं समवर्गीय रेशा आधारित फसल प्रणाली के साथ तमाम उद्यमों जैसे– पशुपालन, मुर्गी एवं बतख पालन, मच्छली पालन आदि को भी समाहित करने हेतु अनेकों कार्यक्रम सम्पादित किये गये हैं। इस तरह के कार्यक्रमों के आयोजन से कुल 1416 जनजातीय कृषक परिवार अब तक लाभान्वित हो चुके हैं।

पटसन एवं समवर्गीय रेशा फसल की अखिल भारतीय नेटवर्क परियोजना के अन्तर्गत जनजातीय उपयोजना के तहत बी.सी.के.वी., कल्याणी, यू.वी.के.वी., कूचबिहार, जे.आर.एस., केन्द्रपाड़ा और आर. ए.आर.एस. नौगांव में स्थित कुल नौ गांवों जिसमें पश्चिम बंगाल, असम एवं ओडिशा के पांच जिलों में 288 जनजातीय परिवारों के 59 है. क्षेत्रफल में कार्यक्रम की शुरूआत की गयी। इन जगहों पर क्रिजैफ बहु पंक्तीय सीडड्रिल द्वारा पटसन की नवीनतम प्रजाति की बुवाई, संतुलित उर्वरक प्रयोग, 'क्रिजैफ नेल वीडर' द्वारा खरपतवार का प्रबंधन, खरपतवार का समन्वित प्रबंधन, समेकित कीट प्रबंधन, पटसन के साथ मूँग की अंतवर्ती इत्यादि तकनीकों का प्रदर्शन किया गया। जनजातीय कृषकों के द्वारा इन तकनीकों के प्रयोग से पटसन उत्पादकता में वृद्धि के फलस्वरूप 8454–29422 रू./है. की अतिरिक्त आय की प्राप्ति हुई।

## अखिल भारतीय पटसन एवं समवर्गीय रेशा नेटवर्क परियोजना

पटसन एवं समवर्गीय रेशा फसलों के कुल नौ प्रजातियाँ जैसे– तोषा पटसन की जे.आर.ओ. 2407 (समाप्ति), के.आर.ओ.–4 तथा बी. सी.सी.ओ.–6 (किसान पाट), सादा पटसन की के.जे.सी.–7 (श्रेष्ठ), जे.आर.सी.–9057 (इशानी) एवं ए.ए.यू.सी.जे.–2 (ख्याति), केनॉफ की जे.आर.के.एम.–9–1 (सत्येन), सेन्ट्रल केनाफ जे.बी.एन.पी.–2 एवं रोजेल की सी.आर.आई.जे.ए.एफ. आर.–5 (रोजेल रत्ना) का विमोचन तथा अधिसूचना केन्द्रीय प्रजाति विमोचन समिति के द्वारा व्यवसायिक उत्पादन के लिए किया गया है। इसके अलावा अखिल भारतीय नेटवर्क परियोजना के 29वीं कार्यशाला के दौरान पटसन, केनाफ तथा रोजेल के एम. एक प्रजाति क्रमशः एन.जे.–7010, जे.बी.एम.पी.–3 तथा जे.आर.आर.–17 को विमोचन हेतु चिन्हित किया गया है।

तोषा पटसन, सादा पटसन तथा रोज़ेल के अलग–अलग 75 अनुवृद्धियों तथा केनॉफ के 51 जननद्रव्यों का मूल्यांकन उनके

संबंधित चेक प्रजातियों के साथ पटसन एवं समवर्गीय रेशा उत्पादक राज्यों में किया गया है। विभिन्न केन्द्रों पर संकरण कार्यक्रम के अन्तर्गत विभिन्न संततियों का मूल्यांकन, पृथक वंशी में एकल पौध का चयन एवं बीज का संग्रहण उनके पुनर्मूल्यांकन हेतु किया गया है। पटसन एवं समवर्गीय रेशा फसलों के विशिष्ट प्रविष्टियों का मूल्यांकन आई.ई.टी., ए.वी.टी.–I, ए.वी.टी.– II एवं अनुकूली जाँच बहु–स्थानीय परीक्षण के तहत पूरा किया गया।

लक्षित उपज मृदा परीक्षण के आधार पर केवल उर्वरक प्रयोग की तुलना में एफ.वाई.एम. का प्रयोग करने से लाभ खर्च अनुपात में सुधार हुआ। मेस्ता में लक्षित उपज मृदा परीक्षण के आधार पर अजैविक उर्वरक के साथ एफ.वाई.एम. प्रयोग करने से लक्षित उपज में 5.2 प्रतिशत भिन्नता (विचरण) के साथ उपज की प्राप्ति हुयी। लक्षित उपज मृदा परीक्षण के आधार पर (100 प्रतिशत एन.पी.के. मृदा परीक्षण लक्षित उपज) उर्वरकों का प्रयोग जैविक उर्वरक के उपस्थिति अथवा अनुपस्थिति में धान के लक्षित उपज (4 टन/है.) को क्रमशः 17.4 प्रतिशत तथा 8.7 प्रतिशत उपज भिन्नता के साथ पाया गया।

कूचबिहार, नौगांव, आमाडालावालासा तथा अदुथूरई में बिना खरपतवार नियंत्रित प्लाट की तुलना में प्रेटिलाक्लोर (50 ई.सी.) 450 या 900 ग्रा./है. या ब्यूटाक्लोर 1.5 कि.ग्रा./है. की दर से प्रयोग करने से खरपतवारों में प्रभावी ढंग से कमी होने के साथ–साथ 5–9 कु./है. अधिक रेशा उपज की भी प्राप्ति हुयी। पटसन+मूँग (प्रजाति पंत मूँग–5 टी.एम.बी.–37) की अंतवर्तीय खेती पद्धति से खर–पतवार अधिकतम दक्षता (74.7 प्रतिशत) के साथ नियंत्रित हुई।

राहुरी में सनई की बुआई 30 सें.मी. x 10 सें.मी. की दूरी से करने से तथा एन.पी.के. का प्रयोग 20:40:40 की दर से करने पर सबसे अधिक बीज उपज (19.6 कि.ग्रा./है.) की प्राप्ति हुई। जबकि, अदुथुरई में सनई की सर्वाधिक बीज उपज की प्राप्ति 60 से.मी. x 15 सें.मी. की दूरी पर बुआई तथा एन.पी.के. 20:60:60 कि.ग्रा./है. करने से हुआ।

विभिन्न केन्द्रों पर सर्वेक्षण के दौरान पटसन फसल में पीली मकड़ी, अर्धकुण्डलक, बिहार रोमिल सूड़ी तथा तना घुन जैसे कीट–पतंगों की प्रमुखता पायी गयी। खासतौर से, नौगांव में पीली सूंडी तथा बैरकपुर में भूरा कीड़ा (ग्रे विभिल) का प्रकोप देखा गया। तना घुन का प्रकोप बहराइच तथा कूचबिहार को छोड़कर सभी केन्द्रों पर देखा गया जबकि पटसन अर्धकुण्डलक का प्रकोप बैरकपुर, नौगांव, केन्द्रपाड़ा तथा कूचबिहार केन्द्रों पर देखा गया। पटसन में पीली मकड़ी के प्रबंधन हेतु बुआई के 35 दिनों के बाद स्पाइरोमेसीफन (240 एस.सी.) 0.7 मि.ली./ली. की दर से तथा नीम (आजाडिरैक्टिन 10,000 पी.पी.एम.) 3 मि.ली./ली. की दर से बुआई के 50 दिन के बाद पर्णीय छिड़काव या स्पाइरोमेसीफेन (240 एस.सी.) 0.7 मि.ली./ली. की दर से बुआई के 35 दिनों या 50 दिनों के बाद छिड़काव सबसे अधिक कारगर पाया गया।

तना सड़न, जड़ गलन, एन्थ्रैक्नोज एवं चित्ती रोग का संक्रमण पटसन में सामान्य रूप में पाया गया। तना सड़न का सबसे अधिक प्रकोप मध्य जून से सितम्बर तक देखा गया। इसके लिए एजोक्सीस्ट्रो+डीफेनोकोनाजोल 325 एस.सी. 1 मि.ली./कि.ग्रा. बीज से बीजोपचार+एजोक्सीस्ट्रोबीन+बुआई के 45 दिन बाद डीफेनोकोनाजोल 325 0.075 प्रतिशत का छिड़काव सबसे अधिक कारगर तरीका के रूप में पाया गया। मध्य जून में बोये गये बीज फसल में फली परिपक्वता के समय में कवकनाशी का छिड़काव करने से अधिकतम स्वस्थ बीज की प्राप्ति हुयी। फ्लैक्स के कुम्हालाना रोग में एजोक्सीस्ट्रोबीन (25 प्रतिशत एस.सी.) 1.0 मि.ली./कि.ग्रा. बीज के साथ उपचार करने पर कारगर पाया गया। मेस्ता में प्रोफेनोफास 2 मि.ली. की दर से पर्णीय छिड़काव बुआई के 35, 50 एवं 65 दिनों पर करने से अमाडालवालसा में चूषक कीट, एफिड, मह्, सफेद मक्खी, पत्ती हॉपर तथा मिलीबग का बेहतर नियंत्रण देखा गया।

## कृषि विज्ञान केन्द्र

कृषि विज्ञान केन्द्र के माध्यम से पटसन, धान, दलहनी फसलों तथा मच्छली पालन से संबंधित उन्नत उत्पादन तकनीकों पर प्रक्षेत्र प्रदर्शन का आयोजन किया गया। प्रथम पंक्ति प्रदर्शन के अन्तर्गत पटसन, प्याज, बैगन, जई तथा बरसीम के नवीनतम उन्नत प्रजातियों का प्रक्षेत्र प्रदर्शन किया गया। राष्ट्रीय खाद्य सुरक्षा मिशन एवं दलहनी तथा तीलहनी फसलों पर राष्ट्रीय मिशन कार्यक्रम के अन्तर्गत मसूर, मूँग, सरसों, मँगफली तथा तील फसलों में क्रमशः 97, 153, 175, 59 तथा 281 प्रथम पंक्ति प्रक्षेत्र प्रदर्शनी का आयोजन किया गया। इसके अतिरिक्त कृषकों, महिला कृषकों, ग्रामीण युवाओं तथा प्रसार कार्यकर्ताओं हेतु दो व्यावसायीक एवं 34 प्रायोजित प्रशिक्षणों सहित कुल 190 प्रशिक्षण कार्यक्रम भी आयोजित किये गये। केन्द्र के माध्यम से जनजातीय उपयोजना के अन्तर्गत लगभग 1250 जनजातीय पुरूष एवं महिला कृषकों को प्रशिक्षित भी किया गया है। प्रधान मंत्री कौशल विकास योजना के अन्तर्गत ग्रामिण युवाओं के कौशल विकास हेतु लगभग 200 घंटों का प्रशिक्षण कार्यक्रम भी आयोजित किया गया है।

# Introduction

ICAR-Central Research Institute for Jute and Allied Fibres is one of the oldest premier research institutes of NARS conducting basic, strategic, anticipatory and applied research on all aspects of jute and allied fibre crops. The institute popularly known as ICAR-CRIJAF was initiated with the inception of Indian Central Jute Committee (ICJC) in 1936. Subsequently, Jute Agriculture Research Laboratory (JARL) was established in 1938 at Dhaka, now in Bangladesh which was later shifted to Chinsura in West Bengal in 1948, and then to Barrackpore, and finally established at the present place (Nilgunj, Barrackpore) in 1953 as Jute Agricultural Research Institute (JARI). ICJC was taken over by Indian Council of Agriculture Research (ICAR) in 1966. The Institute was rechristened to its present name, Central Research Institute for Jute and Allied Fibres (CRIJAF) in January, 1990. To carry out research on jute and allied fibres and seed production, four research stations i.e., Ramie Research Station, Sorbhog, Assam (in 1959), Sisal Research Station, Bamra, Odisha (in 1962), Sunnhemp Research Station, Pratapgarh, Uttar Pradesh (in 1963) and Central Seed Research Station for Jute and Allied Fibres, Budbud, West Bengal (in 1956) were established.

The institute has played major role in developing and popularizing more than 70 varieties of jute and allied fibre crops which have doubled the productivity with considerable reduction in harvest period and enabled this crop to establish in the cropping sequence of different jute and allied fibres growing states. Besides, the institute has developed important technologies related to crop production & protection, improved retting, improved machineries for fibre extraction and intercultural operation, and seed production. CRIJAF is also leading in jute genomic research, maintenance of related database and germplasm of jute and allied fibre crops.

## Location

Geographically it is located at 88°26E longitude and 22°45N latitude at an altitude of 9 m above mean sea level. The institute is situated at 5 km east of Barrackpore Railway Station and is well connected with NSCB International Airport, Kolkata (18 km) and Howrah Railway Station (35 km).

## Mission

To explore traditional and new frontier areas of science for technology development, promotion and policy guidance for a vibrant, effectively productive and resilient jute and allied fibre agriculture.

## Vision

Provide leadership in research and technology development to make jute and allied fibre farming profitable and sustainable.

## Mandate

- Basic and strategic research on improvement of jute and allied fibre crops for biotic and abiotic stresses, yield and quality
- Development of economically viable and sustainable production technology, cropping systems and post-harvest technology
- Co-ordination and monitoring of applied research on national and regional issues to develop improved varieties and technologies
- Dissemination of technologies and capacity building

## Organizational set up

The main institute has 3 research divisions *viz*, Crop Improvement, Crop Production, Crop Protection and Agricultural Extension section at the headquarters to meet research and extension needs in specific areas. The main institute has well-equipped laboratories pertaining to genomics, phenomics, biotechnology, biochemistry, fibre quality, physiology, soil science, microbiology, plant protection and agricultural chemicals. The regional stations with sufficient man power, farm and laboratory facilities work on specific mandate crops and seed production. The research management is supported by different sections cells like PME cell, administration, finance and accounts, purchase and store, library, farm, meteorological unit etc. The institute and the stations have the facility of well laid out research farm with irrigation facility for conducting the field experiments and seed production.

## Ramie Research Station, Sorbhog, Assam

Ramie Research Station of ICAR-CRIJAF was established at Sorbhog, Assam in 1959 in 56 ha area. This station is engaged in the development of improved technology for ramie crop cultivation which is very specific to NE states. Since its inception, Ramie Research Station is playing important role in development and promotion of technology, generation and distribution of planting materials for area expansion and profitable ramie cultivation.

## Sisal Research Station, Bamra, Odisha

Sisal Research Station was established at Bamra, Odisha in 1962. Sisal germplasm block, model nursery and plantations are maintained in this station. Continuous effort by the station in the production and distribution of planting materials enhanced the area under sisal. This station has 106.00 ha area for conducting research and field trials on sisal crop.

## Sunnhemp Research Station, Pratapgarh, Uttar Pradesh

In 1963, on the recommendation of Indian Central Jute Committee (ICJC) the Sunnhemp Research Station was established at Pratapgarh, UP. For a short period it was under the control of Director, Directorate of Jute Development. Later on from 1966 it was under the control of Jute Agricultural Research Institute, JARI (presently ICAR-CRIJAF). The Station moved over to its present campus in 1974. The research on crop improvement, seed and fibre production technology of sunnhemp is exclusively done by this station. It has a research farm, laboratories, office and staff quarters in 9.18 ha campus.

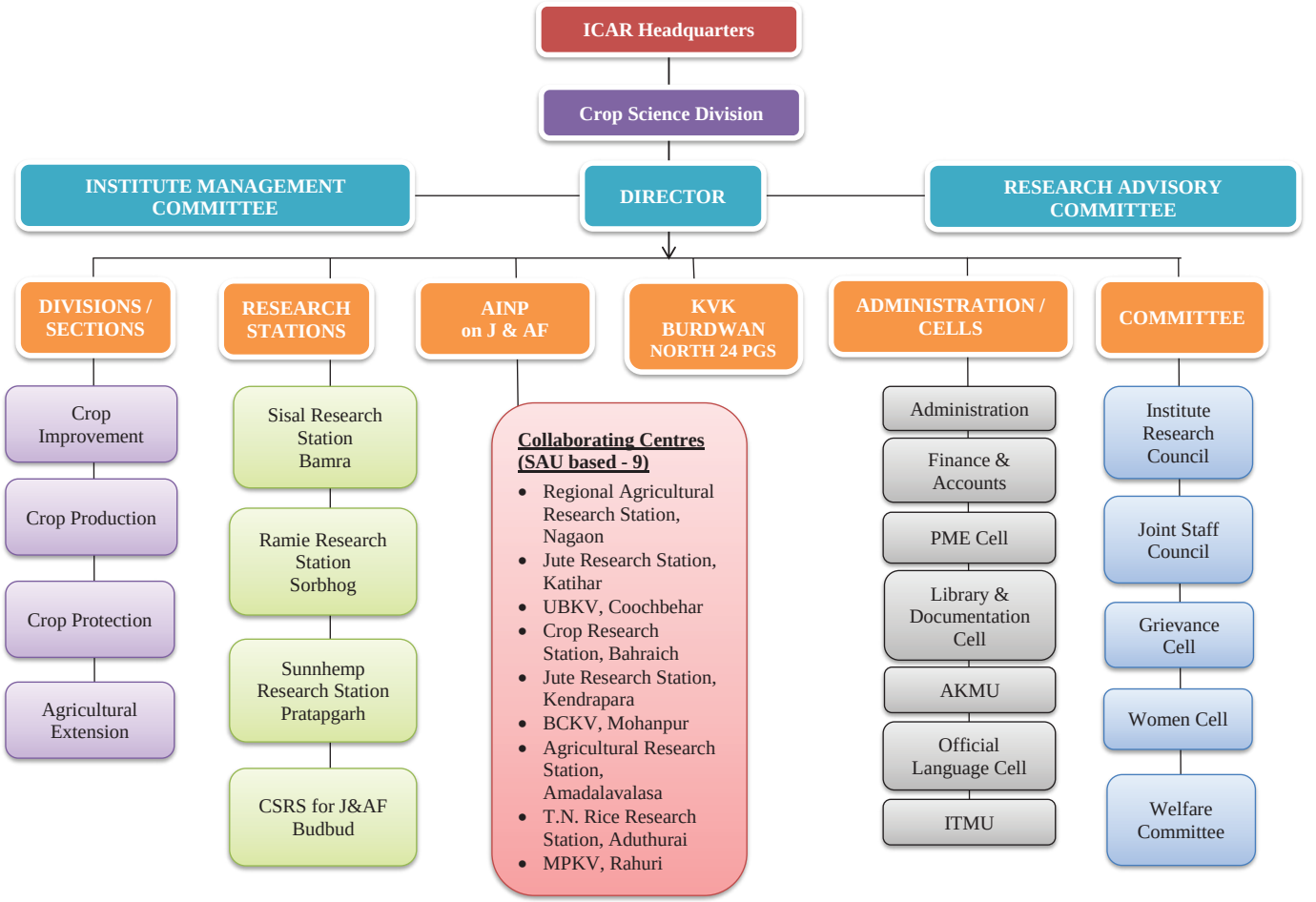
## Central Seed Research Station for Jute and Allied Fibres, Budbud, West Bengal

Central Seed Research Station for Jute and Allied Fibres (CSRSJAF) previously known as Central Nucleus Jute Seed Multiplication Farm, was established in the year 1962 at Budbud, Burdwan, West Bengal. The station has 65 ha research farm, seed processing and storage unit, mobile seed processing unit, combined harvester to support the quality seed production technology. This regional station mainly deals with the production of nucleus seed of jute and allied fibres through maintenance breeding, production of breeder seed of jute, mesta and sunnhemp and production of quality seed (foundation, certified & TL) of jute and other field crops.

## All India Network Projects on Jute and Allied Fibres (AINPJAF)

The coordinating cell of All India Network Projects on Jute and Allied Fibres (AINP JAF) is headquartered at the institute. At present, this project has 15 centres including 9 SAU-based and 6 ICAR-institute based collaborative centres for multilocational evaluation of the varieties, validation of production and protection technologies and quality evaluation of the fibres.

## Organogram



## Krishi Vigyan Kendra (KVK), Burdwan, West Bengal

KVK, Burdwan was established in 2005 in 18 ha area in the campus of Central Seed Research Station for Jute and Allied Fibres, Budbud, Burdwan under the administrative control of ICAR-CRIJAF. The KVK is actively involved in the transfer of technology through on-farm trials (OFTs), frontline demonstrations, capacity building through hand-on training and other promotional extension activities in agriculture and other allied fields of horticultural crops, animal husbandry, fishery and home science. The KVK is well equipped with facilities like trainees hostel, soil testing laboratory, seed production unit, and demonstration units like vermicompost production unit, polyhouse, integrated farming system, well maintained mix-fruit orchard, portable carp hatchery, goatery etc.

## Krishi Vigyan Kendra (KVK), North 24 Parganas (Nilgunj), West Bengal

KVK, North 24 Parganas was established in 2016 in 10 ha area in the North Farm campus of ICAR-Central Research Institute for Jute and Allied Fibres, Barrackpore at Nilgunj. The KVK started functioning since December 2016 to take up the programmes related to on-farm trials (OFTs), frontline demonstrations, capacity building through hand-on training and other promotional extension activities in jute based farming system in the 11 Southern blocks of the District. Foundation stone of Administrative Building and the Trainee's hostel was laid by Hon'ble Union Minister of Agriculture and Farmers' Welfare, Sri Radha Mohan Singh on 13th February 2017. Presently, this KVK is functioning from its temporary office at Extension Section of ICAR-CRIJAF.

## Agricultural Knowledge Management Unit (AKMU)

Agricultural Knowledge Management Unit (AKMU) facilitates the e-governance and manages research information on jute and allied fibres. It provides stable, secured and uninterrupted internet facility to the whole campus. In order to implement the online ICAR-ERP solution the facility of high speed internet connectivity along with secured Wi-Fi systems has been created. The unit is also responsible for maintenance and updation of institute website. The backbone for operating the e-extension, mobile advisory services and other related activities is also supported by AKMU.

## Institute Technology Management Unit (ITMU)

Institute Technology Management Unit (ITMU) deals with protection of intellectual properties (IPs), their maintenance and commercialization of the technologies developed by the institute. ITMC chaired by the Director is the apex decision making body of the institute regarding IP management and their commercialization. It also looks after consultancy, contract research, patents, technology protection protocols, licensing etc.

## Prioritization, Monitoring and Evaluation (PME) Cell

The PME cell of ICAR-CRIJAF was established as per guidelines of the Council. The PME of the Institute is working as "Single window" system for priority setting, research monitoring and evaluation, maintenance of data bases related to projects, achievements, technologies developed, publication etc. PME cell assists the Director of the institute in evaluation, assessment, monitoring, management and co-ordination of all the on-going in-house as well as externally funded projects.

## Library

The institute library, information and documentation unit has rich collection of books and journals of agro – biodiversity especially on jute and other fibre crops such as sisal, ramie, flax , sunnhemp, mesta, etc. It serves the research community with the information at their desks. The library has rich collection of books and journals (current and back volumes). The activity of the library has been digitized and the services are being provided electronically. AGRIS CD is available from 1971 to 2005 for easy access of abstracts of different publications. Library also provided the internet and reprography service to the readers along with Document Delivery Services (DDS) system by Consortium for e-Resources in Agriculture (CeRA) to access different journals on line.

## Human Resource Development

The institute has been recognized for research work for M.Sc and Ph.D programmes by the Presidency University, Calcutta University and R.K.M. Vivekananda University. Beside the institute also conducts short term summer training for M.Sc students of SAUs and general universities (Govt. or private) on payment of appropriate fees. The extension section of the institute also conducts training to farmers and the other stakeholders of jute and allied fibre sectors.

## Management Information System (MIS)/ Financial Management System (FMS) Unit

For effective control of Management Information System and Financial Management System of the institute, ICAR-ERP solution was implemented at ICAR-CRIJAF. The infrastructural facility and the human resources have been appropriately developed for effective implementation of e-governance. The institute also acts as the nodal centre for providing necessary guidance to the other ICAR-institutes in Eastern India for successful implementation of MIS-FMS. The MIS-FMS unit of the institute actively attends the doubts and any specific problem faced by the employees while working in ERS solution.

## Women Cell

The institute women cell addresses the issues related to grievances of women employees in the HQ and in different regional research stations. This cell also organizes training and awareness programmes for the women on agriculture and other allied activities for enhancing their income and over all involvement in the management of family and welfare of the society.

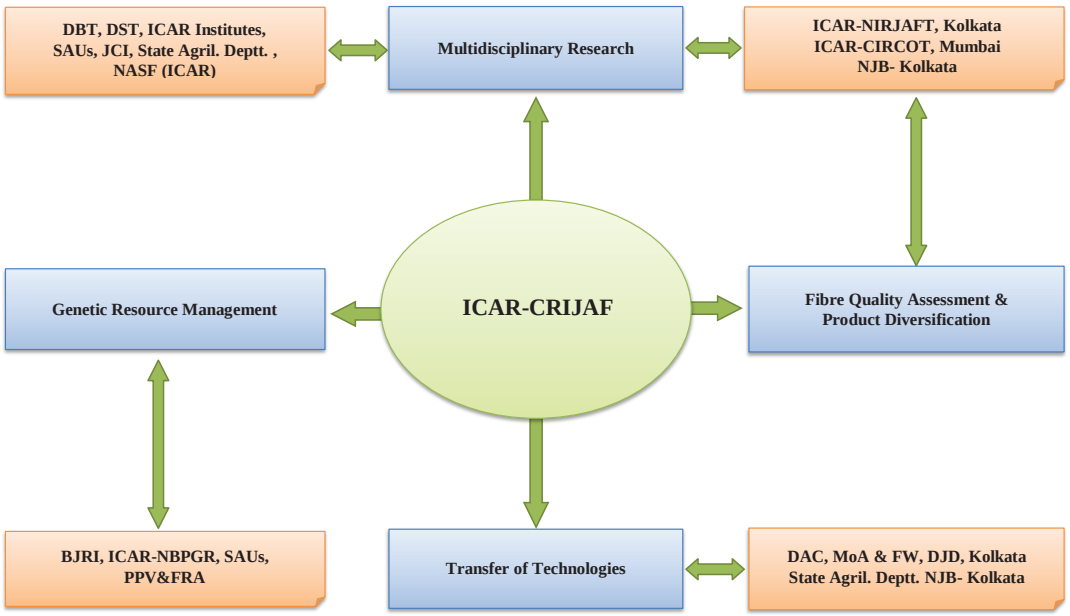
## Regional Centre of National Agricultural Education Accreditation Board

On recommendation of the accreditation board of ICAR, this institute (ICAR-CRIJAF) has been selected as the nodal centre for eastern and north-eastern region for facilitating the, submission of self-study reports of the agricultural universities and other modalities required for accreditation.

## Linkages

Apart from the 9 SAUs engaged in research on JAF crops, the institute has strong linkage with national and international organizations in the field of research, training and policy matters. The institute has R & D collaboration with national funding bodies like DBT, BARC, NASF, NJB, DST (West Bengal), and RKVY (DAC, MoA&FW). Besides collaborative programmes are also going on with DJD, NIRJAFT, IJIRA, JCI, NJB for research, training and developing effective policies for the sector. The International organization like BJRI, Bangladesh is also associated for R & D activities on jute with ICAR-CRIJAF.

## Linkages



# 1. Crop Improvement

## 1.1 Genetic Resource Management

In order to breed better than the available best variety breeders need source of genetic diversity for yield, quality, resistance to biotic and abiotic stresses. These genetic resources cannot be created artificially except to a limited extent through mutation or genetic engineering rather they are generated over years through exploration, collection, evaluation, characterization and conservation activities. ICAR-CRIJAF being the NAGS for jute and allied fibre crops, always prioritized these activities to strengthen the germplasm resources of JAF crops.

### 1.1.1 Collection and conservation of germplasm

A total of 1510 accessions of *C. olitorius*, 287 accessions of *C. capsularis*, 78 accessions of *H. cannabinus*, 245 accessions of wild *Corchorus* species and 24 accessions of wild *Crotolaria* species have been successfully regenerated at ICAR-CRIJAF, Barrackpore, West Bengal and RRS, Bamra, Odisha. Besides, 124 accessions of *Crotolaria* collected from ICAR-NBPGR were also regenerated at ICAR-CRIJAF. *(Source: JB 1.1. Contributors: S.B. Choudhary, H.K. Sharma, A. Anil Kumar, Maruthi R.T., S. Datta and D.N. Saha).*

The genepool of ramie, at Ramie Research Station (RRS), Sorbhog was also enriched with 10 germplasm accessions of *Boehmeria* spp. collected from Assam, Meghalaya and Nagaland (Fig. 1.1) during the month of October, 2016. All the accessions were planted in the introduction plot of RRS for further study and characterization (Fig. 1.2). As per the preliminary identification, three accessions are cultivated type (*Boehmeria nivea*). *(Source: RB 1.0. Contributors: Amarpreet Singh and Monu Kumar).*

Fig. 1.1. Wild ramie plants

Fig. 1.2. Wild ramie plants (cultivated type) planted in germplasm block

### 1.1.2 Characterization, evaluation and utilization

A total of 1227 accessions of *C. olitorius* L. were evaluated for stem rot disease response at two locations namely, Bud Bud, West Bengal and Sorbhog, Assam during 2014-2016. All accessions revealed significant genotype x environment interaction for disease response except JRC 412 that recorded complete mortality across environment over the period (Table 1.1). *(Source: JB 1.1. Contributors: S.B. Choudhary, H.K. Sharma, A. Anil Kumar, Maruthi R.T., S. Datta and D.N. Saha).*

**Table 1.1. Stem rot disease response of selected accessions**

| Genotypes | Plant affected with stem rot symptom (%) | | |
|---|---|---|---|
| | 2014-15 | | 2015-16 |
| | Bud Bud | Sorbhog | Sorbhog |
| OEX 18 | 33 | 86 | 100 |
| OMU 23 | 5 | 13 | 38 |
| OIJ 102 | 20 | 64 | 49 |
| OIJ 156 | 24 | 36 | 57 |
| OIJ 173 | 11 | 19 | 49 |
| OIN 13 | 6 | 23 | 37 |
| JRC 412 | 100 | 100 | 100 |

During multiyear evaluation of 130 flax accessions from 2013 to 2017 a delayed flowering flax accession (LIN 056) with early pod maturity was identified (Table 1.2). The accession found promising for fibre purpose cultivar development programme as delayed flowering ensure prolonged vegetative growth while early pod maturity helps plant to escape terminal heat in field.

**Table 1.2. Per se performance of selected flax accessions during 2013-17**

| Attributes | Years | | | | Mean |
|---|---|---|---|---|---|
| | 2013-14 | 2014-15 | 2015-16 | 2016-17 | |
| **LIN 056 (selection from LIN 035)** | | | | | |
| Plant height (cm) | 134.80 | 121 | 137 | 128 | 130.2 |
| Basal diameter (mm) | 3.68 | 3.30 | 3.71 | 3.10 | 3.44 |
| Days flowering (days) | 82 | 94 | 91 | 87 | 88.50 |
| Pod maturity (days) | 21 | 18 | 23 | 27 | 22.25 |
| Fibre yield (g/plant) | 1.70 | 1.50 | 2.3 | 1.90 | 1.85 |
| **JRF 2** | | | | | |
| Plant height (cm) | 114.80 | 97 | 105 | 118 | 108.7 |
| Basal diameter (mm) | 3.86 | 3.30 | 3.60 | 3.70 | 3.615 |
| Days flowering (days) | 68 | 67 | 64 | 66 | 66.25 |
| Pod maturity (days) | 34 | 31 | 44 | 41 | 37.50 |
| Fibre yield (g/plant) | 2.10 | 1.70 | 1.80 | 2.20 | 1.95 |

Population structure analysis of flax accessions was performed by using qualitative, SSR and EST-SSR markers (Fig. 1.3) with the ΔK value for optimum number of clusters determined at K=3 and 2 for qualitative markers and SSR/ EST-SSR+SSR markers, respectively. Qualitative markers grouped accessions into three clusters with ΔK=3. First cluster

with 85 accessions was the largest and mainly comprised intermediate type accessions from Indian and exotic origin (25.8% each). Cluster-III (9 accessions) was constituted by fibre type exotic accessions from West European countries. Rest all accessions were grouped into cluster-II (36 accessions). Further, EST-SSR+SSR markers grouped accessions into two clusters. Cluster-I dominated with exotic accessions of intermediate and fibre type (40% and 28%, respectively) while cluster-II represented comparatively a mix group with intermediate (Indian: 30.6%, exotic: 22.6%) and linseed type exotic (21.18%) flax. SSR markers based clustering grouped fibre type exotic (20%) and intermediate type (Indian: 20.0%, exotic: 38.2%) together in cluster-I. Most of the linseed type exotic (17.3%) and intermediate type (Indian: 28.0%, exotic: 21.3%) belonged to cluster-II.

The combined analysis based on qualitative, EST-SSR and SSR markers grouped exotic accessions into two and three clusters at K=2 and K=3, respectively (Fig. 1.4). Initially, with two clusters population (K=2) exotic accessions of fibre and intermediate type (88.9% and 64%, respectively) distinguished from rest of flax genotype and grouped into a separate cluster. When one more subgroup was allowed (K=3), Indian accessions of fibre type (63.4%) constituted separate cluster with Indian intermediate type (48.7%). Cluster-II predominantly was constituted by Indian accessions of linseed type (82.16%).

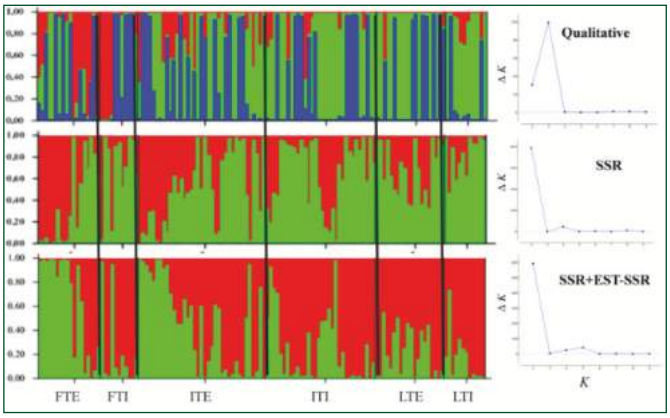



Fig. 1.3. Population structure of flax germplasm based on different markers.

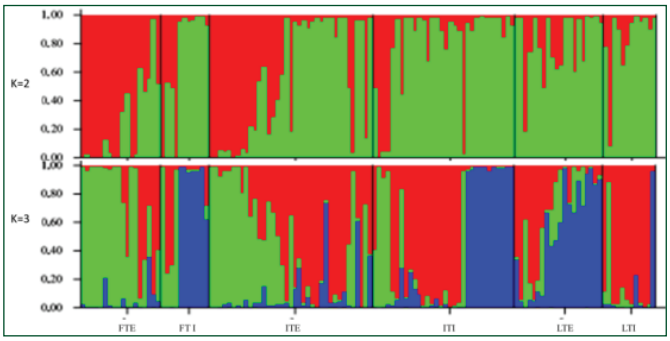



Fig. 1.4. Population structure of flax germplasm based on combined markers.

However, Indian intermediate type and exotic linseed type accessions were substantially distributed among above two clusters. A total of 7 accessions identified admixtures in the analysis. *(Source: JB 1.1. Contributors: S.B. Choudhary, H.K. Sharma, A. Anil Kumar, Maruthi R.T., S. Datta and D.N. Saha).*

### 1.1.3 Distribution

A total of 1875 germplasm lines of JAF have been distributed to different indenters including scientists of CRIJAF, AINP on Jute and Allied Fibres and other institutes. *(Source: JB 1.1. Contributors: S.B. Choudhary, H.K. Sharma, A. Anil Kumar, Maruthi R.T., S. Datta and D.N. Saha).*

### 1.1.4 Pre-breeding

A total of 192 $F_{4:5}$ inter-specific populations derived from *C. olitorius* x *C. aestuans* were evaluated for fibre fineness (Fig. 1.5) which ranged from 0.83 to 2.80 tex with population mean 1.51 tex and CD value 0.27. Both the parents OIJ-248 (1.74 tex), WB 1 (0.73 tex) and check JRO 524 (2.46 tex) were recorded with coarse fibre.

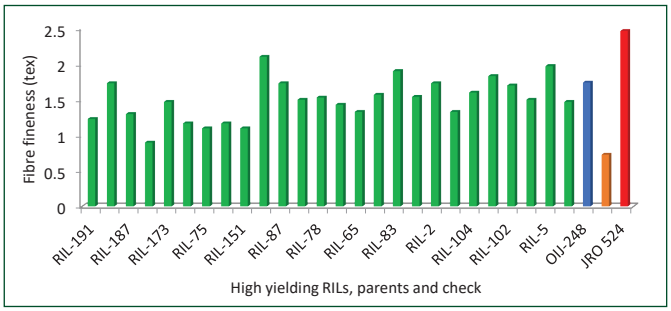



Fig. 1.5. Variation in fibre fineness among high yielding RILs

A total of 192 $F_{5:6}$ inter-specific populations derived from *C. olitorius* x *C. aestuans* along with parents and two cultivated checks (i.e., JRO 524 and JRO 204) were sown on 05.03.2016 to screen for pre-mature flowering resistance. Data on flowering was recorded at 40 days after sowing. Out of 192 RILs only 18 lines were resistant to pre-mature flowering as all the selected lines recorded no flowering, whereas both the parents OIJ-248 (100%), WB 1 (100%) and cultivated checks JRO 524 (72.7%) and JRO 204 (31.7%) recorded more than 5% of flowering (Fig. 1.6).

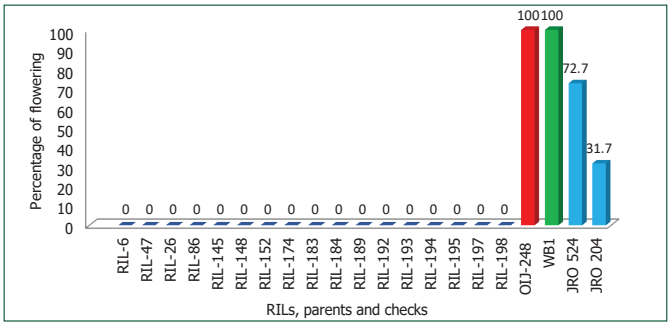



Fig. 1.6. Response of pre-mature flowering resistance of selected RILs, parents and cultivated checks

An inter-specific population (388 $F_2$) derived from cross

JRO 2407 x WCIJ-141-2 (*C. aestuans*) were evaluated for morphological variations. Transgressive segregants for leaf shape, setae and stipule (Fig. 1.7) were observed. A total of 19 $F_2$ plants were observed with exstipulate and non-abscission leaves and similar non-abscission leaves were also observed in *C. olitorius* x *C. fascicularis* $F_2$ population. *(Source: JB 1.1. Contributors: S.B. Choudhary, H.K. Sharma, A. Anil Kumar, Maruthi R.T., S. Datta and D.N. Saha).*

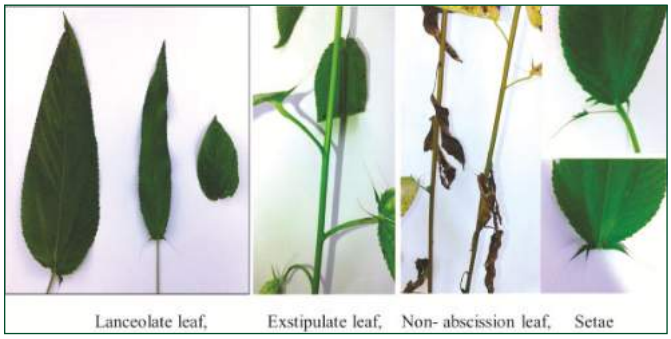



Fig. 1.7. Morphological variations in *olitorius* x *aestuans* inter-specific population

A total of 43 different lines were developed from progenies of four inter-specific cross-combinations, JRO 8432 x *C. pseudocapsularis,* S 19 x *C. trilocularis,* S 19 x JRC 212, Chinsura Green x CIJ 143 and JRO 8432 x *C. trilocularis*. Average fibre yield of selected lines ranged from 30.5 - 33.3 q/ha. out of them, line JROB-3 identified for high biomass production which is under AVT-I trial of AINPJAF. Another line, JROV-3 is also under evaluation of AINPJAF trials for leafy vegetables. However a total of eight *olitorious* lines have been developed from different crosses and mutation breeding.

A number of improved genotypes have been developed from crossing stem rot resistant lines and high yielding cultivars in both *C. olitorius* and *C. capsularis* jute. A $BC_1F_4$ RIL set of 168 lines from the cross OIN-154 x JRO 204 has been developed. Two sets of 100 $F_4$ progenies were developed from the cross between stem rot resistant genetic stocks in *C. capsularis* using resistant line CIM 036 and improved varieties JRC 517 and JBC 5. After selection, 55 lines from the cross CIM 036 x JRC 517 has been advanced to $F_5$ generation. An elite line JRCPS-2 selected from cross (CP 28 x JBC 5) x JBC 5 has been promoted to AVT-I under AINPJAF. One entry JRCP-2 from cross CIM 036 x JBC 5 has been submitted to AINPJAF for multi-location evaluation under IET trial.

In kenaf, a bulked population derived from inter-specific hybridization has been advanced to $F_7$ generation with directional selection for cultivated plant type and tall plant height. Under selection pressure, plant height improved continuously up to $F_6$, but reduced slightly in $F_7$ (Fig. 1.8). Two single plant selections have been made from this population, one having deep-red colour of stem and tall phenotype (plant height 4.8 m) and another green stem colour with tall phenotype (plant height 4.63 m). *(Source: JB 9.4. Contributors: P. Satya, S. K. Pandey and Maruthi R. T.).*

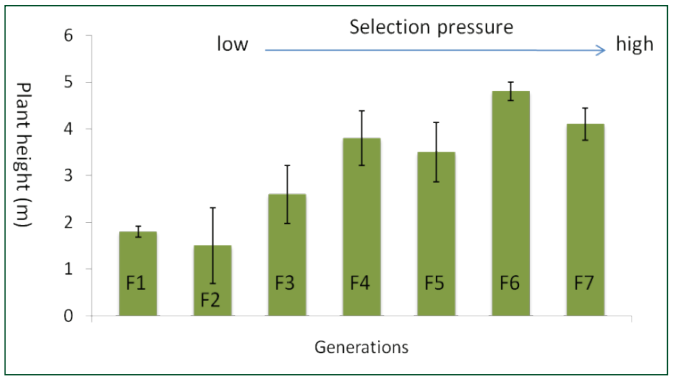



Fig. 1.8. Effect of directional selection on inter-specific hybridization derived population in kenaf

### 1.1.5 Mutation breeding

A total of 588 mutant population of *tossa* jute (*C. olitorius*) was developed. A low lignin *tossa* jute mutant namely *llpf* was characterised for morphological, histological and molecular parameters. Registration proposal for five mutant germplasm lines has been submitted to ICAR-NBPGR, New Delhi. *(Source: 35/14/01/2014-BRNS. Contributors: S.B. Choudhary, H.K. Sharma and A. Anil Kumar).*

Treatment of three varieties of kenaf namely, JBM 2004D, AMC 108 and HC 583 were affected with higher doses of physical mutagen ($Co^{60}$ @ 25 Kr, 35 Kr, 45 Kr, 55 Kr, 65 Kr, 75 Kr and 85 Kr). Seed germination and their regeneration efficiency were observed in both laboratory as well as field conditions. In general, the germination efficiency and ability to establish in to a complete plant of variety AMC 108 was lower than those of HC 583 and JBM 2004D. Irradiation dose beyond 35 Kr affected germination efficiency and doses beyond 75 Kr became completely lethal to kenaf seed irrespective of varieties (Fig. 1.9). However, a γ rays dose of 65 Kr could be considered as the $LD_{50}$ dose for kenaf seed. $M_2$ seeds of all 20 irradiated samples were collected for further regeneration, evaluation and identification of desirable mutants. *(Source: JB 10.0. Contributors: S.K. Pandey, P. Satya and P.N. Meena).*

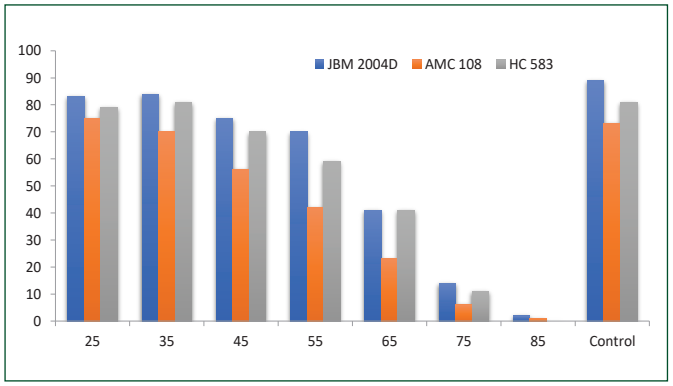



Fig. 1.9: Effect of different doses of γ rays on germination efficiency of kenaf varieties

## 1.2 Jute (*C. olitorious and C. capsularies*)

### 1.2.1 Genetic improvement of *tossa* jute

A model for prediction of fibre yield in *C. olitorius* jute based on fibre wedge characters has been developed and validated which can be utilized for estimating fibre yield without retting the plant. Crosses have been affected between parents having variation in fibre anatomy characters and three backcross-recombinant inbred line (BCRIL) populations were developed for fibre anatomy characters. A total of 158 $F_3$ genotypes were evaluated for morphological and fibre anatomy characters and selections have been practiced to develop 15 high yielding lines with superior fibre anatomy characters. Out of the evaluated lines, three mutant genotypes for superior fibre anatomy characters were registered with NBPGR (OMU 005 - INGR17025, OMU 018 - INGR17026 and OMU 007 - INGR17027) for different fibre anatomy characters (Fig. 1.10). Of the selected lines, one line has been submitted to AINPJAF for initial evaluation trial of *olitorius* jute. In addition, eight dwarf lines with plant height <1.5 m under long day and <0.5 m under short day condition have been identified which can be exploited for genetic mapping of plant height. Using *in-vitro* cell and tissue culture methods, protocols for somatic embryogenesis and organogenesis of *C. olitorius* jute have been developed. *(Source: TMJ-1. Contributors: P. Satya, A.B. Mandal, S.B. Choudhary, H.K. Sharma and K. Meena).*

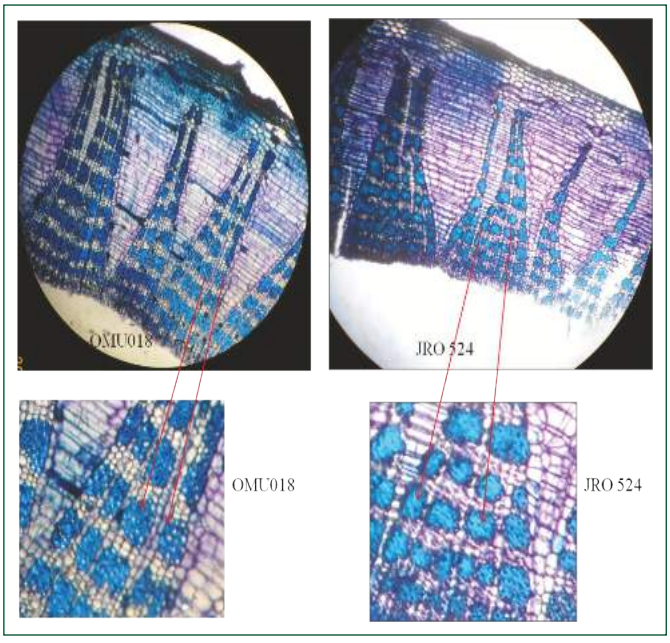



Fig. 1.10. Comparative structure of number of fibre cells per fibre bundle of OMU 018 and leading cultivar JRO 524 (check). Magnifications order 300x.

### 1.2.2 Breeding for resistance to biotic stresses in *tossa* jute

Selected resistant wild and susceptible cultivated germplasm lines from 2014 and 2015 trials were re-evaluated in sick plots of ICAR-CRIJAF, Barrackpore and RRS, Sorbhog, Assam during 2016. At ICAR-CRIJAF, wild germplasm lines recorded as resistant (with zero AUDPC value) and cultivated germplasm lines as susceptible (with high AUDPC value 1312) whereas in Sorbhog conditions only one wild accession (WCIN-136) was survived and rest of the germplasm lines were died in early seedling stage due to severe disease infestation. Based on three years experimentations, line WCIN-136 (*Corchorus aestuans* L.) selected as resistant and OIJ-248 (*Corchorus olitorius* L.) as susceptible line for stem rot disease (Fig. 1.11). Further $F_1$ was developed and advanced to $F_2$ generation to study the inheritance of stem rot disease of jute. Based on morphological and molecular markers, $F_1$ hybridity was confirmed.

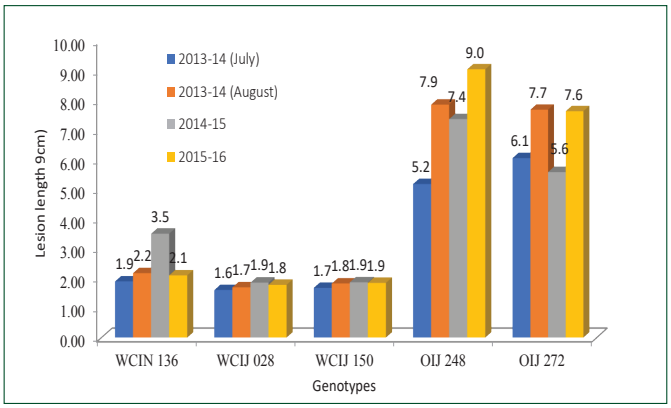



Fig. 1.11. Year-wise stem rot reaction of selected lines to artificial disease inoculation

A total of 217 $F_2$ plants were screened for stem rot resistance by artificial stem inoculation method. Sixteen days after inoculation, data was recorded where 42 $F_2$ plants identified as resistant (<3.5 cm lesion length) and 175 $F_2$ plants as susceptible (>3.5 cm lesion length) based on lesion length. Using observed and expected ratios, chi-square value was calculated (3.64) which was less than chi-square table value (3.84) with one df which indicated disease resistance is governed by single recessive gene. A total of 275 markers (200 SSRs + 75 EST-SSRs) were screened for parental polymorphism study, of which only 33 markers were found polymorphic and were used for bulk segregation analysis to identify the markers co-segregating with disease resistance. But none of the polymorphic markers found co-segregating with disease resistance. *(Source: ICAR-Extramural. Contributors: A. Anil Kumar, Kunal Mandal and Subhojit Dutta).*

Based on 2015-16 results selected resistant lines for stem rot and Bihar hairy caterpillar were again screened for the same biotic stresses during 2016-17. Based on two years mean data (Table 1.3), accessions CIM-13, CIM-50, CIN-348 and CIN-429 were found to be resistant to BHC and CIN-109, WCIN-136 as resistant and CIN-002, CMU-002 moderately resistant to stem rot disease. Resistant and susceptible lines were crossed to generate $F_1$ seeds. *(Source: JB 10.1. Contributors: A. Anil Kumar, H.K. Sharma, Kunal Mandal and B.S. Gotyal).*

**Table 1.3. Mean performance of selected accessions against BHC and stem rot resistance**

| Accession | BHC resistance (% larval weight gain) | | | Stem rot resistance (lesion length in cm) | | |
|---|---|---|---|---|---|---|
| | 2015 | 2016 | Mean | 2015 | 2016 | Mean |
| CIN 002 | 130.7 | 111.9 | 121.3 | 3.9 | 3.3 | 3.6 |
| CIN 109 | 183.3 | 117.7 | 150.5 | 3.1 | 3.0 | 3.0 |
| CIM 13 | 4.1 | -16.5 | -6.2 | 8.6 | 6.4 | 7.5 |
| CIM 50 | -48.6 | 70.6 | 11.0 | 8.3 | 9.1 | 8.7 |
| CIN 429 | 14.1 | 21.4 | 17.8 | 8.0 | 8.6 | 8.3 |
| CIN 348 | 10.6 | 19.0 | 14.8 | 7.9 | 7.1 | 7.5 |
| CMU-2 | 24.8 | 40.5 | 32.6 | 4.5 | 4.7 | 4.6 |
| JRC 212 | 19.6 | 28.6 | 24.1 | 6.2 | 6.5 | 6.4 |
| WCIN-136 | -- | -100.0 | -100.0 | 3.5 | 2.1 | 2.8 |
| SE (m±) | 29.66 | 4.92 | | 0.6 | 0.4 | |

### 1.2.3 Protection of jute varieties and DUS testing

During 2016-17 two new white jute varieties *viz*., KJC 7 and JRCM 2, five *tossa* jute varieties *viz.,* JROM 1, NJ 7055, NJ 7010, NJ 7005, NJ 7050 and two farmer's varieties *viz., Cheka Pat* and *Kamra Pat* were tested at ICAR-CRIJAF, Barrackpore and CSRSJAF, Bud Bud. The candidate variety (KJC 7) was not found to be distinct from reference varieties (JRC 212 & KC 1) with respect to any trait. Another white jute variety JRCM 2 was found to be distinct from reference varieties JRC 321 and JRC 212 with respect to stem colour in the first growing cycle.

New *tossa* jute variety JROM 1 was tested against reference varieties JRO 524 and JRO 8432 for first growing cycle at both the centre which was found to be distinct for leaf shape. The candidate variety NJ 7055 was also not distinct from reference varieties JRO 8432 and JRO 204 with respect to any claimed traits. Another *tossa* jute variety NJ 7010 was tested with same reference varieties which was found to be distinct from reference varieties with respect to plant height only at Barrackpore centre. The candidate variety NJ 7005 was tested against two reference varieties JRO 204 and JRO 524 which was found to be distinct from both the reference varieties with respect to plant height at Barrackpore centre. At CSRSJAF, Bud Bud the candidate variety was distinct for plant height but the observed value did not match with claimed plant height of candidate variety.

Two farmer's varieties *viz., Kamra Pat* and *Cheka pat* were grown but were not characterized as these varieties don't belong to genus *Corchorus* but *Hibiscus.* Besides, twenty three reference varieties of *tossa* jute and eighteen reference varieties of white jute were also maintained and characterized under DUS Project. *(Source: DA&FW (DUS Testing). Contributor: A. Bera).*

### 1.2.4 DNA fingerprint of jute varieties

To identify suitable polymorphic DNA markers with respect to 44 varieties of jute (*C. olitorius*-23 and *C. capsularis*-21), a total of 75 Jute EST-SSR markers were used to amplify. Among these, 21 were found to be polymorphic in *olitorius* and 27 in *capsularis* varieties and these markers were used in DNA finger printing of varieties. A number of primer was able to differentiate varieties in *capsularis* and *olitorius* jute (Table 1.4). A sample gel picture showing particular *capsularis* varieties differentiated from other varieties with EST-SSR-29 and EST-SSR-32 marker (Fig. 1.12).

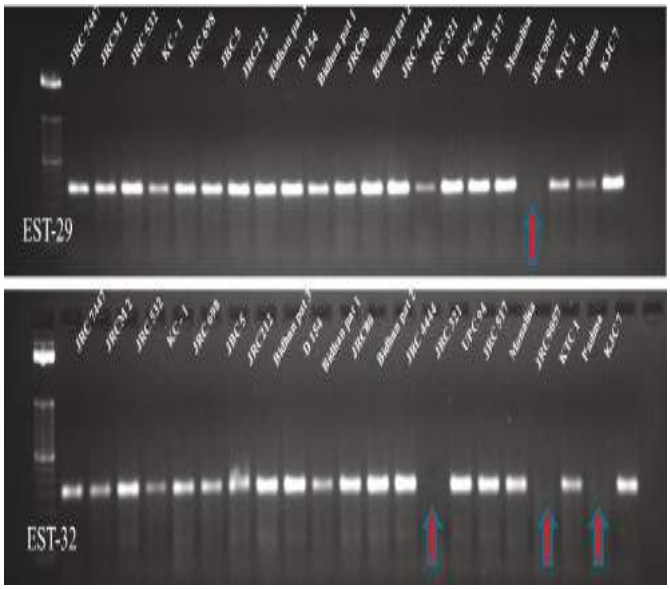



Fig. 1.12. PCR amplification with EST-SSR-29 and EST-SSR-32 primers of *capsularis* jute varieties

**Table 1.4. Markers differentiating *capsularis* and *olitorius* jute varieties**

| Primers | Differentiating variety/varieties |
|---|---|
| ***C. capsularis*** | |
| EST-SSR 29,30,44 | JRC 9057 |
| EST-SSR 24 | JRC 80 & JRC 9057 |
| EST-SSR 7,8,15,32, 42 | JRC 321, JRC 9057 & Padma |
| EST-SSR 23 | Bidhanpat -1, JRC 9057 & Padma |
| EST-SSR 70 | JRC 532, KC-1 & Padma |
| ***C. olitorius*** | |
| EST-SSR 4 | JRO 632, JRO 2345 & CO 58 |
| EST-SSR 13 | KOM 1 and JRO 2345 |
| EST-SSR 29 | CO 58 and JRO 2345 |
| EST-SSR 64 | CO 58, KOM 1 and JRO 2345, |

All the *capsularis* varieties were differentiated by polymorphic markers, whereas among *olitorius* varieties JRO 204, JRO 2407, S 19, JROG 1, Tarun, IRA, TJ 40 and Chinsura Green could not be differentiated with polymorphic markers. *(Source: JB 9.5. Contributors: J. Mitra, C.S. Kar and A. Anil Kumar).*

## 1.3 Mesta (*Hibiscus cannabinus* and *H. sabdariffa*)

### 1.3.1 Varietal development

A total of 50 promising roselle progenies belonging to 17 $F_6$ populations were advanced to successive generation. From another set of 14 $F_2$ populations 45 individual plants were selected based on plant height and basal diameter. Bulk seeds were harvested from gamma irradiated $M_2$ mutants of three mesta genotypes (Long calyx H, HS4288, MT 150). Based on station trials two kenaf lines (JRHC-6, JRHC-7) and one roselle line (JRHS-7) were contributed to IET trials under AINPJAF for fibre purpose. *(Source: JB 9.6. Contributors: H.K. Sharma, A. Anil Kumar, Maruthi R.T. and A.R. Saha).*

### 1.3.2 Genetic improvement of mesta

A total of 75 germplam lines of kenaf were evaluated with two check varieties in RBD with three replications for consecutive two year 2015 and 2016. Observations on eight plant growth parameters and agronomic traits including fibre yield were recorded. Based on two years experimentations the plant height of kenaf germplasm ranged from 151-338 cm with a mean of 300±28.7 cm. Average basal diameter was 18.4±2.6 mm (range 8.7–25.4 mm). Fibre yield ranged from 10.6–35.7 g/plant with an average of 18.9±5.2 g/plant and percentage fibre recovery ranged from 5.4–8.5% with mean value of 6.0±0.7% (Table 1.5). Nine accessions namely, KIN-085, KIN-147, KIN-148, KIN-149, KIN-154, KIN-156, KIN-168, KIN-170 and KIN-175 performed better than both the check varieties HC 583 and AMC 108 for fibre yield as well as fibre recovery percent and hence, selected for hybridization programme. *(Source: JB 10.0. Contributors: S.K. Pandey, P. Satya and P.N. Meena).*

**Table 1.5. Range and mean performance of 75 kenaf germplasm evaluated for two years**

| Characters | 2015 | 2016 | Mean | Range | SD | No. of superior lines |
|---|---|---|---|---|---|---|
| Plant height (cm) | 307 | 293 | 300 | 151-338 | 28.7 | 7 |
| Base diameter (mm) | 18.5 | 18.3 | 18.4 | 8.7-25.4 | 2.6 | 8 |
| Mid diameter (mm) | 12.4 | 12.5 | 12.5 | 5.8-18.6 | 1.8 | 12 |
| Top diameter (mm) | 4.76 | 3.6 | 4.2 | 2.2-7.8 | 0.9 | 11 |
| Green biomass (g/plant) | 380 | 270 | 325 | 146-452 | 74.1 | 10 |
| Dry stick yield (g/plant) | 48.0 | 41.3 | 44.7 | 9.7-78.5 | 12.2 | 8 |
| Dry fibre yield (g/plant) | 18.4 | 19.3 | 18.9 | 10.6-35.7 | 5.2 | 9 |
| Fibre % | 4.85 | 7.21 | 6.0 | 5.4-8.5 | 0.7 | 6 |

A total of 50 lines of roselle were also evaluated with two check varieties in RBD with three replications during 2016. Observations on plant growth parameters and agronomic traits including fibre yield were recorded. Average plant height ranged from 140-374 cm with an average of 257±67.3 cm. Basal diameter ranged from 12.5-22.2 mm with a mean value of 17.14±2.42 mm. Fibre yield/plant also showed high variability (4.7-30.7 g/plant) with an average of 15.3±6.9 g/plant. Seven accessions exceeded best check variety HS 4288 (6.88 %) in terms of fibre recovery based on green biomass yield (Table 1.6). The promising selected lines were AR-23, AR-13A, AS-80-1, AS-80-3, ER-79, REX-5 and REX-62. These lines will be utilized in hybridization programme for varietal development. *(Source: JB 10.0. Contributors: S.K. Pandey, P. Satya and P.N. Meena).*

**Table 1.6. Range and mean performance of 50 roselle germplasm during 2016**

| Characters | Mean | Range | SD | No. of superior lines over best check |
|---|---|---|---|---|
| Plant height (cm) | 257 | 140-374 | 67.3 | 7 |
| Base diameter (mm) | 17.14 | 12.50-22.20 | 2.42 | 9 |
| Mid diameter (mm) | 11.70 | 7.00-16.40 | 2.17 | 11 |
| Top diameter (mm) | 3.89 | 2.90-4.90 | 0.49 | 12 |
| Green biomass with leaves (g/plant) | 378 | 155-733 | 139 | 9 |
| Green biomass without leaves (g/plant) | 292 | 107-572 | 121 | 6 |
| Dry stick yield (g/plant) | 43.61 | 10.5-90.60 | 20.80 | 4 |
| Dry fibre yield (g/plant) | 15.30 | 4.7-30.70 | 6.88 | 3 |
| Fibre % | 5.41 | 2.35-9.98 | 1.77 | 7 |

### 1.3.3 Hybridization in mesta

A 10 x 10 half diallel crossing was attempted using selected nine germplasm lines *viz.*, KIN-085, KIN-147, KIN-148, KIN-149, KIN-154, KIN-156, KIN-168, KIN-170, KIN-175 and cultivated variety MT 150. Seed of 45 $F_1$ crosses have been collected along with seed of parental lines. These 45 $F_1$ hybrids will be evaluated along with 10 parental lines and suitable checks in randomized block design with three replications during the ensuing season. Observation on plant growth parameters, agronomic traits and reactions to biotic stresses will be recorded. *(Source: JB 10.0. Contributors: S.K. Pandey, P. Satya and P.N. Meena).*

### 1.3.4 Evaluation for diversified uses in roselle

A total of 20 promising lines of roselle suitable for calyx and leafy vegetable purpose were evaluated in station trials. From those lines three lines suitable for leafy vegetable purpose and three for calyx purpose were contributed to IET trials-2017-18 under AINPJAF. Three elite lines of roselle (Extra-long calyx 2014-1, HSLC-2-1, HSLC-3-3) selected from 50 roselle lines in year 2014-15 were further evaluated in different growing seasons (sowing in May-2016, Oct-2016) for calyx length along with check variety HS 4288 (Table 1.7). These lines were found consistently superior in calyx length over check HS 4288 across four growing seasons. *(Source: JB 9.6. Contributors: H.K. Sharma, A. Anil Kumar, Maruthi R.T., S.B. Choudhary and A.R. Saha).*

**Table1.7. Promising lines of roselle for fruit and calyx length**

| Trait | Season | Extra-long calyx 2014-1 | HSLC-3-1 | HSLC-2-1 | HS 4288 |
|---|---|---|---|---|---|
| Fruit length (mm) | 2014 (May- October) | 55.61 | 50.01 | 53.74 | 32.72 |
| | 2015 (May- October) | 53.65 | 55.29 | 56.28 | 37.30 |
| | 2016 (May-October) | 54.02 | 48.53 | 51.04 | 35.82 |
| | 2016-17 (October-March) | 53.12 | 56.31 | 55.61 | 31.90 |
| | Mean | 54.63 | 52.65 | 55.01 | 34.44 |
| Calyx length (mm) | 2014 (May- October) | 50.98 | 47.27 | 49.34 | 29.61 |
| | 2015 (May- October) | 48.39 | 51.49 | 52.38 | 32.21 |
| | 2016 (May- October) | 47.96 | 44.87 | 51.10 | 33.12 |
| | 2016-17 (October-March) | 49.47 | 52.07 | 49.71 | 28.72 |
| | Mean | 49.20 | 48.93 | 50.63 | 30.92 |

## 1.4 Sunnhemp (*Crotalaria juncea*)

### 1.4.1 Varietal development in sunnhemp

Adoption of sunnhemp as a cover crop is limited primarily due to the scanty availability of seed sources, leading to high seed costs and unreliable supplies. Hence, 44 accessions of sunnhemp were evaluated to identify accession with high biomass and seed production abilities. Observations on eleven agro-morphological (Table 1.8) traits were recorded. Ten potential accessions with high seed yield and superior performance for biomass characters were identified. Further, entire set of 44 sunnhemp accessions will be evaluated in the ensuing year for fibre yielding potential.

**Table 1.8. Reproductive characterization of sunnhemp accessions**

| Characters | Mean | Range | SEm± |
|---|---|---|---|
| Days to 50% flowering (DAS) | 46.5 | 33-55 | 0.924 |
| Plant height (cm) | 142 | 112-171 | 5.734 |
| No. of leaves/plant | 105 | 32-162 | 14.736 |
| No. of primary branches/plant | 8 | 3-15 | 1.302 |
| No. of secondary branches/plant | 10 | 2-17 | 1.916 |
| No. of internodes/plant | 34 | 22-46 | 2.422 |
| Internode length (cm) | 2.51 | 1.88-3.20 | 0.168 |
| No. of pods/plant | 70 | 31-139 | 14.108 |
| No. of seeds/pod | 9.86 | 6.4-15 | 1.203 |
| Seed yield/plant (g) | 16.12 | 6.5-32.4 | 1.427 |
| 100 seed weight (g) | 3.64 | 2.73-4.89 | 0.183 |

A total of 15 superior accessions selected in previous year were crossed in different combinations and improved populations were developed. Through mass selection three lines were identified for improved fibre yield and were submitted to AINPJAF initial evaluation trial in 2017. Early-flowering (day neutral) sunnhemp accessions of previous year's selection were evaluated this year by sowing in two seasons (Long day & Short day). To ensure long day condition during flowering accessions were sown on 4th April, 2016 and on 23rd September, 2016 for short day condition. The number of days taken for flower initiation by three selected population against check varieties (K 12 Yellow & K 12 Black) was presented in figure 1.13. *(Source: JB 10.2. Contributors: Maruthi, R.T., S.B. Choudhary and Subhojit Datta).*

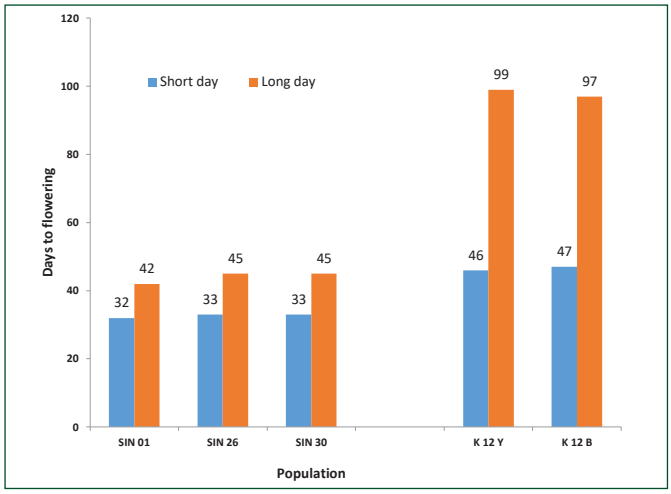



Fig. 1.13. Flower initiation in selected sunnhemp population and check varieties.

# 2. Seed Science and Technology

## 2.1 Seed Research

### 2.1.1 Seed quality enhancement through seed coating in jute (*Corchorus olitorius* L.)

Seed coating technique was deployed for delivering fungicide (carbendazim@1g a.i./kg seed), insecticide (clothianidin@2 g a.i./kg of seed) and growth regulator ($GA_3$ @100ppm) on jute seed. Lite fleck red polymer (Centor India™) was used @16 g/kg seed for seed coating. Seed coating with polymer had no adverse effect on seed germination during storage but seed coating with polymer+insecticide+fungicide increased seedling vigour index significantly (Table 2.1). Seed coating with polymer supplemented with insecticide and fungicide enhanced jute fibre yield (44.7 q/ha) significantly (11.7% increase) compared to control (40 q/ha) (Fig. 2.1). Seed enhancement through polymer coating also reduced insect and disease incidence under field condition. *(Source: TMJ 10. Contributors: A. Bera, C.S. Kar, M. Kumar and S.K. Sarkar).*

**Table 2.1. Effect of seed coating on vigour index**

| Treatments | Initial | Ambient Storage | Storage in moisture vapour proof container | | |
|---|---|---|---|---|---|
| | | 2 month | 2 month | 4 month | 6 month |
| T1-Control | $611^{abc}$ | $548^{abcd}$ | $603^{bcd}$ | $587^{abc}$ | $578^{abcde}$ |
| T2-Polymer @16 g/kg seed | $631^{ab}$ | $586^{a}$ | $624^{ab}$ | $615^{ab}$ | $599^{ab}$ |
| T3-Clothianidin @2 g a.i./kg | $616^{abc}$ | $582^{ab}$ | $609^{bcd}$ | $592^{abc}$ | $580^{abcd}$ |
| T4-Carbendazim @1 g a.i./ kg | $6191^{ab}$ | $559^{abcd}$ | $585^{d}$ | $578^{bcd}$ | $537^{de}$ |
| T5-Polymer+Clothianidin | $627^{abc}$ | $593^{a}$ | $624^{ab}$ | $609^{abc}$ | $595^{abc}$ |
| T6-Polymer+Carbendazim | $603^{bc}$ | $568^{abcd}$ | $595^{cd}$ | $608^{abc}$ | $585^{abcd}$ |
| T7-Carbendazim +Clothianidin | $591^{c}$ | $572^{abc}$ | $593^{cd}$ | $579^{bcd}$ | $577^{abcde}$ |
| T8-Polymer+Clothianidin+Carbendazim | $634^{a}$ | $600^{a}$ | $631^{a}$ | $622^{a}$ | $608^{a}$ |
| T9-Polymer+GA3+Clothianidin+ Carbendazim | $628^{ab}$ | $595^{a}$ | $623^{ab}$ | $619^{a}$ | $603^{ab}$ |

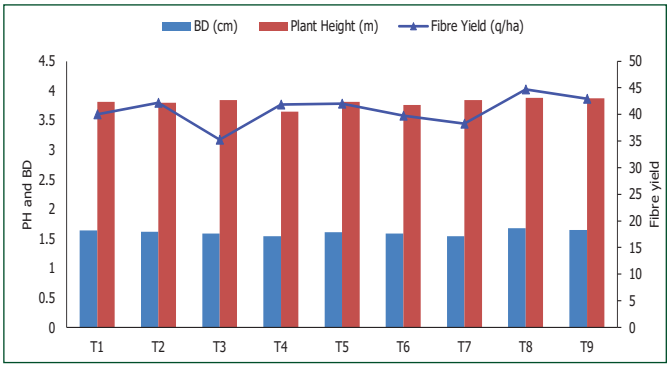



Fig. 2.1. Effect of seed coating on fibre yield parameters of jute

### 2.1.2 Assessment of diseases in mesta seed crop

The effect of sowing date, fertilizer and fungicide application on productivity of quality disease free seeds of roselle was studied (Table 2.2). Among the seed yield attributing traits, number of capsule per plant differed significantly with date of sowing, fertilizer dose and application of fungicides. The highest number of capsule/plant was noted in D2 (23.0), F2 24.3) and in S2 (21.1). Interactions of different treatments were also significant with maximum capsule/plant in D2F2S2 (28.0) and D2F2S3 (28.1). In September sown (D2) crop, maximum seeds per capsule was recorded (25.4) than August sown crop (20.4). Fertilizer dose NPK 80:40:40 (F2) resulted in more seeds/capsule (24.1). Spraying at capsule maturation stage significantly increased seeds/capsule (24.3) over control (21.7). Significant improvement in seed yield (14.5 q/ha) was recorded in September sown crop (D2) than early sowing (11.1 q/ha). Higher doses of fertilizer (NPK 80:40:40) resulted in 14.5 q/ha seed yield as against 11.18 q/ha in control. Similarly, spraying of fungicide at capsule maturation stage resulted in significant increase in seed yield (13.80 q/ha) over the control (12.3 q/ha).

The number of empty capsules (5.7%) was more in August sown crop (D1) than the crop sown in September (4.6%). Crop without any fertilizer application (F3) resulted in more empty capsules (5.6%) than fertilized crop (4.8-4.9%). Fungicide spray at capsule maturation stage (S2) resulted in 4.4% empty pods than the control (5.7%). September sown crop had less seed discolouration (1.4%) than early sown crop (2.5). Spraying of fungicide at capsule maturation stage significantly reduced the seed discolouration (1.6%). At the time of harvesting severe infestation of dusky cotton bug was noticed inside the capsule with adverse effect on seed quality. *(Source: JM 8.7. Contributors: S. K. Sarkar and Amit Bera).*

**Table 2.2. Effect of sowing dates, fertilizer and fungicide on yield attributes and seed yield of roselle**

| DFS | D1 | | | D2 | | |
|---|---|---|---|---|---|---|
| | F1 | F2 | F3 | F1 | F2 | F3 |
| **Capsules/plant** | | | | | | |
| S1 | 15.73 | 19.70 | 14.57 | 21.70 | 25.33 | 19.97 |
| S2 | 17.57 | 21.17 | 16.47 | 22.50 | 28.00 | 21.30 |
| S3 | 16.50 | 23.30 | 12.67 | 22.17 | 28.13 | 17.70 |
| Mean | D1=17.5, D2=23.0, F1=19.4, F2=24.3, F3=17.1, S1=19.5, S2=21.1, S3=20.1 | | | | | |
| CD (P=0.05) | D= 0.2, F=0.2, S=0.2, DxF=0.2, DxS= 0.3, FxS=0.3, DxFxS =0.4 | | | | | |
| **Seeds/capsule** | | | | | | |
| S1 | 20.53 | 21.87 | 18.60 | 25.47 | 26.77 | 23.77 |
| S2 | 22.97 | 22.67 | 19.80 | 27.63 | 27.67 | 24.87 |
| S3 | 19.50 | 20.40 | 17.40 | 24.50 | 25.73 | 22.67 |
| Mean | D1=20.4, D2=25.4, F1=23.4, F2=24.1, F3=21.1, S1=22.8, S2=24.3, S3=21.7 | | | | | |
| CD (P=0.05) | D= 0.6, F=0.2, S=0.2, DxF=NS, DxS= NS, FxS=0.4, DxFxS =NS | | | | | |
| **Discoloured seed (%)** | | | | | | |
| S1 | 3.23 | 2.60 | 2.27 | 2.23 | 1.60 | 1.50 |
| S2 | 1.77 | 2.20 | 1.43 | 1.23 | 1.60 | 1.30 |
| S3 | 2.20 | 3.20 | 3.53 | 1.40 | 2.10 | 2.57 |
| Mean | D1=2.5, D2=1.4, F1=2.0, F2=2.2, F3=2.1, S1=2.2, S2=1.6, S3=2.5 | | | | | |
| CD (P=0.05) | D= 0.1, F=0.1, S=0.1, DxF=0.1, DxS= 0.2, FxS=0.2, DxFxS =NS | | | | | |
| **Empty capsules (%)** | | | | | | |
| S1 | 5.47 | 6.23 | 5.77 | 4.17 | 5.20 | 4.90 |
| S2 | 4.67 | 4.07 | 6.13 | 3.50 | 2.93 | 4.97 |
| S3 | 6.20 | 6.10 | 6.40 | 4.97 | 4.97 | 5.33 |
| Mean | D1=5.7, D2=4.6, F1=4.8, F2=4.9, F3=5.6, S1=5.3, S2=4.4, S3=5.7 | | | | | |
| CD (P=0.05) | D= 0.3, F=0.1, S=0.1, DxF=NS, DxS= NS, FxS=0.2, DxFxS =NS | | | | | |
| **Seed yield (q/ha)** | | | | | | |
| S1 | 10.50 | 11.77 | 9.23 | 14.20 | 16.10 | 12.50 |
| S2 | 11.60 | 13.80 | 10.93 | 14.17 | 17.53 | 14.37 |
| S3 | 11.20 | 12.10 | 8.73 | 14.50 | 15.80 | 11.33 |
| Mean | D1=11.1, D2=14.5, F1=12.7, F2=14.5, F3=11.2, S1=12.4, S2=13.8, S3=12.3 | | | | | |
| CD (P=0.05) | D= 3.1, F=1.4, S=0.5, DxF=NS, DxS= NS, FxS=NS, DxFxS =NS | | | | | |

D1=mid-August, D2=mid-September, F1=60:30:30, F2=80:40:40, F3=control, S1= Seed treatment with carbendazim 50WP @0.1%, S2=foliar spray with carbendazim at pod maturation stage, S3= No spraying

## 2.2 Seed Production

### 2.2.1 National Seed Project (NSP) breeder seed production

Breeder seed of 11 varieties of jute, 2 varieties of mesta and 1 variety of sunnhemp were produced as per DAC & FW indent (Table 2.3). A total of 7.84 q breeder seed of jute, 1.7 q mesta and 3.5 q sunnhemp were produced against the DAC & FW indent of 6.5 q, 0.5 q and 3.0 q, respectively (Fig. 2.2).

**Table 2.3. Breeder seed production of jute and allied fibre crops during 2016-17**

| Variety | DAC & FW indent (q) | Actual production (q) |
|---|---|---|
| **Jute** | | |
| JRO 2407 | 0.10 | 0.14 |
| CO 58 | 0.12 | 0.24 |
| JRC 517 | 0.30 | 0.32 |
| JBO 2003 H (Ira) | 0.40 | 0.50 |
| JRO 204 | 1.90 | 2.20 |
| S 19 (Subala) | 0.17 | 0.30 |
| JRO 8432 | 0.02 | 0.06 |
| JRO 524 | 2.10 | 2.50 |
| JRO 878 | 0.20 | 0.22 |
| JRC 532 | 0.20 | 0.30 |
| JRO 128 | 1.02 | 1.06 |
| Total | **6.53** | 7.84 |
| **Mesta** | | |
| Satyen (JRKM 9-1) | 0.20 | 0.80 |
| Central Kenaf (JBMP 2) | 0.30 | 0.90 |
| **Total** | **0.50** | **1.70** |
| Sunnhemp | | |
| SUIN 053 | 3.00 | 3.50 |
| **Total** | **3.00** | **3.50** |

Fig. 2.2. Visit of monitoring team at CSRSJAF, Bud Bud

### 2.2.1.1 Production and maintenance of nucleus seeds

Seeds harvested from selected individual true to type plants of a variety during *kharif* 2015 were used to raise progeny rows during *kharif* 2016. About 3.6 q of nucleus seeds of the released varieties of jute (31 varieties), kenaf (5 varieties), roselle (6 varieties) and sunnhemp (5 varieties) were produced for breeder seed production in *kharif* 2017-18 (Table 2.4).

**Table 2.4. Nucleus seed production of jute, mesta and sunnhemp varieties**

| Variety | Quantity (kg) | Variety | Quantity (kg) | Variety | Quantity (kg) | Variety | Quantity (kg) |
|---|---|---|---|---|---|---|---|
| **Jute** | | S 19 | 7.5 | JRC 9057 | 3.0 | CRIJAFR 2 | 5.0 |
| JRO 524 | 11.5 | JRO 66 | 3.5 | JRC 7447 | 5.0 | CRIJAFR 8 | 5.0 |
| JRO 8432 | 6.0 | JBO 1 | 5.0 | Bidhan Pat 1 | 5.5 | AMV 4 | 6.5 |
| JBO2003H | 13.5 | KOM 62 | 2.5 | Bidhan Pat 2 | 4.0 | Total | 77.0 |
| JRO128 | 16.5 | JRC 321 | 8.5 | Total | 207.7 | **Sunnhemp** | |
| JRO 204 | 15.5 | JRC 532 | 6.5 | **Mesta** | | K 12 yellow | 16.0 |
| JRO 878 | 5.0 | JRCM 2 | 7.0 | MT 150 | 7.5 | SUIN 053 | 24.0 |
| TJ 40 | 3.5 | JRC 517 | 10.5 | HC 583 | 8.5 | SH 4 | 14.0 |
| JROM 1 | 6.0 | JBC 5 | 7.0 | AMC 108 | 6.0 | SUIN 037 | 15.0 |
| JROG 1 | 5.5 | JRC 212 | 7.0 | HS 4288 | 10.0 | JRJ 610 | 6.0 |
| CO 58 | 7.5 | JRC 80 | 7.5 | HS 7910 | 7.0 | Total | 75.0 |
| JRO 7835 | 5.5 | JRO 3690 | 4.0 | Central Kenaf JBMP 2 | 8.0 | Grand Total | 359.7 |
| JRO 632 | 4.0 | JRC 698 | 2.7 | JRKM 9-1 | 6.0 | | |
| JRO 2407 | 6.0 | Monalisa | 5.0 | AMV 3 | 7.5 | | |

### 2.2.1.2 Monitoring of foundation and certified seed production from breeder seed supplied by CRIJAF at Guntur, Andhra Pradesh

A team of scientists from CRIJAF visited Guntur, Andhra Pradesh to monitor the foundation seed production activity undertaken by different agencies using breeder seed of jute varieties supplied by CRIJAF (Fig. 2.3). It was observed

Fig. 2.3. Foundation seed plot of JRO 524 at Pusuluru Guntur, AP

that foundation seed production around Pedanandipadu, Pusuluru and Kakumanu were well managed and genetic purity was maintained as per recommendation. But in other areas like Pamidipadu and Punuru, genetic purity of foundation seed plots of CRIJAF varieties were not maintained and percentage of mixture of other jute varieties was more than their permissible limits. *(Source: NSP. Contributors: C.S. Kar, S.K. Biswas, Amit Bera and H.R. Bhandari).*

### 2.2.2 ICAR Seed Project

Quality seeds of different crops were produced under this project for distribution or sale among farmers. A total of 827.6 q seeds of different crops were produced. 52.2 q TL seeds of jute along with mesta (37.5 q), sunnhemp (15.7 q), dhaincha (19.6 q), paddy (490.0 q TL, 100.0 q certified), wheat (90.0 q) and mustard (56.5 q) were produced (Fig. 2.4). Planting material of sisal (50,000 bulbils & suckers) and ramie (2.8 q rhizome & 3.6 lakh plantlet) were also produced under this project. Revenue amount of Rs. 15.0 lakh has been generated in ICAR Seed Project during 2016-17. *(Source: MSP. Contributors: C.S. Kar, S.K. Biswas, Amit Bera, A. K. Jha, A. P. Singh, M. K. Tripathi and H.R. Bhandari).*

Fig. 2.4. TL seed production plot of mustard at CSRSJAF, Bud Bud

### 2.2.3 Seed Production Programme under NFSM Commercial Crops (jute)

Production of Foundation Seed was undertaken under the guidance and strict monitoring of ICAR-CRIJAF at WB (BCKVV, Nadia and other Govt. Farms), Bihar (JRS, Katihar, KVK Munger) of Jute variety JRO 204 and JRO 2407 and 7.2 q foundation seed was recorded certified as per Seed Standards of Govt. of India. Under Seed Village programme and production at Govt. Farm 32.8 q jute seed of JRO 204, CO 58, IRA, and S 19 was produced. *(Source: NFSM. Contributors: C.S. Kar and Amit Bera).*

### 2.2.4 Jute seed production in West Bengal: Exploring a new horizon

For popularization of jute seed production in drier tract of West Bengal, farmers' training programes were conducted on "Jute seed production techniques in drier tract of West Bengal" in 6 locations of district Bankura. Out of 6 training programmes, 2 were conducted before sowing, 2 during flowering period and remaining 2 were conducted during harvesting of jute seed crop. About 670 farmers participated in these training programmes. Total 165 CRIJAF Nail Weeder, 50 CRIJAF Multi-row Seed Drill and 46 Knapsack sprayers were also distributed among the farmers involved in jute seed production in district Bankura (Fig. 2.5) and Purulia. *(Source: DST, Govt. of West Bengal. Contributors: Amit Bera, C.S. Kar, and H. Choudhury).*

Fig. 2.5. One day training programme on jute seed production at Uparshol, Bankura

## 2.3 Seed Day

Seed day was organized on 15th March, 2017 at ICAR-CRIJAF, Barrackpore with an aim to create awareness among farmers regarding quality seeds. On that occasion 550 kg of TL jute seed (JRO 204, 220 kg; S 19, 110 kg; JRO 524, 55kg; CO 58, 110 kg and Ira, 55 kg) produced under ICAR seed project were distributed among 110 farmers of MGMG programme implemented by ICAR-CRIJAF. Total 200 farmers participated in this programme (Fig. 2.6 & 2.7). *(Source: ICAR Seed Project. Contributors: C.S. Kar, S.K. Biswas, Amit Bera, M.K. Tripathi, A.K. Jha, Amarpreet Singh and H.R. Bhandari).*


Fig. 2.6. Seed day at ICAR-CRIJAF under ICAR seed project on 15th March, 2017


Fig. 2.7. Director, ICAR-CRIJAF distributing jute seed of new varieties to farmers

# 3. Biotechnology

## 3.1. Functional Genomics in Jute

### 3.1.1. Identification and characterization of major genes involved in hemicellulose biosynthesis in bast and hypocotyl tissues of jute

Using the bast and hypocotyl transcriptomes of *Corchorus capsularis* cv. JRC-212 and its mutant *dlpf*, three isoforms of *Csl* (cellulose synthase-like) gene were identified in jute. This gene encodes 1,4-beta-D-xylan synthase (EC: 2.4.2.24) and is putatively involved in hemicellulose biosynthesis. All three Csl isoforms are present in bast tissue, whereas the hypocotyl tissue was characterized by only CcCsl3 (Table 3.1).

**Table 3.1: Major isoforms of *cellulose synthase-like* (Csl) gene in bast and hypocotyl tissues of jute**

| Isoform | Tissue | Unigene | Sequence (bp) | Coding region (aa) |
|---|---|---|---|---|
| *CcCsl1* | Bast | S1_30007 | 1104 | 348 |
| *CcCsl2* | Bast | S1_27822 | 828 | 131 |
| *CcCsl3* | Bast | S1_7093 | 1684 | 521 |
| | Hypocot | S3_11173 | 1792 | 521 |
| *CcmCsl3* | Bast | S2_10652 | 2249 | 654 |

Phylogenetic analysis of Csl proteins formed three clades in the phenogram (Fig. 3.1). Of the three isoforms, CcCsl1 and CcCsl3 were clustered with those of *Populus trichocarpa* and *Theobroma cacao*, respectively in clade II; however, CcCsl2 was not closely related to any Csl proteins of the species characterized including other bast fibre crops like flax. This results showed that CcCsl2 might be specific for xylan-type bast fibre formation because it was not expressed in hypocotyl tissue. Differential expression of all *CcCsl* genes were validated by qRT-PCRs, with wild-type and 18s gene (housekeeping) as experimental and endogenous controls, respectively.

### 3.1.2. Mapping of hypocotyl transcriptomes to major biosynthetic pathways in jute

Unigenes identified from hypocotyl transcriptomes were mapped to major biosynthetic pathways in jute based on KEGG-KAAS and BRITE hierarchies, followed by cross validation of protein families. Genes expressed in sucrose, starch, amino-sugar and nucleotide-sugar metabolism in hypocotyl tissues of the *dlpf* mutant and its wild-type cv. JRC-212 (*C. capsularis*) were identified.

In *C. capsularis* cv. JRC-212, a total of 200 unigenes were mapped to starch and sucrose metabolic pathway (Fig. 3.2). In comparison, 232 unigenes were associated with starch and sucrose metabolism in its mutant *dlpf*. Maximum isoforms

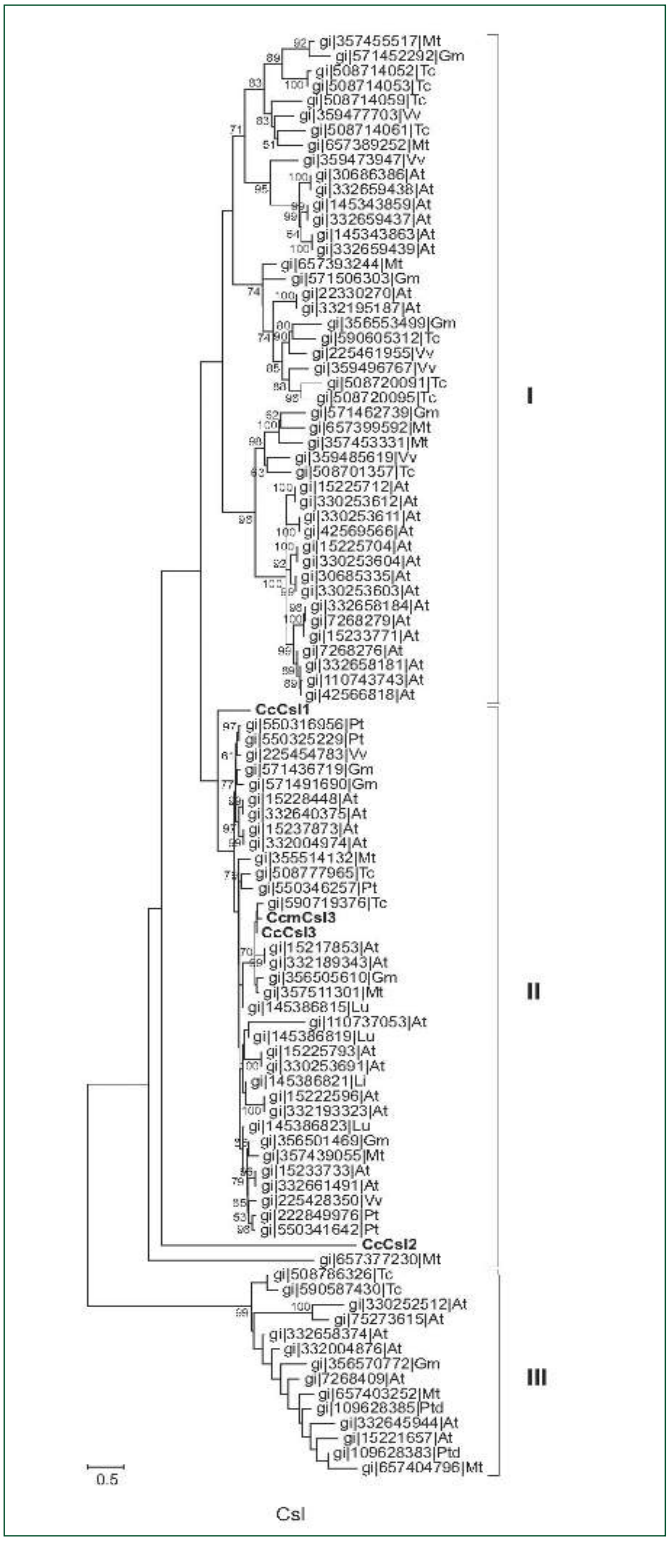



Fig. 3.1. Unrooted phylogenetic tree (neighbor-joining) of cellulose synthase-like (Csl) proteins of jute and those characterized from other plant species. Values at nodes represent % bootstrap support out of 1000 replicates (values > 50% are shown)

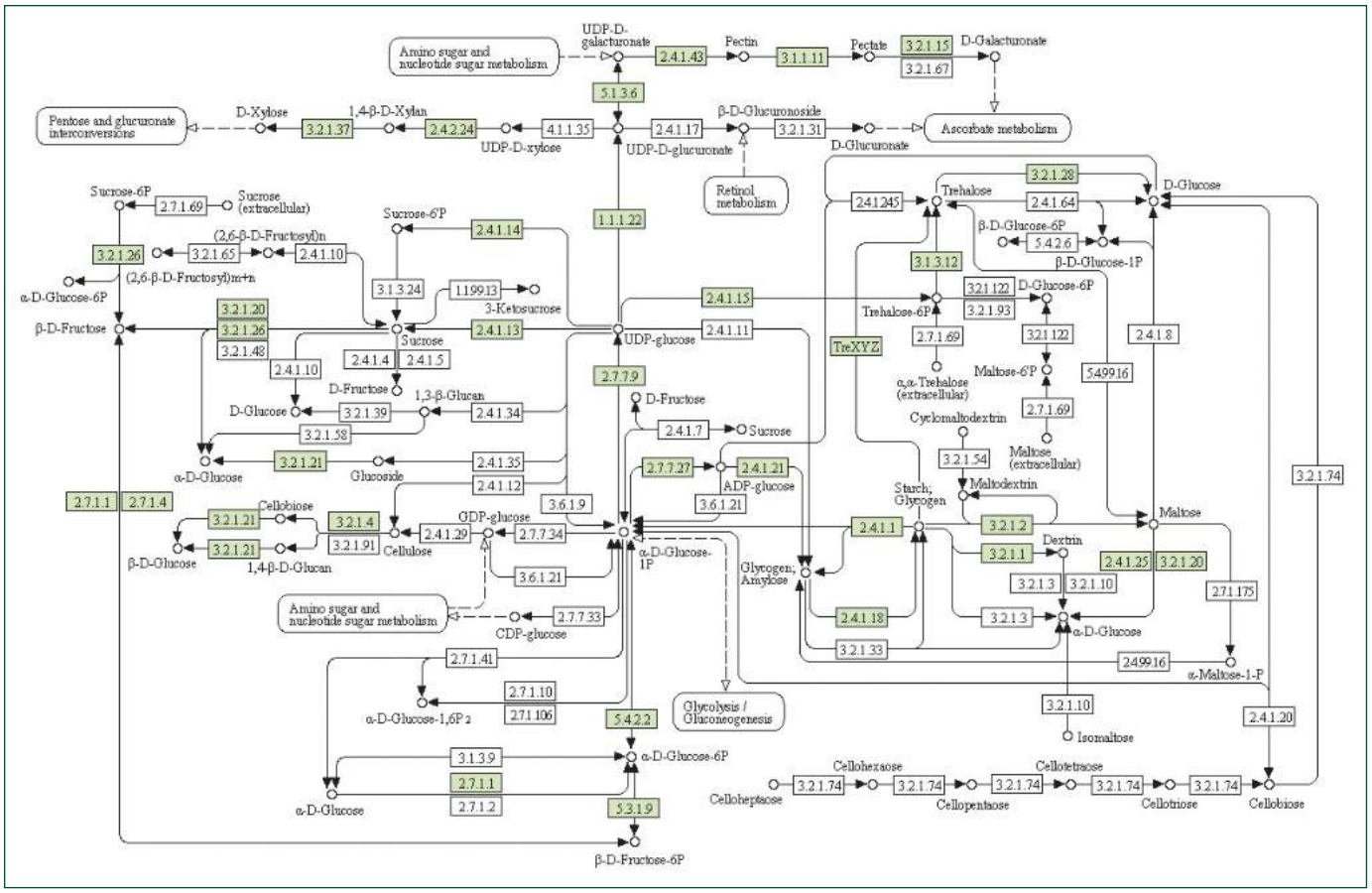



Fig. 3.2. KEGG pathway mapping of hypocotyl transcriptome of *C. capsularis* cv. JRC-212 to starch and sucrose metabolism (PATH:ko00500)

were identified for alpha-1,4-galacturonosyltransferase (GAUT), pectinestease, beta-glucosidae, trehalose 6-phosphate synthase/phosphatase (TPS) and UDP-glucuronate 4-epimerase (GAE). Altogether 145 wild-type unigenes were mapped to amino-sugar and nucleotide-sugar pathways. More or less the same number of mutant unigenes (150) were identified for amino-sugar and nucleotide-sugar metabolism. Fifteen isoforms of chitinases were identified in jute. However, only one isoform of fucokinase was identified.

### 3.1.3 Identification and characterization of β-galactosidase (BGAL) in hypocotyl tissues of jute

Twelve isoforms of β-galactosidase (BGAL) were identified in hypocotyl tissues of *C. capsularis* cv. JRC-212 and its mutant *dlpf*. Their sequence (bp) and coding region (aa) lengths are shown in Table 3.2.

**Table 3.2: Major isoforms of β-*galactosidase* (BGAL) gene in hypocotyl tissues of jute**

| Isoform | Unigene | Sequence (bp) | Coding region (aa) |
|---|---|---|---|
| CcBGAL1 | Unigene_S3_343 | 3077 | 863 |
| CcmBAL1 | Unigene_S4_38611 | 3422 | 857 |
| CcBGAL2 | Unigene_S3_32625 | 3698 | 1126 |
| CcmBAL2 | Unigene_S4_5026 | 3711 | 1126 |
| CcBGAL3 | Unigene_S3_43878 | 2208 | 611 |
| CcmBAL3 | Unigene_S4_928 | 2196 | 611 |
| CcBGAL4 | Unigene_S3_40156 | 3615 | 728 |
| CcmBAL4 | Unigene_S4_13559 | 2888 | 626 |
| CcBGAL5 | Unigene_S3_360 | 3171 | 819 |
| CcmBAL5 | Unigene_S4_32942 | 2822 | 773 |
| CcBGAL6 | Unigene_S3_15575 | 3219 | 848 |
| CcmBAL6 | Unigene_S4_32403 | 3265 | 848 |
| CcBGAL7 | Unigene_S3_7389 | 3024 | 864 |
| CcmBAL7 | Unigene_S4_19542 | 2644 | 774 |
| CcBGAL8 | Unigene_S3_32331 | 3193 | 882 |
| CcmBAL8 | Unigene_S4_35751 | 3281 | 657 |
| CcBGAL9 | Unigene_S3_28587 | 1870 | 490 |
| CcmBAL9 | Unigene_S4_38555 | 1978 | 490 |
| CcBGAL10 | Unigene_S3_32556 | 3317 | 724 |
| CcmBAL10 | Unigene_S4_52393 | 3402 | 499 |
| CcBGAL11 | Unigene_S3_33927 | 2436 | 734 |
| CcmBAL11 | Unigene_S4_1354 | 2545 | 734 |
| CcBGAL12 | Unigene_S3_4440 | 2192 | 462 |
| CcmBAL12 | Unigene_S4_21904 | 2214 | 462 |

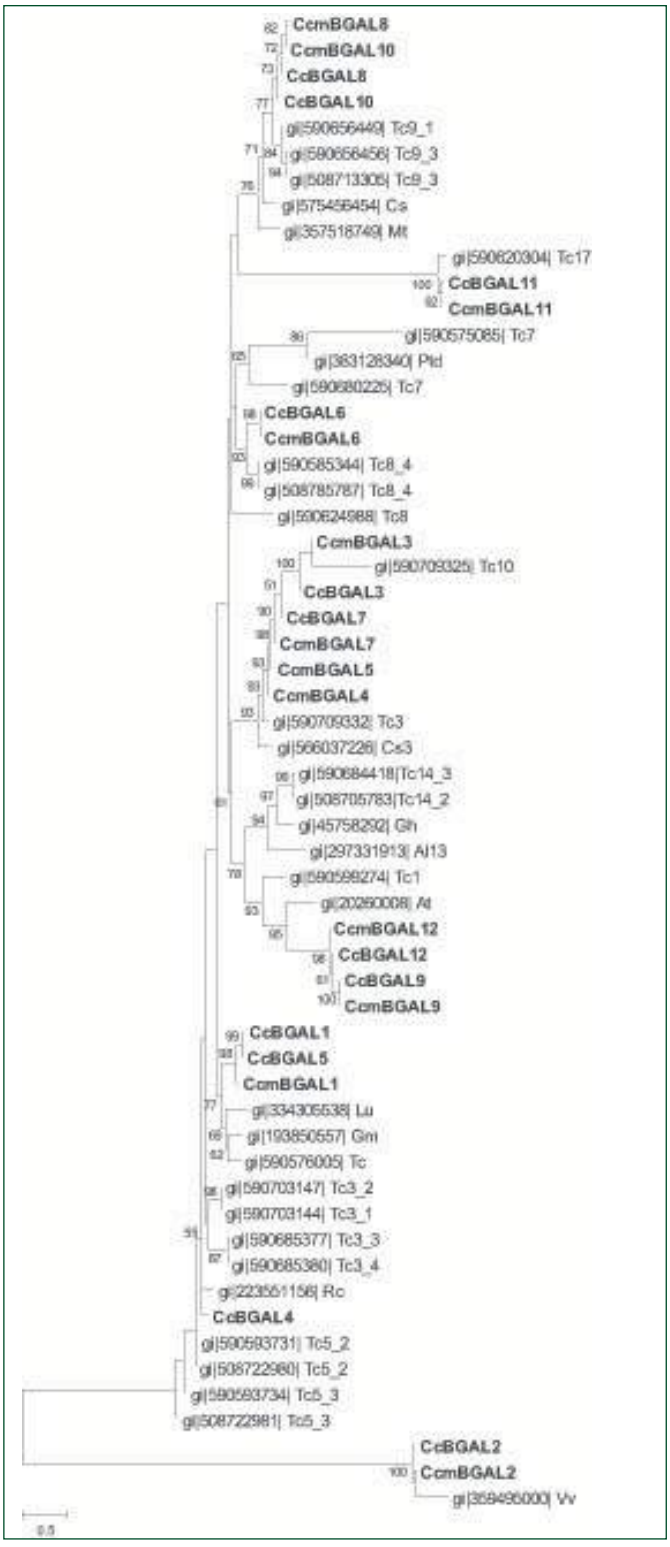



Fig. 3.3. Unrooted phylogenetic tree (neighbor-joining) of β-galactosidase (BGAL) proteins of jute and those characterized from other plant species. Values at nodes represent % bootstrap support out of 1000 replicates (values > 50% are shown)

The longest coding region (1126 aa) was identified for CcBGAl2, whereas the shortest for CcBGAL12 (462 aa). Phylogenetic analyses of BGAL proteins showed that CcBGAL1 and CcBGAL5 are closely related to those of *Linum usitatissimum* (flax), CcBGAL2 to those of *Vitis vinifera*, CcBGAL9 and CcBGAL12 to those of *Arabidopsis thaliana* and CcBGAL4 to those of *Ricinus communis* (Fig. 3.3). The other CcBGAL isoforms had the highest sequence homologies with those of *T. cacao*. Differential gene expression analyses based on qRT-PCR showed that all *CcBGAL* genes, except *CcBGAL7* and *CcBGAL9,* were up-regulated in mutant hypocotyl as compared to that in its wild-type. The up-regulation of so many *CcBGAL* homologues in lignin-deficient mutant suggested their putative development-specific roles in hypocotyl tissue. The down-regulation of *CcBGAL7* and *CcBGAL9* in mutant hypocotyl requires further in-depth development-specific gene expression analyses, in comparison with that in bast fibre. *(Source: ICAR-NPTC 3070. Contributor: D. Sarkar).*

## 3.2. Genetic Engineering and Tissue Culture

### 3.2.1 Herbicide tolerance in jute

An *in-vitro* shoot and root regeneration systems was developed in tossa jute (*Corchorus olitorius*) which will be used for transformation with genes conferring herbicide tolerance. For *in vitro* regeneration of shoots, among the two types of explants used, shoot tip explants showed better regeneration than cotyledonary petiole and can be used for genetic transformation. Shoots were successfully regenerated from shoot tip explants of cv. JRO 2407 and JRO 524 in standardized shooting medium (MS +2 µM BAP+ 0.54 µM NAA) after 25 days of culturing (Fig. 3.4). Shoots could be elongated in MS medium supplemented with 1 µM BAP & 3.27 µM GA3. Maximum shoots were obtained from standardized Shoot Growth Medium (2.85 µM NAA & 4.44 µM BAP) after 2 weeks of transferring in new medium. Rooting was obtained by culturing the regenerants under Standard Rooting medium (½ MS supplemented with 0.05% Myo-inositol+1.5% sucrose+0.30% Gelrite and 1.476 µM IBA) (Fig. 3.5). Best shoot regeneration from shoot tip explants was in shooting medium (SM) (MS+0.54 µM NAA +2 µM BAP); elongation medium (EM) (MS+1 µM BAP + 3.27 µM GA3) and rooting (medium (RM) ½ MS +1.5 µM IBA). Continuous culture in low NAA (0.25 µM) and BAP (0.5 µM)

Fig. 3.4. Shoot regeneration in standardized shooting medium

Fig. 3.5. Root regeneration in *in vitro* shoots

also allowed the shoot to proliferate almost as good as the above combinations. ½ MS + 0.25 µM NAA also allowed sufficient rooting. Rooted plantlets transferred to hardening medium (Soilrite + ½ MS without sucrose) for acclimatization (Fig. 3.6).

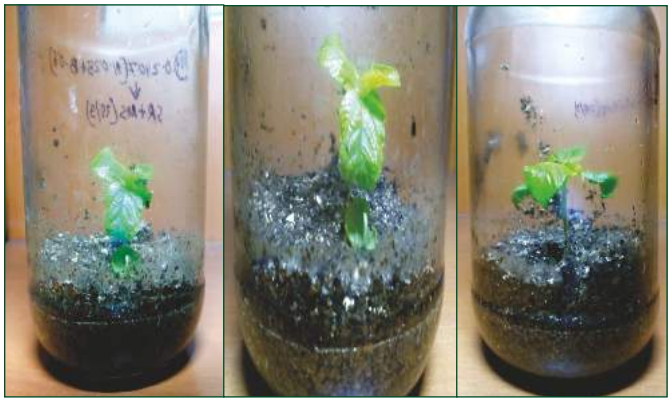


Fig. 3.6. Hardening and acclimatization of rooted plants

## Characterization of jute EPSPS gene for application of genome editing technologies

Herbicide tolerance in jute is being targeted at present mainly by introduction of a gene from another organisms, mostly bacteria, which is able to overcome the herbicide-induced metabolic blockage. However this transgenic technology is marred with regulatory labyrinth; and randomness of gene integration site & copy number; cost and time involved. Genome editing technologies enable precise modifications of DNA sequences and offer great promise for crop improvement. CRISPR/Cas9 has revolutionized genome editing because of its simplicity and versatility. We are attempting to develop an efficient method to introduce multiple discrete point mutations in the jute EPSPS and ALS gene using CRISPR/Cas9 to make major herbicides glyphosate and imazethapyr non-toxic to jute plant. The available jute transcriptome were searched for EPSPS genes and following two transcripts were identified in *Corchorus capsularis*, gi|757195277| and >gi|757233259|. Nucleotide and protein BLAST analyses revealed that these share considerable homology and share conserved motifs with other higher plant EPSPS genes. Jute EPSPS was found to share maximum homology with cacao (*Theobroma cacao*) followed by *Gossypium raimondii* and upland cotton (Fig. 3.7).

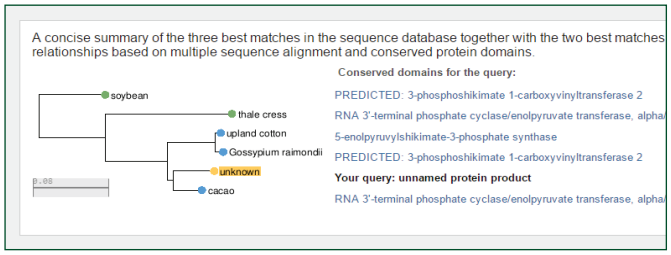



Fig. 3.7. Jute EPSPS gene shows strong homology with reported EPSPS from higher plants

Using bioinformatics tools, glyphosate-EPSPS interaction sites were predicted and key amino acids were identified. The following amino acids paly major role in glyphosate binding and therefore are potential targets for mutation and genome editing: K104, N182, A183, G184, Q267, D429, V430, E459, R506, E508, K535 (Fig. 3.8)**.** Startegies are being developed to finalize the selction of genomic target sites for editing and search for off-targeting, if any using bioinformatics tools. After synthesis of chimeric guide RNA and assembling the Cas9 / sgRNA construct, Agrobacterium based transformation and regeneration will be carried out. *(Source: ICAR-NPTC 3082. Contributor: S. Datta).*

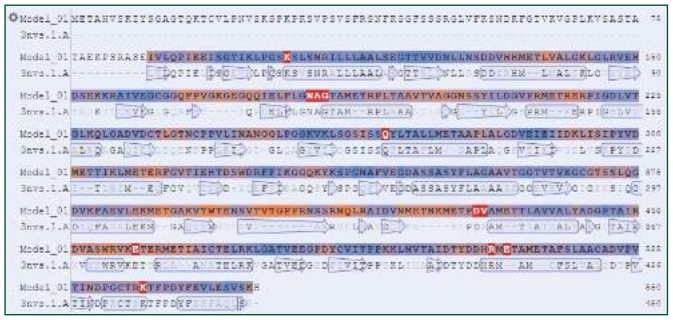


Fig. 3.8. Glyphosate binding residues in jute EPSPS (K104, N182, A183, G184, Q267, D429, V430, E459, R506, E508, K535).

### 3.2.2. Development of in vitro culture system in flax

### Plantlet regeneration in flax using hypocotyl explants

An efficient *in vitro* plantlet regeneration protocol was developed in flax (*Linum ustatisium*) var. JRF2 using 12 days old hypocotyl explants. Profuse callus induction was observed on MS medium with varying doses of cytokinins (Table 3.3.). Calli were highly friable, greenish with pale yellow patches. Multiple shootlets were developed on simple cytokinin enriched medium with 15-26 shootlets per calli which were elongated on the same medium. At 3-5 cm height, those shootlets were separated and cultured on rooting medium containing ½ MS with varying concentrations of auxin - IBA. Plantlets with well-developed rooting system were acclimatized in Hoagland solution (pH. 5.8) for three days under 16/8h light (~2000 lux)/dark. Further work is in progress.

**Table 3.3: Different synthetic hormones used for plantlet regeneration in flax cv JRF2**

| Hormone (mg/L) | No. of plates used for hypocotyl culture | No. of hypocotyls cultured/ plate | In vitro culture response (%) | | |
|---|---|---|---|---|---|
| | | | Callus induction | Shoot let induction | Rooting* |
| 1.0 TDZ | 10 | 5 | 100.0 | 75.0 | NA |
| 1.5 Kin | 10 | 5 | 100.0 | 95.0 | NA |
| 1.0 TDZ | 10 | 5 | Only swelled | - | NA |
| 1.0 BAP | 10 | 5 | 100.0 | 25.0 | NA |
| 1.0 BAP+0.5 IAA | 10 | 5 | 100.0 | 20.0 | NA |
| 1.5 IBA (1/2 MS) | | | NA | NA | 57.5 |
| 1.0 IBA (1/2 MS) | | | NA | NA | 50.0 |

*Rooting medium: ½ MS+IBA

### 3.2.3 *In-planta* floral-dip transformation in flax

To avert the hassles of *in vitro* culture based plantlet regeneration, an attempt was made for *in planta* transformation using *cry1A(b)* gene (Fig 3.9) to impart tolerance to lepidopteran insect pests via floral-dip transformation using *Agrobacterium* strain LBA4404.

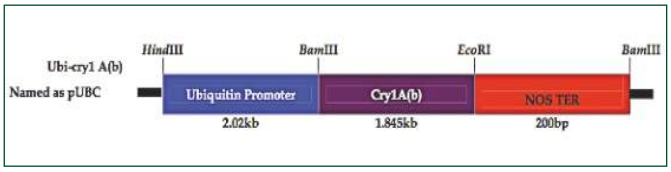



Fig. 3.9. Construct used in floral-dip transformation for transferring cry1A(b). Legends: cry1A(b) under up and down regulation of ubiquitin promoter and nos terminator (recipient vector pCAMBIA1301)

Flax var. JRF 2 seeds were sown on soil in pots under glasshouse condition. Emergence of primary inflorescence was checked regularly and after 4 weeks plants were made ready by cutting the leaves around the buds for floral-dip transformation. Floral-dipping was done in *Agrobacterium* cells (at an $O.D._{600}$ of 0.5 ) suspended in infiltration medium (IM) (5.0% sucrose + 01% Tween-20) and the buds were dipped in IM for 1-2min and covered with plastic wrap to maintain high humidity in the dome for overnight. The procedure was repeated in the succeeding day and after 48h, the plastic wrap was removed and the plants were maintained normally until their seeds were matured for collection (Fig. 3.10).


Fig 3.10. Different steps of floral-dip transformation, Legends: A. Buds dipped in IM containing Ag cells at an $O.D._{600}$ of 0.5, B. Plants were tagged after floral-dip, C. Plants kept covered with black polyethylene bags O/N, D. Plants grown till maturity of the seeds, E. Matured plants with capsules derived from floral-dipped buds, F. Matured capsules, G. Threshed seeds.

plants with capsules derived from floral-dipped buds, I. Matured capsules, J. Threshed seeds, K Matured cleaned seeds obtained from capsules.

**Analysis of transgene/s introgession:** The vectors introgessed into the bud had GUS reporter system. Upon floral-dip transformation, the buds were analysed for transient expression of the transgene/s after 48h. Collected buds were stained for GUS histochemical assay. Maximum buds displayed positive results (Fig. 3.11) which confirmed transgene/s introgession. PCR analysis confirmed successful introgression (Fig. 3.12) of the transgenes. *(Source: JB9.3. Contributors: A. B. Mandal and Kanti Meena).*


Fig. 3.11. Differential GUS expression in floral parts of flax var. JRF2, Legends: A. GUS stained buds obtained from floral-dip transformation of pBI121 (optimization) B. GUS stained buds obtained from floral-dip transformation of *Cry1A*(b) C. Close-view of a single flower showing distinct GUS stained reproductive parts.

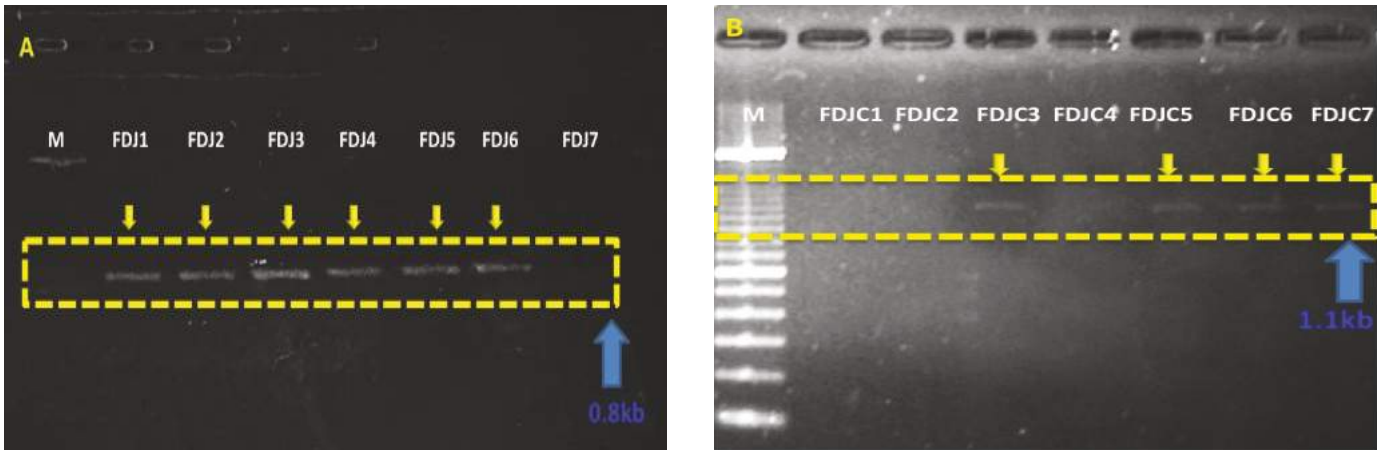



Fig. 3.12. PCR amplification of *npt II* & *uid A* genes. Legends: A. Lane1: Molecular 100bp ruler, Lanes 2-8: PCR amplicon profiles for npt II. PCR amplification of *npt II* gene (0.8 kb) in pBI121. 6 samples out of 7 showed correct amplification, B. Lane1: Molecular 100bp ruler, Lanes 2-8: PCR amplicon profiles for uid A. PCR amplification of *uid A* gene (1.1kb) in pCAMBIA1301 harbouring cry1A(b). 4 out of 7 DNA samples showed correct amplification.

### 3.2.4 Clonal fidelity test using RAPD & ISSR primers and polypeptide profiling to confirm true to type nature of the mericlones of *in vitro* micropropagated plantlets in ramie.

No ectopic expression of characters at the morphological level was observed among the mericlones obtained from *in vitro* micropropagation of ramie, which has been reconfirmed by molecular assays involving PCR studies and polypeptide profiling.

**PCR analysis:** PCR amplification was performed using a set of five RAPD primers-OPA5 (5'AGGGTCTTG3'), OPA6 (5'GGTCCCTGAC3'), OPA2 (5'TGCCGAGCTG3'), OPA1 (5'CAGGCCCTTC3'), OPA3 (5'AGTCAGCCAC3') and 3 ISSR primers A885 (5'BHBGAGAGAGAGAGAGA3'), A840 (5'GAGAGAGAGAGAGAGAYT3'), A842 (5'GAGAGAGAGAGAGAGAYC3') were used for assessing variation at genomic level in mother plant and different mericlones, following standard procedure. Reaction was carried out in 25 µl volume containing 1X reaction buffer, 2.5 mM $MgCl_2$, 1.0 unit of Taq DNA polymerase, 0.2 mM dNTPs, 50-100 ng of gDNA, and 5-10 pmol of primer. Thermal cycling was performed following preheating for 5 (RAPD)/4 (ISSR) min at 94˚C; followed by 44 cycles for 1 min (RAPD) /30 sec (ISSR) at 94 ˚C (denaturation), 1 min at annealing temperature based on the primer Tm and 2 min at 72 ˚C (extension), and

1 cycle of final extension at 72 ˚C for 10 min followed by cooling to 4 ˚C. PCR amplicons were electrophoresed on a 1.6 % agarose gel containing ethidium bromide in 0.5 X TBE buffer at 80V for 1 1/2 h. Size of the amplification products was estimated using 1kb DNA ladder (Fig. 3.13).

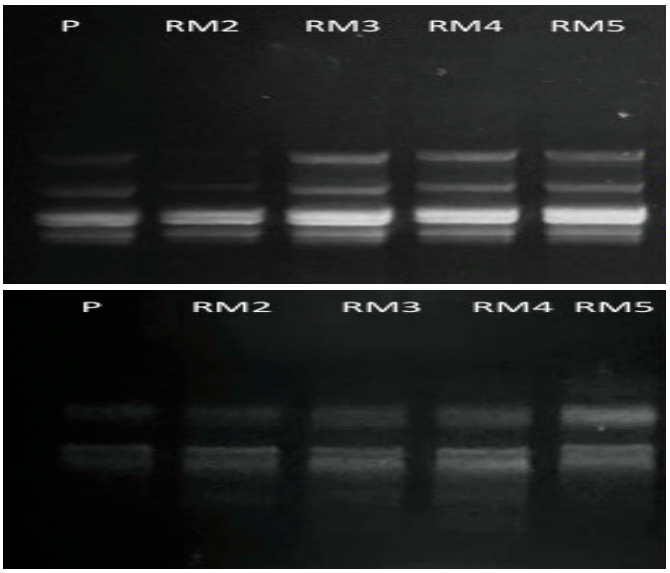



Fig. 3.13. PCR amplicon profile of micropropagated ramie plants using RAPD (OPA5) and ISSR primers (A840). Legends: lanes 1: Parent; 2: RM2; 3:RM3;4:RM4;5:RM5.

**Polypeptide profile studies:** About 100 mg young leaf samples from 3 months old field grown plants (derived from *in vitro* micropropagated plants), were used for protein extraction by TCA Acetone method in liquid $N_2$. Protein was quantified following Bradford method. Crude samples (20µg/µl) were subjected to SDS-PAGE following Laemmli 1976. No variation was observed in respect of polypeptide profile of the mericlones compared to the parent. In essence, no deviation in banding profile was detected with respect to 5 RAPD primers, 3 ISSR primers and polypeptide profile, which indicates true-to-parent nature of the mericlones, which is desirable in an *in vitro* micropropagation protocol for raising safe planting materials for large-scale cultivation. *(Source: JB 9.3. Contributors: A. B. Mandal and Kanti Meena).*

### 3.2.5. DNA fingerprinting for roselle varieties

Seed materials (foundation) from 10 roselle variety were selfed to obtain homozygous seed. Those seeds were germinated under laboratory condition in petri dishes. The germinating seedlings after 5 days were used for genomic DNA isolation by bulking 20 seedlings in each variety using CTAB method. The DNA was quantified for quality and quantity in agarose and spectrophotometer. PCR analysis was carried out using 20 kenaf based EST- SSR, 10 SRAP combination and 10 ISSR markers. SRAP combination Me3m9 showed variation in sample no. 3 (AMV-4) (Fig 3.14) and ISSR U836 showed variation in sample no. 9 (GR-27).These markers may be used to diagnose the variety at molecular level.

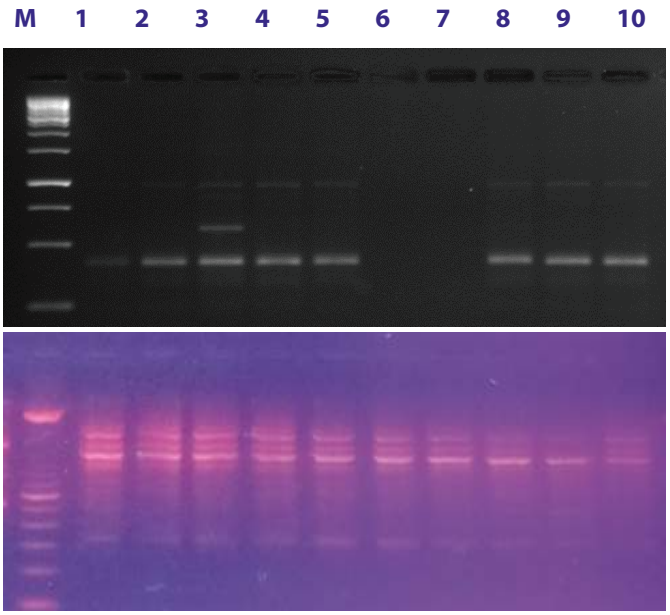



Fig. 3.14. Screening 10 roselle varieties with SRAP (Me3Em9) marker (A) and ISSR (U836) marker (B). Legends, M: 1kb ladder, Lanes1-10: 1: AMV1, 2: AMV2, 3: AMV4, 4: AMV2, 5: CRIJAF5, 6: CRIJAF8, 7: HS 4288, 8: HS 7910, 9: GR-27, 10: Non-bris

Genomic DNA was isolated from 10 each male sterile and fertile lines of kenaf and the bulk of sterile and fertile were screened with 20 EST-SSR (Kenaf based) and 30 SSR (jute based markers), however no polymorphic markers were identified. There is urgent need for screening more number of markers to have ample polymorphism, which will be undertaken in future. *(Source: JBT 4.5. Contributor: Kanti Meena, P. Satya, S. K. Pandey and H. K. Sharma).*

## 3.3 Bioinformatics in Fibre Crops

### 3.3.1 RNA-seq analysis in Sunnhemp for marker discovery and self-incompatibility gene identifications

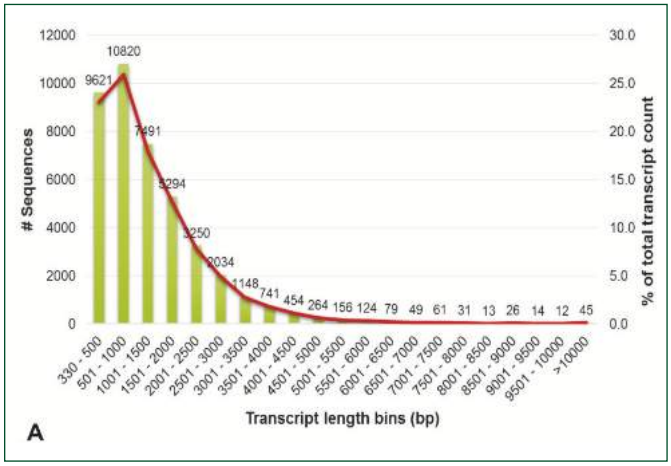
Genomic resources in Sunnhemp (*Crotalaria juncea* L.) are scarce affecting the genetic characterization of germplasm and identification of self-incompatibility genes for genetic improvement. Unopened flower buds from 60-day old plant of Sunn hemp cultivar SUN-053 (SWASTIKA) was used for high quality RNA extraction and 2 x 150 bp paired end library preparation. The library was sequenced with Illumina NextSeq 500 platform for generating ~5-10 GB data (NCBI Biosample accession number - SAMN05942583; Bioproject number - PRJNA350604; SRA number - SRR5043622). The raw sequence data of the flower RNA-seq was processed and filtered in house using FastQC and Trimmomatic tools. The processed data were assembled using the de novo Trinity software with minimum contig length >300, K-mer size 31, K-mer coverage 2 and read normalized options. Finally, the RNA-seq assembly was filtered based on RSEM value filtration with TPM=3, FPKM=3 and Isopact=1 to obtain a high quality assembly of 41727 trinity transcripts. The N-50

stat of the assembly was found 1906, with a median contig length of 1025, average contig length of 1360 and a total of 56.76 million bases (Table 3.4).

**Table 3.4: Details of the RNA-seq read generated and assembled in Sunnhemp**

| RNA-seq features | Values |
|---|---|
| Library | 2 x 150 bp PE |
| Raw reads | 23415447 (~7 GB) |
| De novo Trinity assembly after read filtering | 177071 |
| Total trinity 'genes' | 75473 |
| Contig N50 | 1722 |
| Post RSEM value filtration (cutoff tpm=3.0; fpkm=3.0; isopact=1.00) | **41727 (26971 Genes)** |
| Contig N50 | 1906 |
| GC percentage | |

Sequence length distribution and Isoform contained in the RNA-seq assembly of Sunnhemp is provided in Fig. 3.15. Further, the quality of RNA-seq assembly was analyzed using Transdecoder (33,366 proteins) and Trinotate (9,643 proteins from viridiplantae origin) tools to predict proteins in the assembly and evaluated against the EuKaryotic Orthologous Group (KOG) database. Predicted transcript numbers were compared to published transcriptome of other legumes, such as *Glycine max*, *Phaseolus vulgaris* and *Vigna unguiculata* to find a significant number of transcript sequence matches. The RNA-seq assembly was used for identification of transposable elements (TEs) and transcription factor (TF)-coding genes. As a part of molecular marker discovery, 3,591 non-redundant SSR primers consisting of di, tri and tetranucleotide repeats from 10,199 SSR loci and 4,769 putative Intron Linked Polymorphism (ILP) markers were discovered for validations.



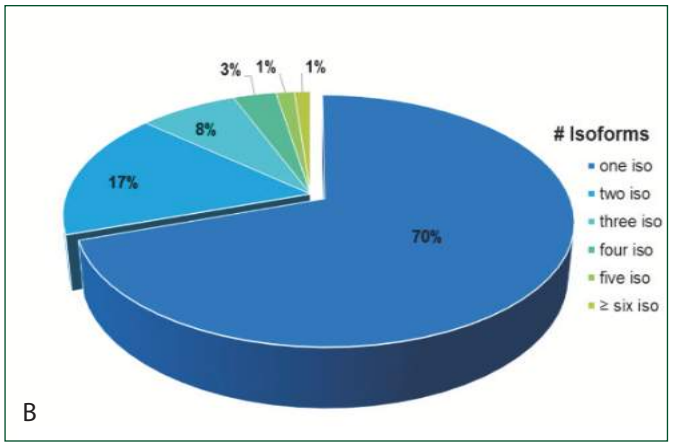




Fig. 3.15. Length distribution (a) and content of isoforms (b) in RNA-seq assembly of sunnhemp

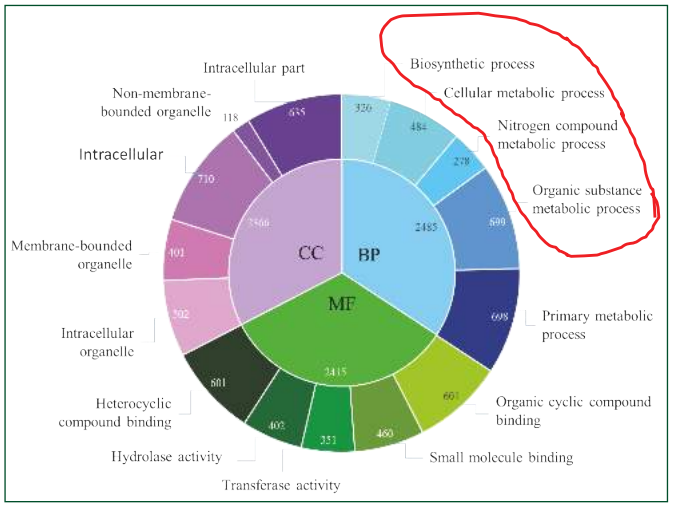



Fig. 3.16. Blast2GO analysis of the jute unigene sequences consisting of ILP markers.

### 3.3.2 Novel intron-linked polymorphism (ILP) marker development from jute unigenes

A non-redundant set of 6,037 intron-linked polymorphism (ILP) markers were mined from 34,163 jute unigene sequences using Arabidopsis gene and introns as model (Table 3.5). Based on BLAST2GO analysis, these ILP markers

**Table 3.5: Details of ILP marker discovery from jute unigenes.**

| Descriptions | Values |
|---|---|
| Total jute Unigenes analyzed | 34,163 |
| Total ILP markers returned | 24,972 |
| Total number of unigenes with ILP markers | 5,864 |
| Found match to Arabidopsis unigenes | 3812 |
| After redundancy check and single amplimer filtration | 6037 from 2290 unigenes (~2.64 ILP markers per unigene) |

were found to be associated with important genes involved in important biological processes (Fig. 3.16). Out of these 6,037 ILP markers, 4649 (77%) and 2627 (43.5%) found complementary unique binding site in the published *C. capsularis* and *C. olitorius* genome, respectively. These markers are being utilized in validation for characterization of jute germplasm. *(Source: CI-JBT 4.4. Contributors: Dipnarayan Saha, Subhojit Datta, Asim Kumar Chakraborty and Pratik Satya).*

### 3.3.3 Functional marker development and characterization of fibre flax germplasm

Functional gene derived simple sequence repeat (SSR) markers from transcription factor (TF) - coding genes and long non coding RNA (lncRNA) sequences were developed in flax. A non-redundant set of 506 and 74 SSR markers were deigned from 2481 TF-coding genes and 2603 lncRNA sequences, respectively. A subset of 60 TF-derived SSR and all the 74 lncRNA-derived SSR primers were chosen to analyze population structure and genetic polymorphisms among the 93 fibre flax accessions consisiting of exotic fibre flax accessions from a published core collection and Indian dual purpose or fibre type accessions. The average number of allele estimated was 2.5 per locus and the average polymorphism information content (PIC) value 0.26 per primer. Average gene diversity (He) and observed heterozygosity (Ho) ranged from 0.01 to 0.63 (average 0.32) and 0.00 to 0.98 (average 0.17), Fig. 3.17. Structure analysis showing optimum K=2 (a) and membership contributions of Indian and exotic fibre flax (b). Hierarchical clustering analysis pattern through PCoA (c) and unweighted neighbor joining clustering (d) patterns were also depicted in figure, respectively

A Bayesian model based approached clustered the fibre flax accessions into two clusters based on optimum K value=2 and the Q matrix membership contribution. Among the 93 fibre flax accessions, 75 were considered as pure type (Q score >80%), while 18 accessions (Q score <80%) consisted of admixtures. As per the AMOVA analysis, out of the total variations, 25% of variation was attributed to variability among populations, 30% to among individuals of the populations and 45% to within individuals. The $F_{ST}$ value 0.248 indicates a moderate level of genetic differentiation existing between the two populations. Principal coordinate's analysis (PCoA) and genetic dissimilarity based clustering analysis revealed significant differentiation of the Indian and exotic fibre flax accessions with few of them placed in a mixed cluster (Fig. 3.17). A subset or core of 16 fibre flax consisting of both Indian accessions and exotic accessions (IC0096564, IC0096567, IC0096595, IC0096666, JRF3 and IC0096556, AR-1, Belochka, CIli 593, CIli-590, CIli 1129/Atlas Fibre, Korostenskij 3, Nika, Tammes type 2, Torok 11 and Wada fiber) were found to retain 99.5% of the allelic richness. *(Source: JB 10.3. Contributors: Jiban Mitra, Dipnarayan Saha and Kunal Mandal).*

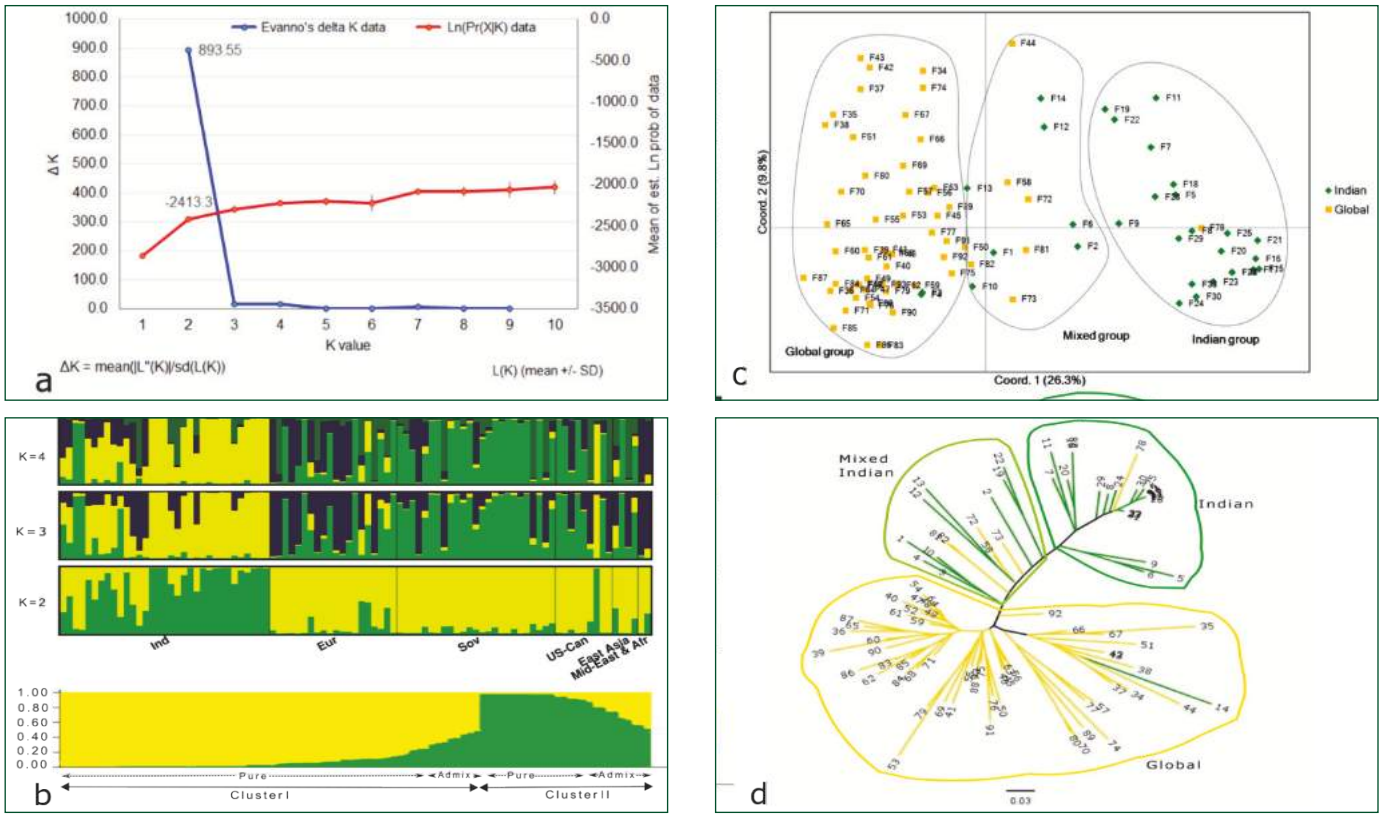



Fig. 3.17. Structure analysis showing optimum K=2 (a) and membership contributions of Indian and exotic fibre flax (b). Hierarchical clustering analysis pattern through PCoA (c) and unweighted neighbor joining clustering (d) patterns were also depicted in figure, respectively

# 4. Soil and Nutrient Management

## 4.1 Soil Health

### 4.1.1 Long term fertilizer experiment (LTFE)

Long-term (45 years) effect of continuous application of farmyard manure and inorganic fertilizer either alone or in combination on crop yields, nutrient uptake and soil properties were evaluated in a permanent field trial in jute-rice–wheat cropping system. During the period under report jute (cv. JRO 524), rice (cv. Khitish), and wheat (cv. UP 262) were cultivated with different combination of fertilizer and manurial treatment.

**Crop Yield:** Yield of jute, rice and wheat ranged from 8.73 to 20.78 q $ha^{-1}$, 11.30 to 32.50q $ha^{-1}$ and 4.68 to 16.68 q $ha^{-1}$, respectively, under different treatments (Table 4.1). Application of fertilizers, alone or in combination with FYM significantly increased the yield of jute, rice and wheat over control. The highest yield of rice and jute was recorded in 100% NPK+FYM treatment, whereas highest yield in wheat was recorded in 150% NPK treatment combination. The 150% NPK treatment was found to be at par with the application of 100% NPK+FYM, while inclusion of K along with NP (100% NPK) caused an increase of around 27.82%, 35.0% and 16.51% over application of 100% NP in jute, rice and wheat, respectively.

**Table 4.1. Yield of jute, rice and wheat during 2015-16 in LTFE**

| Treatment | Yield (q/ha) 2015-16 | | |
|---|---|---|---|
| | Jute | Rice | Wheat |
| 50% NPK | 13.11$^{cd}$ | 22.58$^{e}$ | 9.33$^{d}$ |
| 100% NPK | 18.69$^{b}$ | 29.01$^{b}$ | 15.33$^{abc}$ |
| 150% NPK | 20.52$^{a}$ | 31.88$^{a}$ | 16.68$^{a}$ |
| 150% NPK+HW | 14.69$^{c}$ | 27.61$^{bc}$ | 12.88$^{bc}$ |
| 100% NPK +Zn | 17.31$^{b}$ | 28.99$^{b}$ | 15.68$^{ab}$ |
| 100% NP | 13.61$^{c}$ | 25.02$^{d}$ | 12.10$^{cd}$ |
| 100% N | 11.61$^{d}$ | 22.60$^{e}$ | 12.13$^{cd}$ |
| 100% NPK + FYM | 20.78$^{a}$ | 32.50$^{a}$ | 16.33$^{a}$ |
| 100 % NPK – S | 13.90$^{c}$ | 26.10$^{cd}$ | 12.68$^{bcd}$ |
| Control | 8.73$^{e}$ | 11.30$^{f}$ | 4.68$^{e}$ |

*Mean values in a column followed by a common letter are not significantly different by DMRT at 5% level

**Nutrient Uptake:** Nutrient uptake by jute, rice and wheat was higher in fertilized plots as compared to the unfertilized control. Application of 100% NPK+FYM resulted in higher uptake of N, P in jute (96.9, 31.1 kg $ha^{-1}$) and rice (83.9, 15.6 kg $ha^{-1}$) (Fig.4.1 and Fig. 4.2). NPK uptake by jute, rice and wheat increased with increasing dose of fertilizer. Total K uptake varied from 57.1 to 120 kg $ha^{-1}$ in jute, 44.9 to 69.5 kg $ha^{-1}$ in rice and 26.0 to 98.1 kg $ha^{-1}$ in wheat, respectively (Fig. 4.3). The highest potassium uptake was found in 100%NPK+FYM, followed by 150% NPK and the lowest K uptake was observed in control plots in all the crops.

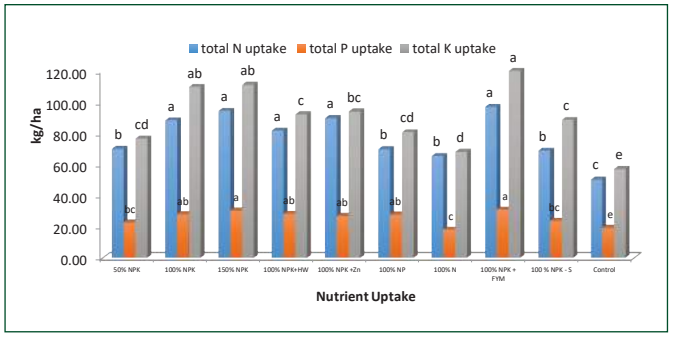



Fig.4.1.Nutrients uptake by jute under different fertilizer treatments

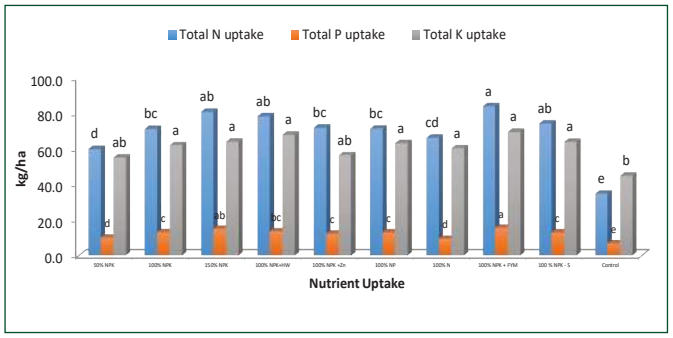



Fig.4.2. Nutrients uptake by rice under different fertilizer treatments

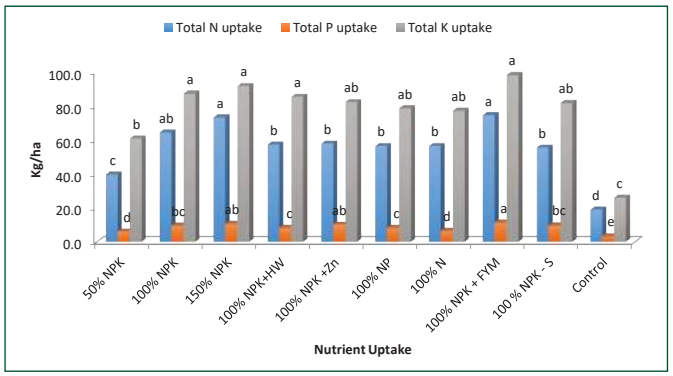



Fig.4.3. Nutrients uptake by wheat under different fertilizer treatments

**Uptake of a nutrient under different treatments followed by a common letter is not significantly different by DMRT at 5% level*

**Soil Properties:** Major physicochemical properties of surface soil were presented in Table 4.2. The soil pH ranged from 7.24 to 7.52. Continuous cropping without application of any organic manure and chemical fertilizers resulted in the lowest concentration of OC in the soil. Among different treatments, soils supplied with 100% NPK+FYM had as much as 51% higher OC when compared with no-fertilizer/ no-manure control. There was significant difference among

the treatments with respect to N, P and K availability in soil. Highest available K was observed in 150% NPK treated soil while the highest available N and P were observed in 100% NPK+FYM treated soil. Integrated use of organic manure and chemical fertilizers resulted in a positive influx of nutrients thereby increased OC, available nitrogen, available phosphorus and available potassium in the soil from 5.91 to 8.98 g/kg, 198.71 to 276.95 kg/ha, 3.99 to 68.99 kg/ha, and 125.64 to 197.98 kg/ha respectively. *(Source: JC 5.2. Contributors: D.K. Kundu, S.P. Mazumdar, A.R. Saha, B. Majumdar, A.K. Ghorai and M.S. Behera)*

**Table 4.2. Effect of chemical fertilizer and organic manures on physicochemical properties of surface soil**

| Treatment | pH | Organic Carbon (g/kg) | Available Nutrients | | |
|---|---|---|---|---|---|
| | | | N (kg/ha) | P (kg/ha) | K (kg/ha) |
| 50% NPK | 7.31$^{bc}$ | 6.98$^{d}$ | 245.69$^{bc}$ | 29.66$^{d}$ | 155.84$^{d}$ |
| 100% NPK | 7.31$^{bc}$ | 7.23$^{c}$ | 255.25$^{ab}$ | 48.23$^{c}$ | 178.75$^{b}$ |
| 150% NPK | 7.33$^{bc}$ | 7.38$^{b}$ | 271.95$^{a}$ | 62.47$^{b}$ | 197.98$^{a}$ |
| 150% NPK+HW | 7.37$^{b}$ | 7.30$^{bc}$ | 224.81$^{c}$ | 27.03$^{d}$ | 177.31$^{b}$ |
| 100% NPK +Zn | 7.31$^{bc}$ | 7.20$^{c}$ | 245.86$^{bc}$ | 28.00$^{d}$ | 179.24$^{b}$ |
| 100% NP | 7.33$^{bc}$ | 7.19$^{c}$ | 245.49$^{bc}$ | 47.94$^{c}$ | 122.87$^{f}$ |
| 100% N | 7.24$^{c}$ | 6.80$^{e}$ | 240.27$^{bc}$ | 3.99$^{f}$ | 129.97$^{e}$ |
| 100% NPK+FYM | 7.52$^{a}$ | 8.98$^{a}$ | 276.95$^{a}$ | 68.99$^{a}$ | 197.09$^{a}$ |
| 100 % NPK - S | 7.32$^{bc}$ | 6.98$^{d}$ | 240.32$^{bc}$ | 20.61$^{e}$ | 173.00$^{c}$ |
| Control | 7.33$^{bc}$ | 5.91$^{f}$ | 198.71$^{d}$ | 6.40$^{f}$ | 125.64$^{f}$ |

*Mean values in a column followed by a common letter are not significantly different by DMRT at 5% level

### 4.1.2 Long-term soil carbon changes in different fertilizer treatments in jute based agro-ecosystem

A study on carbon sequestration under jute based agro-ecosystem was initiated with an objective to see resulting change in soil organic carbon (SOC) due to continuous application of chemical fertilizer and manures. To simulate the SOC changes as influenced by different combination of fertilizer uses on jute based cropping system, RothC model was used. It was also assessed that how many years is required to reach the equilibrium point of SOC with the amount of plant residues and manure inputs which were supplied since the year 1972.

The graph of RothC modelled and measured SOC data of three fertilizer treatments used in this study is presented in Fig. 4.4. Under $NPK_{000}$ and $NPK_{100}$ treatments, simulation of 40 years data indicates that the SOC content increases slightly at the beginning (year 1973-1985), then it decreases gradually afterwards. Whereas in case of $NPK_{100+FYM}$ treatment, SOC contents was slightly increased from its initial value and maintained the increased value till the year 2012. To arrive equilibrium point of SOC (18.18 t C/ha), $NPK_{000}$ and $NPK_{100}$ treatments took almost 39 years and 35 years, respectively. $NPK_{100+FYM}$ treatment took about 27 years to reach the equilibrium point. The yearly contribution of plant residues from jute plants was about 1.03 t C/ha, followed by wheat (0.68 t C/ha) and rice (0.49 t C/ha). The result shows that fertilizer management systems, which include FYM, have more capacity to recover the soil carbon. The initial SOC content had a large effect on the SOC recovery capacity. *(Source: JA 6.0. Contributors: A.K. Singh, M.S. Behera, D. Barman, A.R. Saha, S.P. Mazumdar and D.K. Kundu)*

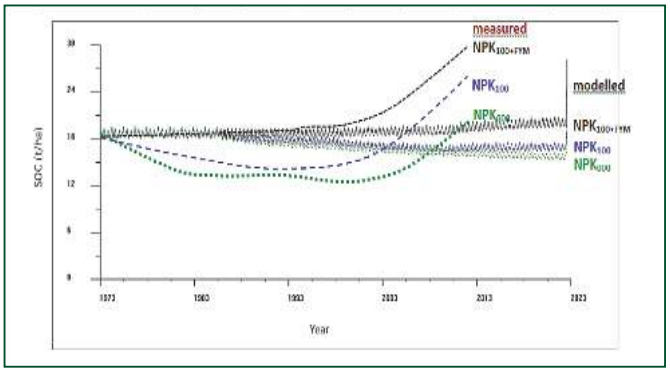



Fig 4.4. Modelled and measured soil carbon over time for three fertilizer treatments under Jute-Rice-Wheat cropping system

## 4.2. Nutrient Management

### 4.2.1 Soil test and integrated plant nutrient management for sustainable agriculture (STCR)

Targeted yield equations for jute (JRO 2407) and rice (Banskathi) have been derived with all the basic data i.e., nutrient requirement, soil fertilizer and organic efficiency.

| Jute (JRO 2407) | Rice (Banskathi) |
|---|---|
| FN= 9.35 T-0.78 SN-0.38 ON | FN= 9.64 T-0.85 SN-0.13 ON |
| FP= 2.99 T-1.53SP-0.20 OP | FP= 1.72 T-0.78SP-0.07 OP |
| FK= 4.39 T-0.57SK-0.10OK | FK= 3.37 T-0.39SK-0.08OK |

The field verification trials on jute (var. JRO 204) and rice (var. GS 3) were undertaken in the farmers' fields at different locations. Application of fertilizers as per ST-TY with and without FYM achieved the target of 40 q/ha fibre production of jute with (-) 11.00 and (-) 7.25 % yield deviation, respectively (Table 4.3). Application of fertilizers as per ST-TY with and without FYM achieved the target of 50 q/ha grain production of rice with (+) 1.6 and (+) 7.2% yield deviation, respectively (Table 4.4). Application of fertilizers as per ST-TY with and without FYM achieved the target of 22 t/ha tuber yield of potato. *(Source: JA 5.6 Contributors: A. R. Saha, B. Majumdar, S. P. Mazumdar)*

**Table 4.3. Verification of IPNS fertilizers prescription equations of jute (JRO 204) in farmers' fields**

| Treatments | Fertilizer Doses (kg/ha) N:$P_2O_5$:$K_2O$ | Fibre Yield (q/ha) | Cost of cultivation (Rs/ha) | Net return (Rs/ha) | Yield Deviation (%) | B:C ratio |
|---|---|---|---|---|---|---|
| Control | 0:0:0 | 20 | 62000 | 8000 | - | 1.1 |
| FP | 59:50:50 | 31 | 66693 | 41807 | - | 1.6 |
| RD | 80:40:40 | 31.9 | 66185 | 45465 | - | 1.7 |
| ST-TY (35q/ha) | 89:40:19 | 32 | 65706 | 46294 | -8.57 | 1.7 |
| ST+FYM (35 q/ha) | 82:36:18 | 33.3 | 65386 | 51164 | -4.86 | 1.8 |
| ST-TY (40 q/ha) | 123:49:24 | 35.6 | 66744 | 57856 | -11.00 | 1.9 |
| ST+FYM (40q/ha) | 116:46:22 | 37.1 | 66446 | 63404 | -7.25 | 2.0 |

FP=Farmer's Practice, RD=Recommended dose, ST=Soil Test, TY=Target yield, FYM=Farmyard Manure

**Table 4.4. Verification of IPNS fertilizer prescription equations of rice (GS 3) in farmer's field during 2016-17**

| Treatments | Fertilizer Doses (kg/ha) N:$P_2O_5$:$K_2O$ | Grain Yield (q/ha) | Cost of cultivation (Rs/ha) | Net return (Rs/ha) | Yield Deviation (%) | B:C ratio |
|---|---|---|---|---|---|---|
| Control | 0 :0 :0 | 21.3 | 30000 | 1311 | - | 1.0 |
| FP | 59:50:50 | 44.6 | 34693 | 30869 | - | 1.9 |
| RD | 80:40:40 | 45.3 | 34185 | 32406 | - | 1.9 |
| ST-TY (45 q/ha) | 65:31:31 | 47.1 | 33282 | 35955 | 4.7 | 2.1 |
| ST+FYM (40 q/ha) | 59:21:23 | 49.6 | 32477 | 40435 | 10.2 | 2.2 |
| ST-TY (50 q/ha) | 121:44:53 | 50.8 | 35291 | 39385 | 1.6 | 2.1 |
| ST+FYM (50q/ha) | 115:34:45 | 53.6 | 34485 | 44307 | 7.2 | 2.3 |

FP=Farmer's Practice, RD=Recommended dose, ST=Soil Test, TY=Target yield, FYM=Farmyard Manure

### 4.2.2 ST-TY equation based INM on nutrient budgeting under jute-rice-lentil system

An experiment was conducted to study the long term effect of ST-TY equation based integrated nutrient management on yield and nutrient budgeting under jute-rice-lentil sequence. The treatments were $T_1$- control, $T_2$-ST-TY (5 t/ha), $T_3$-ST-TY (4 t/ha), $T_4$-$T_3$+FYM (5 t/ha), $T_5$-$T_3$+Azotobacter+PSB, $T_6$-$T_4$+Azotobacter+ PSB, $T_7$-FYM @ 5 t/ha, $T_8$-$T_7$+Azotobacter+PSB, $T_9$-Recommended dose of fertilizer (RDF), and $T_{10}$-Farmers practice (FP).

**Table 4.5. Effect of ST-TY based fertilizers application on jute fibre yield and agronomic efficiency**

| Treatment | Fibre yield (q/ha) | Agronomic efficiency (kg/kg) | | |
|---|---|---|---|---|
| | | N | $P_2O_5$ | $K_2O$ |
| $T_1$- Control | 18 | - | - | - |
| $T_2$- ST-TY(4 t/ha) | 38 | 11.8 | 39.6 | 25.7 |
| $T_3$- ST-TY(3.5 t/ha) | 35 | 12.7 | 40.3 | 26.4 |
| $T_4$- $T_3$+FYM (5 t/ha) | 36.8 | 15.8 | 50.0 | 32.5 |
| $T_5$- $T_3$+Azotobactor+PSB | 34.7 | 14.0 | 44.3 | 28.8 |
| $T_6$- $T_4$+ Azotobactor+PSB | 38.7 | 17.2 | 54.3 | 35.3 |
| $T_7$- FYM @ 5 t/ha | 28.2 | - | - | - |
| $T_8$- $T_7$+ Azotobactor+PSB | 32.7 | - | - | - |
| $T_9$- RDF | 33.9 | 18.9 | 37.8 | 37.8 |
| $T_{10}$- FP | 26.5 | 35.2 | 13.7 | 13.7 |

Application of fertilizers as per ST-TY could achieve the targeted yield of 40 q/ha jute fibre with (-) 5.0% yield deviation. ST-TY in combination with FYM achieved the targeted yield of jute fibre (35 q/ha) with (+) 5.14% yield deviation (Table 4.5). Similarly, application of fertilizers as per ST-TY could achieve the targeted yield of 50 q/ha of rice with (-) 2.4 % yield deviation. Application of FYM and biofertilizers in combination with ST-TY achieved the targeted yield of rice (40 q/ha) with (+) 12.25 % yield deviation (Table 4.6). Agronomic efficiency of P and K fertilizers increased due to application of FYM and biofertilizers. *(Source: JA 5.6a Contributors: A. R. Saha, B. Majumdar, S. P. Mazumdar)*

**Table 4.6. Effect of ST-TY based fertilizers application on rice yield and agronomic efficiency**

| Treatment | Grain Yield (q/ha) | Agronomic efficiency (kg/kg) | | |
|---|---|---|---|---|
| | | N | P | K |
| $T_1$- Control | 28.7 | - | - | - |
| $T_2$- ST-TY(5 t/ha) | 48.8 | 14.6 | 56.3 | 30.3 |
| $T_3$- ST-TY(4 t/ha) | 41.8 | 15.5 | 50.8 | 27.6 |
| $T_4$- $T_3$+FYM (5 t/ha) | 43.8 | 18.8 | 63.9 | 34.2 |
| $T_5$- $T_3$+Azotobactor+PSB | 42.5 | 17.2 | 58.3 | 31.2 |
| $T_6$- $T_4$+ Azotobactor+PSB | 44.9 | 20.3 | 68.7 | 36.7 |
| $T_7$- FYM @ 5 t/ha | 37.7 | - | - | - |
| $T_8$- $T_7$+ Azotobactor+PSB | 38.5 | - | - | - |
| $T_9$- RDF | 40.4 | 14.1 | 28.3 | 28.3 |
| $T_{10}$- FP | 33.3 | 7.0 | 14.0 | 14.0 |

### 4.2.3 Changes in sulphur fractions and its utilisation by jute and mesta crop using $^{35}S$ tracer

A study was conducted to monitor the changes in the available pools and different fractions of sulphur (S) in order

to ascertain the depletion/build-up of S in the mesta and jute growing soil. After harvest of mesta crop, the total S content in surface soil increased from 331 to 345 mg/kg under highest sulphur level (45 kg/ha) treatment (Fig. 4.5). Sulphur build-up was more in surface soils as compared to lower soil depths (Fig. 4.6 & Fig 4.7). Organic Sulphur in surface soils ranged from 208 to 255 mg/kg. Forms of S present in the soil were in the order of Organic S > Non-sulphate S > Ca $(H_2PO_4)_2$ S > $CaCl_2$ extractable S.

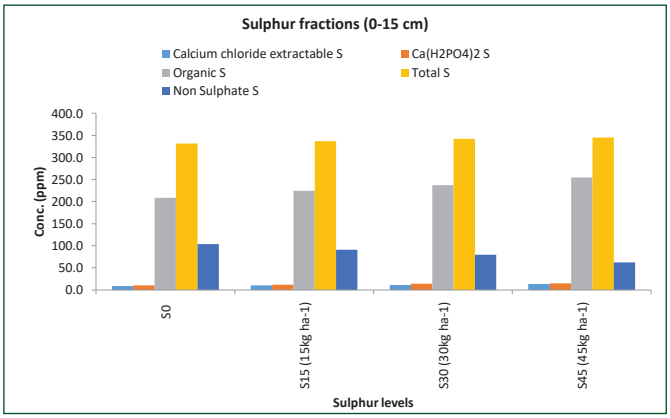



Fig. 4.5. Depth wise (0 -15 cm) distribution of different forms of sulphur (mg/kg) in post-harvest soils (mesta)

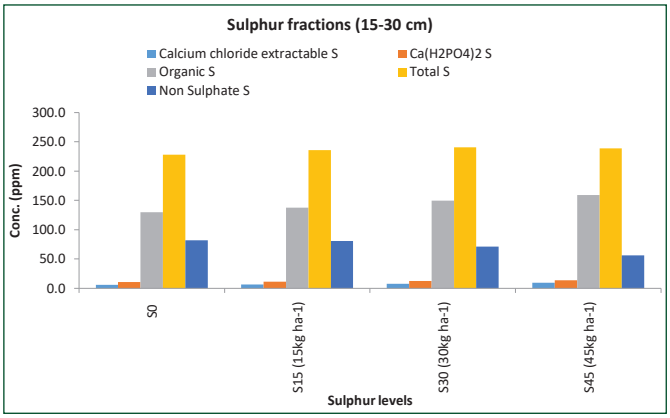



Fig. 4.6. Depth wise (15-30 cm) distribution of different forms of sulphur (mg/kg) in post-harvest soils (mesta)

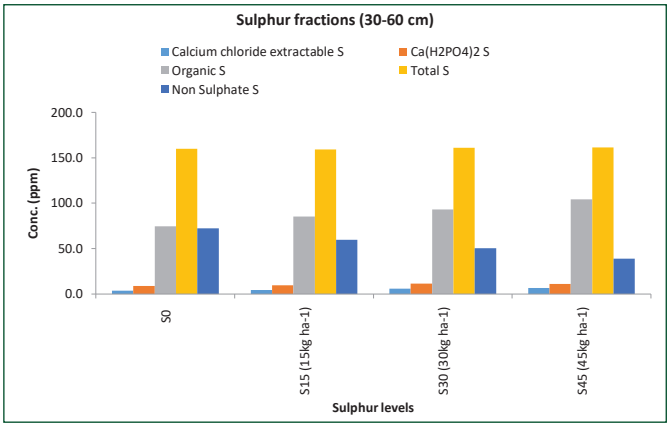



Fig. 4.7. Depth wise (30-60 cm) distribution of different forms of sulphur (mg/kg) in post-harvest soils (mesta)

Sulphur utilisation was higher in mesta as compared to jute crop. In mesta plots, control treatment and application of 15 kg S/ha suffered an apparent loss of S, whereas increase in S application to 30 and 45 kg S/ha had apparent gains. Application of 45 kg S/ha recorded higher benefit cost ratio (BCR). In case of jute crop, only control treatment suffered an apparent loss of S, whereas S application had apparent gains. All the jute varieties had positive S balance with application of S. *(Source: BRNS Contributors: S. P. Mazumdar, D. K. Kundu, S. Mehetre and R. K. De).*

### 4.2.4 Soil organic carbon build-up and aggregate stability under conservation tillage with crop residue in Jute based cropping systems

Field experimentation on conservation tillage with or without residue along with traditional tillage practices under the selective jute based cropping systems was conducted to study its effect on soil physico-chemical properties and crop productivity. Results of 1st year crop cycle indicated that SOC contents (Fig. 4.8) under conservation tillage with residues incorporation are much higher. Maximum SOC content in 0-15 cm and 15-30 cm soil depth was under jute-rice-lentil (0.73% and 0.60%, respectively) followed by jute-rice-wheat (0.70% and 0.56%, respectively) and jute-rice-potato (0.67% and 0.59%, respectively). Significant difference in SOC among the tillage treatments may be ascribed to the reduction in tillage operations and addition of crop residues. Soil aggregation represented by mean weight diameter (MWD) and percent water stable macro-aggregates (% WSMA) was significantly affected by tillage practices and crop residue incorporation (Fig. 4.9.).

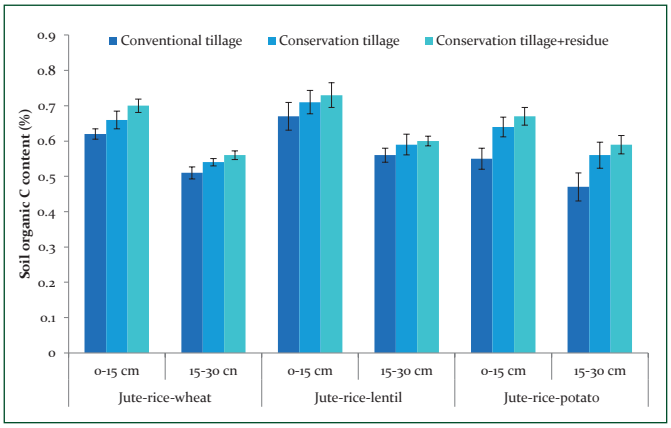



Fig 4.8. Effect of tillage practices on soil organic carbon content (%) in various cropping systems

Conservation tillage with residue incorporated plots showed higher aggregate stability (MWD range: 0.51-0.83 mm, WSMA range: 41.1-62.8%) as compared to other tillage treatments. Soil organic carbon was found to be the major contributor to soil aggregate formation. Removal of residues from the surface and exposing the surface soil through tillage for accelerated decomposition might be responsible for reduced aggregate stability in conventional tillage practice.

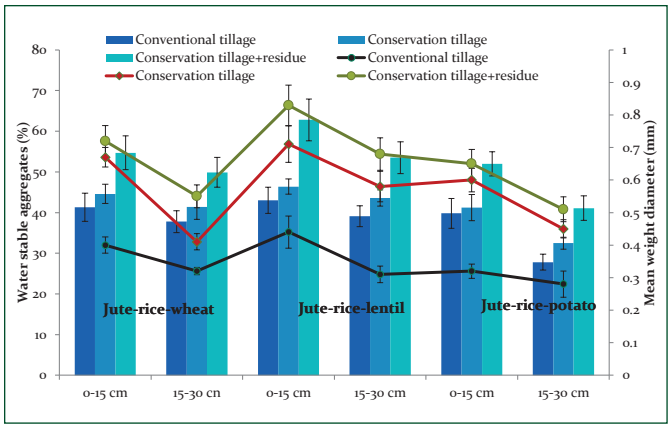



Fig 4.9. Effect of tillage practices on soil aggregate stability in various cropping systems

However, the crop yield in conventional tillage practice was higher over conservation tillage practice. *(Source: JA 5.7. Contributors: R. Saha, M.S. Behera, Mukesh Kumar, A.R. Saha, B. Majumdar, D. Barman, S.P. Mazumdar, P. Bhattacharyya, R.K. Naik and D.K. Kundu).*

### 4.2.5 Soil health characterization and carbon sequestration potential in ramie based cropping system

A study on soil health characterization and carbon sequestration potential of ramie based cropping system was initiated during 2016-17. Composite soil samples were collected at four different depths (0-20, 20-40, 40-60 and 60-100 cm) under each ramie based systems from Ramie Research Station (Sorbhog, Assam). Depth wise distribution of SOC, total organic C, available N, P and K were studied. Dehydrogenase activity (DHA) and Fluorescein-diacetate activity (FDA) were measured. Soil organic C and nutrient content decreased with increase in depth irrespective of cropping systems. Differential behaviour in increasing organic carbon content may be ascribed to the variable amount of biomass addition and variable rates of decomposition of organic matter added through various systems. DHA varied 85 to 126 µg/g/day, FDA from 4.79 to 12.98 µg/g/hr. *(Source: JA 7.2 Contributors: S. P. Mazumdar, S. Mitra, A.R. Saha, B. Majumdar, M. Kumar, Monu Kumar, A. Singh).*

## 4.3 Enhancement of Nitrogen Use Efficiency (NUE) in Jute

### 4.3.1 Growth and physiological parameters of jute gemplasm in controlled condition

Seven days old seedlings of 25 *olitorius* jute germplasm were grown in Hoagland solution at two nitrogen levels, low N (1 mM $NO_3$ N) and optimum N (16 mM $NO_3$ N) levels. Seedlings were grown for 30 days under 16 hours light period and observations were taken on 37$^{th}$ day. Maximum shoot length was recorded with OIJ 008 both at low nitrogen (10.20 cm) and at optimum nitrogen (9.17 cm) levels, respectively. Highest root length was recorded with OIJ 079 (9.30 cm) at low N level and with OIJ 024 (7.83 cm) at optimum N levels. Whereas, lowest root length was recorded with OIJ 081 (4.33 cm) at low N level and with OIJ 082 (4.20 cm) at optimum N levels. Maximum leaf dry weight was recorded with germplasm OIJ 078 (4.18 mg/plant) and OIJ 070 (4.07 mg/plant) at 1 and 16 mM $NO_3$ N levels, respectively. The olitorius germplasm OIJ 008 recorded maximum shoot dry weight (2.99 g/plant) and total dry weight (8.45 g/plant) at low N condition while maximum value of both the parameters (3.34 & 8.71 g/plant, respectively) were recorded with OIJ 086 at optimum N level. Maximum value of root dry weight was recorded with OIJ 070 (1.44 g/plant) and OIJ 049 (1.41 g/plant) at 1 and 16 mM $NO_3$ N levels, respectively while highest value of leaf dry weight were recorded with OIJ 078 (4.18 g/plant) and OIJ 070 (4.07 g/plant) at low and optimum N levels, respectively. The *olitorius* germplasm OIJ 070 recorded highest NR activity at both low nitrogen (23.64 µ molar $NO_2$/g fresh tissue/hour) and optimum nitrogen (22.64 µ molar $NO_2$/g fresh tissue/hour) levels. At optimum N level, maximum chlorophyll content was recorded with OIJ 070 (7.60) while OIJ 086 recorded highest chlorophyll content (6.97 ) at low N level (1 mM NO3 N) under controlled condition.

### 4.3.2 Field experiment on NUE

150 *olitorius* jute germplasm (OMU accessions) were grown in field at three N application levels: $N_0$: no applied N, $N_{40}$: 40 kg N/ha and $N_{80}$: 80 kg N/ha, respectively. The *olitorius* germplasm OMU 008 recorded maximum plant height (420.0 cm) at highest N level (80 kg N/ha) as well as maximum value of plant height (370.0 cm) and basal diameter (1.80 cm) in absence of applied N. Maximum value of basal diameter at 80 kg N/ha application level was recorded with OMU 46 (1.85 cm). The *olitorius* germplasm OMU 008 recorded maximum leaf dry weight (21.0 g/plant), wood dry weight (95.26 g/plant), bark dry weight (50.77 g/plant) and total dry weight (167.03 g/plant) in absence of applied nitrogen. At 80 kg $Nha^{-1}$ level, accession OMU 46 recorded maximum values of wood dry weight (95.26 g/plant), bark dry weight (73.00 g/plant) and total dry weight (187.76 g/plant) while maximum leaf dry weight was recorded with OMU 20 (40.00 g/plant) at 80 kg $Nha^{-1}$ application level. Maximum fibre yield of jute was recorded with accession OMU 008 (23.50 g/plant) in absence of applied N while at 80 kg $Nha^{-1}$ level, accession OIJ 054 recorded maximum fibre yield (27.89 g/plant) of jute. *(Source: TMJ 9 Contributors: S. Mitra, J. Mitra, P. Satya, D. Saha, M. Kumar).*

# 5. Crop Husbandry

## 5.1 Jute

### 5.1.1. Assessment of productivity and nutrient management of selected jute based cropping system

System productivity, sustainability and soil quality of five jute based cropping sequences were assessed under variable nutrient and crop residue management practices. Higher system productivity was recorded in jute-rice-baby corn system (205 q/ha) followed by jute-rice-garden pea system (82 q/ha). Among the nutrient and crop residue management practices, higher system productivity was recorded with 100% RDF with crop residue incorporation treatment. Sustainability index followed the same trend as system productivity. Carbon management index (CMI) an indicator of soil quality was also calculated and higher CMI (60.8) was recorded with jute-rice-mustard and mung bean cropping system. Application of 100% RDF with crop residue recorded higher CMI (57.11) compared to other nutrient and crop residue practices (Fig 5.1). Labile and non-labile carbon pool were also estimated (Fig 5.2) and the higher labile (9.73 Mg/ha) and non-labile carbon (8.23 Mg/ha) were recoded in jute-rice-mustard and mung bean cropping system followed by jute-rice-garden pea (8.89 and 7.05 Mg/ha) and jute-rice-wheat systems (8.84 Mg/ha and 7.01 Mg/ha). Crop residue incorporation in soil helped to increase the labile and non-labile carbon in soil. *(Source: JA 5.6. Contributors: Mukesh Kumar, S. Mitra, A.K. Ghorai and B. Majumdar).*

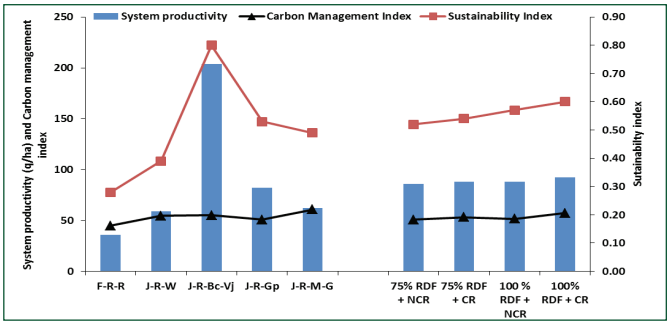



Fig. 5.1. System productivity, sustainability index and carbon management index of different jute based cropping systems under nutrient and crop residue management practices

*J-jute, R-rice, W-wheat, Bc-baby corn; M-mustard, G-green gram; CR-crop residue incorporation; NCR- without crop residue incorporation*

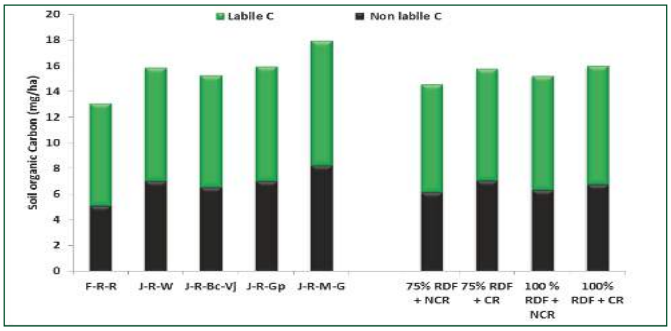



Fig. 5.2. Labile and non-labile carbon fraction in soil under different jute based cropping systems and different nutrient and crop residue management practices.

*J-jute, R-rice, W-wheat, Bc-baby corn; M-mustard, G-green gram; CR-crop residue incorporation; NCR- without crop residue incorporation*

### 5.1.2 Prospects of growing spices, medicinal and aromatic plants in jute and sisal based cropping systems

#### 5.1.2.1 Scope of growing spices, medicinal and aromatic plants (MAPs) in jute (fibre crop) based cropping system

Performance of MAPs in jute fibre and *kharif* rice based cropping system was evaluated. Maximum jute equivalent yield (86.24 q/ha) was recorded in jute-*kharif* rice-asalio followed by jute-*kharif* rice-menthol mint (74.5 q/ha) among different MAPs cropping sequences (Table 5.1).

**Table 5.1 Interaction effect of cropping system and fertility levels on jute equivalent yield (JEY) and system economics in jute (fibre)-*kharif* rice-MAPs sequence**

| | Treatments | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | $C_6$ | Mean |
|---|---|---|---|---|---|---|---|---|
| JEY (q/ha) | $F_1$ | 81.70 | 66.69 | 63.54 | 66.19 | 60.23 | 114.98 | 75.55 |
| | $F_2$ | 90.78 | 76.51 | 73.10 | 82.81 | 67.97 | 125.94 | 86.18 |
| | Mean | 86.24 | 71.60 | 68.32 | 74.50 | 64.10 | 120.46 | |
| | CD (P=0.05) | C=3.52, F=2.06, C x F=5.05 | | | | | | |
| Net return (Rs/ha) | $F_1$ | 142097 | 125294 | 95926 | 116090 | 100624 | 170554 | 125098 |
| | $F_2$ | 154204 | 138479 | 104882 | 138291 | 101064 | 167376 | 134049 |
| | Mean | 148151 | 131887 | 100404 | 127190 | 100844 | 168965 | |
| | CD (P=0.05) | C=4518.23, F=3410.14, C x F=8353.11 | | | | | | |
| B:C ratio | $F_1$ | 2.19 | 2.42 | 1.89 | 2.21 | 2.09 | 1.85 | 2.10 |
| | $F_2$ | 2.13 | 2.30 | 1.81 | 2.09 | 1.83 | 1.71 | 1.97 |
| | Mean | 2.16 | 2.36 | 1.85 | 2.15 | 1.96 | 1.78 | |
| | CD (P=0.05) | C= 0.039, F=0.01, C x F=0.034 | | | | | | |

$C_1$=jute-*kharif* rice-asalio, $C_2$=jute-*kharif* rice-ashwagandha , $C_3$=jute-*kharif* rice-isabgol, $C_4$=jute-*kharif* rice-menthol mint, $C_5$=jute-*kharif* rice-senna, $C_6$=jute-*kharif* rice-potato, $F_1$= RDF, $F_2$ = RDF+ 5 t FYM/ha

However, traditional crop jute-*kharif* rice-potato registered maximum yield of 120.46 q/ha. Fertilizer treatment - RDF+5t FYM recorded 14.02% higher yield than RDF alone. Similar trend was observed in case of gross return. Asalio recorded gross return of Rs 2,75,968/ha whereas traditional crop potato registered return of Rs 3,85,472/ha. Inclusion of asalio in jute based cropping system recorded net return (jute-*kharif* rice-asalio) of Rs 1,48,151/ha followed by ashwagandha (Rs 1,31,887/ha). However traditional crop potato registered highest net return of Rs 1,68,965/ ha. Maximum benefit cost ratio of 2.36 was recorded in case of jute-*kharif* rice-ashwagandha cropping sequence which was 32% higher compared to traditional cropping sequence jute-*kharif* rice-potato (1.78).

### 5.1.2.2 Performance MAPs in jute (seed crop) and autumn rice based cropping system

Jute-stevia-autumn rice cropping sequence recorded highest jute equivalent yield (217.96 q/ha) followed by fennel (81.97q/ha) and ajwain (79.33 q/ha). Traditional jute-tomato-autumn rice cropping sequence recorded 84.53 q/ha. Fertilizer treatments RDF+5t FYM/ha recorded 17.35% higher yield than RDF alone. Considering the system economics, highest net return of Rs 3,10,867 was recorded in jute-stevia-autumn rice cropping system which was 61% higher as compared to traditional cropping sequence. This was followed by ajwain (Rs 1,14,729) and fennel (Rs 1,15,061). Maximum B:C ratio (2.64) was recorded in jute-ajwain-autumn rice followed by fennel (2.48). Whereas, B:C ratio of the traditional crop sequence was comparatively low (2.27).

### 5.1.2.3. Performance in jute fibre-cum-seed and boro rice based cropping system

Jute-nagella-boro rice recorded maximum JEY (51.15 q/ha) followed by asalio (48.91 q/ha). However traditional cropping sequence jute-garden pea-boro rice recorded JEY of 48.56 q/ha. Considering the system economics, jute-nagella-boro rice recorded highest net return of Rs 90,306, which was 14.26 % higher than that of traditional sequence. Application of FYM with RDF enhanced the yield by 27.7 %. Nagella recorded the maximum B:C ratio of 2.42 followed by coriander (2.36). Though the JEY of garden pea was higher compared to other spices and MAPs, the B:C ratio was low (2.18).Thus jute-nagella-boro rice was the most profitable sequence in this study. *(Source: JA 6.9 Contributors: M.S. Behera, D.K. Kundu, S Satpathy, A .K Jha, A. Singh and R K Naik)*

### 5.1.3 Irrigation methods and soil water conservation practices for improving water productivity in jute

Experiments were conducted to improve water and fibre productivity by manipulating sowing methods, water conservation and nutrient management practices. Sowing of jute crop in furrow with application N:$P_2O_5$:$K_2O$::60:30:30 kg/ha (RDF) and one irrigation yielded 26.0 q jute fibre/ha at 113 DAS and water productivity was 1492 litre water/kg fibre. Irrigation requirement was reduced by 35% over flood irrigation on flatbed sowing. Line sown crop and application of single irrigation followed by one nail weeding at 5 days after crop emergence (DAE) for soil mulching with RDF (N:$P_2O_5$:$K_2O$::60:30:30) produced 32.30 q jute fibre/ha. It produced 12% more fibre yield compared to line sown jute with single irrigation at RDF without nail weeding operation. Soil mulching by CRIJAF Nail weeder (at 5 & 8 DAE) maintained 5-6% more moisture, kept the soil cooler (by 1-3 $^0$C) at 5 to 10 cm soil depth and helped the jute seedling to escape early drought stress (there was no rain till 30 DAS) (Fig. 5.5 and 5.6). With augmented fertilizer application (N:$P_2O_5$:$K_2O$::80:40:40 kg/ha) and single irrigation recorded 31.8 q jute fibre/ha and water productivity was 1217 litre water/kg fibre. Application of RDF with one irrigation and mung waste @ 2 t/ha produced 37.4 q fibre yield/ha and water productivity was 1035 litre water/kg fibre. Control (jute sown by broadcasting, N:$P_2O_5$:$K_2O$::60:30:30 and one irrigation) plot recorded 30.3 q fibre /ha yield and water productivity of 1277 litre water/kg fibre.

Fig. 5.4. Soil mulch in broadcasted jute by CRIJAF Nail weeder at 5 DAE

Fig 5.5. No soil mulch in broadcasted jute


Fig 5.6 Effect of soil mulch with nail weeder on jute seedlings

## *In situ* jute retting

*In situ* jute (120 days old jute) retting was demonstrated in North 24 Parganas district of West Bengal under low volume water (v/v 1:1.25) in micro retting tank (120 sq. metre area, 3.5 ft depth). Retting was completed within 14-16 days, which produced golden coloured fibre. Under clay soil, in Nowada, Murshidabad, retting was demonstrated in polyethylene lined micro tank with native culture (50 kg retting tank soil) and retting additives (1kg molasses, 50 kg sunnhemp twig and ammonium sulphate @ 1kg ). The jute retting was completed in 31 days (120 DAS) as compared to 27 days required for retting with CRIJAF Sona. *(Source TMJ 5.0. A.K. Ghorai, D.K. Kundu and D. Barman).*

Fig 5.7 *In situ* jute retting at Badshanagar, Nowda , Murshidabad in lined micro tank

## 5.1.4 Use of jute fabrics and gunny bags in agricultural field

Possibilities of jute gunny bags/jute fabrics in agricultural field was explored in problem soils, underutilized waterbodies and anaerobic rice field to increase cropping intensity, employment opportunity and net return from unit area in traditional mono and multi cropped area.

**Use of gunny bag based soil columns in *Kharif* rice field:** *Kharif* rice (cv. GS 1) field was diversified with different vegetable and pulse crops which were sown in reinforced soil columns (30 cm X45 cm @ 3137/ha) of old gunny bag. From this rice-vegetable/pulse relay /intercropping system, 3.0 tonnes of rice along with other crops e.g, 173 q pumpkin, 210.5 q bottle gourd, 24.8 q bitter gourd, 125 q brinjal, 18.8 q arhar, 24 q radish, 26 q *kharif* spinach, 78.42 q white amaranth, 9.9 ginger/ha were harvested. Highest gross return and return per unit cost was obtained from cucurbits followed by arhar and other green vegetables Table 5.2.

Fig 5.7. Arhar and bittergourd in *kharif* rice relay cropping system grown on gunny bag based soil columns

**Table 5.2. Vegetables in *kharif* rice field in dual culture on medium land using gunny bag based soil columns and its economics**

| Crops | Jute bags used/ ha | Rice yield (t/ha) | Inter/ relay crop yield (q/ha) | Net return from relay/ inter crops (Rs/ha) | Return per unit cost (Rs/Rs) |
|---|---|---|---|---|---|
| Pumpkin | 412 | 3.00 | 173.00 | 157718 | 4.14 |
| Bottle gourd | 412 | 3.00 | 210.46 | 260460 | 5.71 |
| Bitter gourd | 827 | 3.00 | 24.80 | 73879 | 2.47 |
| Arhar | 1046 | 3.00 | 18.82 | 32659 | 1.57 |
| Radish | 1046 | 3.00 | 24.00 | 8399 | 1.21 |
| *Kharif* spinach | 1046 | 3.00 | 26.14 | 15679 | 1.32 |
| White amaranth | 1046 | 3.00 | 78.42 | 10451 | 1.28 |
| Brinjal | 1046 | 3.00 | 125.00 | 43899 | 1.54 |
| CD (P=0.05) | -- | -- | 29.49 | 41690 | 0.60 |

**Use of gunny bags in summer rice field:** Summer rice (cv. *Khitish*) field was diversified with gunny bag reinforced soil columns (30 cm x 45 cm) @ 3137/ha. Different vegetables

were sown/ transplanted on soil columns in early January. Rice was transplanted on 20th Feb 2017. The hydrograph of ponding varied from 0-5 cm during rice growth period. In this system, 4.5 t/ha raw rice along with late cabbage (51q), carrot (28.3) , brinjal (152 q), tomato (69 q), coriander (9.3 q), onion (12.3 q), summer radish (33 q), chilli (11.8q) were harvested (Fig.5.8.) Highest gross return and return per unit cost was obtained from brinjal, carrot, cabbage, coriander and radish (Table 5.3). In hot summer, the temperature inside the rice canopy and soil columns (10 cm) was lower by 3-9 $^{0}$C over ambient temperature. The lower column temperatures facilitated development of fleshy roots of summer radish and carrot. Lower rice canopy temperature helped in better setting of tomato fruits in hot summer and increased shelf life and freshness of ripened tomato fruits, cabbage and coriander. In ginger, low soil moisture (6.48 to 19.92% ) were recorded from soil columns (15 cm depth) than when grown on ridges (16.53 to 20.79), in successive observations.

Fig 5.8. Brinjal and chilli in summer rice on gunny bag based soil columns

**Field level demonstration on use of gunny bags in rice field:** Field demonstration were conducted in North 24 Parganas, using gunny bags based soil columns both in summer and *kharif* rice field. In farmers field this system increased the cropping intensity from 200 to 400 per cent with better economy. The gross return from bottle gourd in relay system was about Rs 2,60,000/ha maintaining the rice yield (Fig 5.9).

Fig. 5.9. Intercrop of black gram in pumpkin grown on gunny bag based soil columns FLD in Gheedah, North 24 Parganas (WB)

**Table 5.3. Vegetables with summer rice in dual culture on medium land using gunny bag based soil columns and its economics**

| Crops | Jute bags consumes/ ha | Rice yield (t/ha) | Inter/ relay crop yield (q/ha) | Net return from relay/ inter crops (Rs/ha) | Return per unit cost (Rs/Rs) |
|---|---|---|---|---|---|
| Cabbage | 12405 | 4.5 | 51 | 11315 | 1.28 |
| Brinjal | 12405 | 4.5 | 152 | 83684 | 2.26 |
| Carrot | 12405 | 4.5 | 28.3 | 5684 | 2.80 |
| Tomato | 12405 | 4.5 | 69 | 65584 | 0.30 |
| Onion | 12405 | 4.5 | 12.3 | -21983 | 0.34 |
| Chilli | 12405 | 4.5 | 11.8 | -916 | 0.97 |
| Cauliflower | 12405 | 4.5 | 29 | -7316 | 0.80 |
| Coriander | 12405 | 4.5 | 9.3 | 10184 | 1.28 |
| Radish | 12405 | 4.5 | 33 | 13689 | 1.38 |
| CD (P=0.05) | NS | NS | 5.60 | -- | 0.31 |

**Gunny bags based soil columns in saline soil:** Field level demonstrations were conducted in 14 farmers' field in saline soil at Atbunia, Najat Sandeshkhali-1, North 24 Parganas to develop *kharif* rice-vegetable relay system. It yielded 33 q pumpkin along with normal rice yield (5.0 t/ha). Cropping intensity was enhanced (200%) over traditionally rice–fallow system of 100 per cent cropping intensity.

**Floating cultivation using gunny bag reinforced soil columns:** An attempt was made to grow field/horticultural crops on a shallow agricultural water body (3.5 ft) using gunny bag based soil columns (10 cm, 15 cm and 22.4 cm height) on floats of thermocol sheets ( 1m X 0.5m X 0.1 m) (Fig 5.10) to utilize water bodies effectively and intensively. Herein water requirement for crops was met through capillarity. Cabbage, cauliflower, onion, carrot, water spinach, red amaranth, coriander, garden pea, okra were grown successfully on shallow water body effectively. The system will be standardized in few successive seasons. *(Source: JA 6.7 Contributors: A. K. Ghorai, D.K. Kundu and S. Kumar).*

Fig 5.10. Cabbage, onion and coriander grown in gunny bag based soil columns on floats

### 5.1.5. Estimation of competition effects in jute-mung bean intercropping system

The experiment was laid out in a three-way parallel row systematic design in 1:1 alternate row arrangement with the area into 3 segments (each of 6 m long) or parallel terraces of 18 x 6 m2 area. Jute (NJ 7010) and mung bean (cv. TMB 37) crops were sown on 19th March, 2016. The arrangement of 27 spacing combinations were - 3 levels (22.5, 20, 17.5 cm) of inter-row spacing for each component crop together with varying intra-row spacing (jute- 5, 6.5, 8 cm and mung bean – 8, 10, 12 cm); each spacing varied independently of the other factors. As spacing variations between adjacent harvest areas were very small and systematic, plants could be considered as almost equally spaced. Therefore, guard rows were not needed between the harvest areas. Mung bean pods were picked at 59, 70, 75 DAS and jute was harvested at 115 DAS. Land Equivalent Ratio (LER) were calculated from the data and subjected to further analysis. In all of the 27 spacing combinations, LER > 1, signifying greater efficiency of land utilization compared to mono-cropping. The three effects, namely, intra-row spacing of jute and mung bean and their interaction were significant.

Fig 5.11 Jute-mung bean intercropping

The optimum levels of the three spacing factors are 8.41 cm, 10.84 cm and 40.15 cm for intra-row spacing of jute (DA), intra-row spacing of mung bean (DB) and inter-row spacing (DI), respectively. Thus optimum plant density in the intercropping is 30 jute plants/ $m^2$ and 23 mung bean plants/ $m^2$, whereas in mono cropping plant density of jute was 55 and for mung bean was 33/ $m^2$. *(Source: JST 6.1; Contributors: A. K. Chakraborty and A. K. Ghorai)*

## 5.2 Sisal

### 5.2.1 Production potential and economic benefit of intercropping of medicinal and aromatic plants in sisal plantation

Considering the total sisal equivalent yield of different spices, medicinal and aromatic plants grown as intercrops (Fig. 5.12), safed musili recorded maximum yield of 30.41 q/ha followed by aloevera (28.43 q/ha) and vetiver (25.85 q/ha). Among spices, fennel registered yield of 24.31 q/ha. The traditional tuber crop, elephant footyam recorded yield of 23.32 q/ha followed by okra vegetable (23.01 q/ha). Safed musli recorded maximum net return of Rs 1,54,228

Fig. 5.12 Intercrops in sisal plntation

followed by aloevera (Rs 1,38,371). Fennel (Rs 1,14,188) and elephant footyam (Rs 1,03,519) registered lower net return as compared to MAPs. Among the MAPs, vetiver recorded highest B:C ratio of 2.68 followed by safed musili (2.62). Fennel and traditional crop elephant footyam registered B:C ratio of 3.34 and 2.18 respectively. Thus vetiver in case of MAPs, fennel in case of spices and elephant footyam in case of vegetables were found to be most profitable in the systems. *(Source: JA 6.9. Contributors: M.S. Behera, D.K. Kundu, S. Satpathy, A .K. Jha, A. Singh and R. K. Naik)*

### 5.2.2 Use of drip irrigation for improving productivity of sisal-based fruit-fibre system in central plateau region of India

The effect of drip irrigation levels on sisal-based fruit-fibre system was studied at SRS, Bamra (Fig. 5.13). Irrigating custard apple with 100% PE recorded the maximum dry weight of sisal fibre (12.91 q/ha). Custard apple recorded the maximum yield of 12.72 q/ha followed by guava (12.25 q/ha). Irrigating the fruit plants with 100% PE recorded higher yield compared to 80% PE and 60% PE. As regards to plant height, guava recorded maximum plant height of 248 cm followed by mango of 135 cm. Irrigating guava with 100% PE registered maximum height of 255 cm. Considering

Fig.5.13 Guava and papaya in sisal-based fruit-fibre system under drip irrigation

the growth parameters, custard apple recorded higher primary branches and guava recorded maximum number of secondary branches (10.3). Irrigating guava with 100% PE registered higher number of secondary branches compared to other fruit plants. *(Source: SLA 1.6 Contributors: M.S. Behera, D.K. Kundu and A .K .Jha.)*

# 6. Biotic and Abiotic Stresses

## 6.1. Pest Management

### 6.1.1. Isolation and characterization of pheromone components of major insect pests of jute

#### 6.1.1.1. Jute stem weevil, *Apion corchori*

Sliced abdominal tips of virgin female weevils were dipped in n-hexane to carry out the gas chromatography coupled with electro-antennogram detector (GC-EAD) and mass spectrometry studies for identifying the probable behavioral modifying compounds dissolved in the solvent. Electroantennogram of male *A. corchori* antenna in response to the volatiles of female weevil pheromonal gland extracts was analyzed by GC-EAD. The male antenna showed response to compounds eluted at various time intervals commencing from 4.5$^{th}$ minute to 22.5$^{th}$ minute to GC-EAD programme (Fig. 6.1).

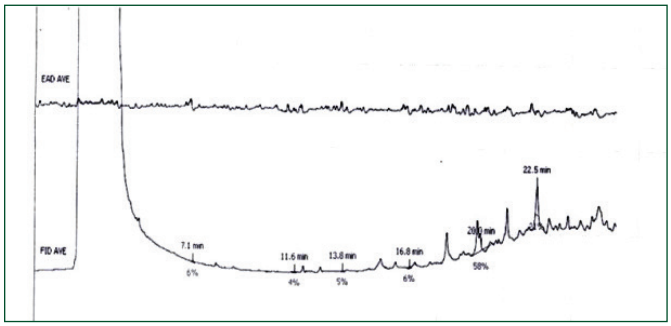



Fig. 6.1 GC-EAD response of *A. corchori* male antenna to female abdominal gland extract

#### 6.1.1.2. Jute hairy caterpillar, *Spilosoma obliqua*

Gas chromatography coupled with electro-antennogram detector (GC-EAD) studies were conducted on the male antenna and the volatiles of adult female. Antenna of male *S. obliqua* moths were mounted on to the electrodes of EAG and its response to insect volatiles of female moth pheromonal gland extracts were analyzed by GC-EAD. The male antenna responded to the volatile compounds in the solvent dipped with female abdominal tips at 4.8$^{th}$ 8.3$^{th}$ 11.8$^{th}$ 14.8$^{th}$ 15.7$^{th}$ 19.8$^{th}$ 21.1$^{th}$ 21.9$^{th}$ 24.7$^{th}$ and 25.6$^{th}$ minutes respectively (Fig. 6.2).

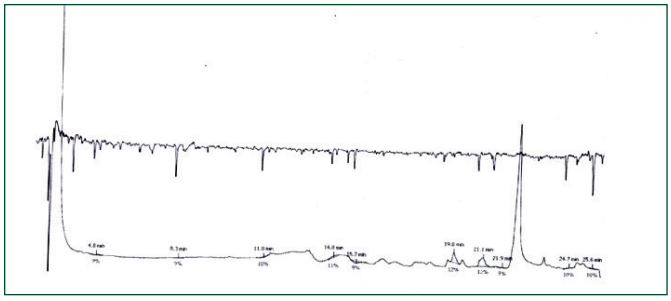


Fig. 6.2 GC-EAD response of *S. obliqua* male antenna to female abdominal gland extracts

#### 6.1.1.3. Jute semilooper, *Anomis sabulifera*

The GC-EAD study was conducted on the male antenna of jute semilooper and the solvent dipped with female antenna for detecting behaviour modifying compounds dissolved in the solvent. The sample of volatiles isolated in the solvent was injected into GC-EAD which splits equally between the detector of GC and EAD. The male antenna showed a response to compounds at 4.6$^{th}$, 5.0$^{th}$, 7.2$^{th}$, 7.7$^{th}$, 8.5$^{th}$, 9.1$^{th}$, 11.4$^{th}$, 14.1$^{th}$, minutes respectively (Fig. 6.3).

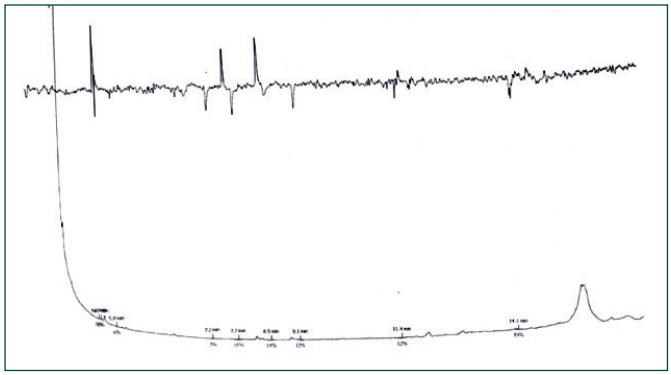


Fig. 6.3 GC-EAD response of *A. sabulifera* male antenna to female abdominal gland extracts

#### 6.1.1.4. Chemical profile of specific behavior modifying compounds

GC-MS analysis of insect volatiles from female pheromonal glands of three pests of jute showing specific response to male antenna revealed presence of compounds with diverse chemistry and molecular weight (Table 6.1). *(Source: J.E. 1.6: Contributors: V. Ramesh Babu., B. S. Gotyal and S. Satpathy)*

**Table 6.1. Chemical profile of female volatiles of major insect pests of jute analyzed through GC-MS**

| Retention Time (min) | Compound Identified | Match (%) | Molecular Weight |
|---|---|---|---|
| Jute stem weevil, *Apion corchori* | | | |
| 4.59 | 3-hexanone | 81 | 100 |
| 4.77 | 3-hexanol | 91 | 101 |
| 4.85 | 3-ethyl 2-heptanol | 47 | 126 |
| Jute hairy caterpillar, *Spilosoma obliqua* | | | |
| 4.59 | 2-heptanol 6-methyl-acetate | 64 | 115 |
| 4.77 | 6-hepten-3-ol | 27 | 96 |
| Jute semilooper, *Anomis sabulifera* | | | |
| 4.59 | 9-octadecenoic acid, -methyl ester | 62 | 296 |
| 4.77 | n-heptadecanol-1 | 72 | 238 |

### 6.1.2. Identification and characterization of volatile organic compounds (VOCs) of jute plant imparting resistance for hairy caterpillar

The resistant jute species (wild) and the susceptible check (JRO-204) were selected for headspace volatile collection and further electrophysiological analysis of volatiles. Leaves of *C. aestuans, C. pseudo-olitorius, C. tridens, C. trilocularis, C. fascicularis and C. olitorius* were collected in side a glass fabricated volatile collection unit (VCU). The volatiles in the headspace of the chamber were collected onto adsorption tubes. The adsorbed volatiles were eluted immediately with 20 ml *n*-hexane. GC-MS analysis of the volatiles indicated presence of compounds with very specific effect on insect. In *C. aestuans* the repellent compounds, benzene-1 ethyl-3 methyl, dodecane and tridecane were eluted at 6.70, 12.13 and 14.17 min respectively (Fig.6.4). Similarly, linolenic acid was detected in *C. tridens* and presence of squalene and mesitylene were confirmed in *C. pseudo-olitorius*. In case of *C. fascicularis,* chemical compounds viz., linolenic acid and diisoocytyl phthalate eluted at 25.26 and 32.23 min respectively and the volatile solvent of *C. trilocularis* eluted dodecane and squalene at 12.13 and 30.26 min respectively. Whereas in case of cultivated species, cv. JRO-204, the chemical compounds tetradecane and Cis, cis, cis-7, 10, 13 hexadecatrienal eluted at 15.83 and 21.88 min respectively (Table 6.2). Further these chemical compounds need to be studied for their behavioral effect on *S. obliqua* through GC-EAD. *(Source: JE. 1.8; Contributors: B.S.Gotyal, R.Rao Korada, S.Satpathy and V. Ramesh Babu).*

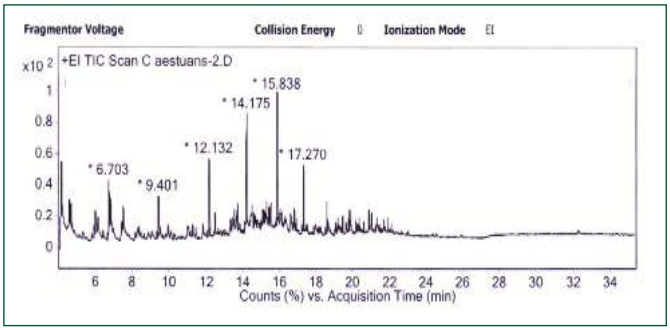



Fig. 6.4 GC-MS analysis of *C. aestuans* leaf headspace VOCs

**Table 6.2 Chemical profile of plant volatiles analyzed through GC-MS from wild and cultivated species of jute**

| Jute species | Library/ Retention time |
|---|---|
| *C. aestuans* (WCIN-179) | Benzene-1 ethyl-3 methyl (6.70 min) |
| | Dodecane (12.13 min) |
| | Tridecane (14.17 min) |
| *C. tridens* (WCIN-188) | Linolenic acid (25.44 min) |
| *C. pseudo-olitorius* (WCIN-182) | Mesitylene (6.70 min) |
| | Squalene (30.26 min) |
| *C. fascicularis* (WCIN-202) | Linolenic acid (25.26 min) |
| | Diisooctyl phthalate (32.23 min) |
| *C. trilocularis* (WCIN-186) | Dodecane (12.13 min) |
| | Squalene (30.26 min) |
| *C. olitorius* (Cv. JRO-204) | Tetradecane (15.83 min) |
| | Cis, cis, cis-7,10,13 hexadecatrienal (21.88 min) |

### 6.1.3. Endophytism of entomopathogenic *Lecanicillium lecanii* isolates

#### 6.1.3.1. Establishment and detection of endophyte in jute

Seed treatment with conidial suspension of *L. lecanii* caused endophytic colonization of the fungal entomopathogen within jute seed and later into the plant system which was detected by PCR with *L. lecanii*-specific primers. Tissues from treated seed, leaf from 30 day-old jute plant grown from treated seeds and dead/infected mealybugs on these leaves were sampled for microscopy. Tissues from all the samples were incubated at room temperature for 10 min in 1X PBS (pH7.4) buffer. Alexa fluor WGA-AF 488 (Molecular Probes) dye was used in this study. Congo red (1µg/ml) was added into the stock solution of WGA-AF 488 for counter staining. Tissue was incubated in staining solution for 10 min at 37$^0$C. 1X triton buffer was used for washing. WGA-AF 488 was excited with a 488-nm laser line and detected at 505–540 nm and congo red was excited at 546 nm and detected at 590 nm. The fluorescence microscopy revealed endophytic colonization of *L. lecanii* in the tissues sampled from different plant parts and the insect (Fig 6.5 & 6.6).

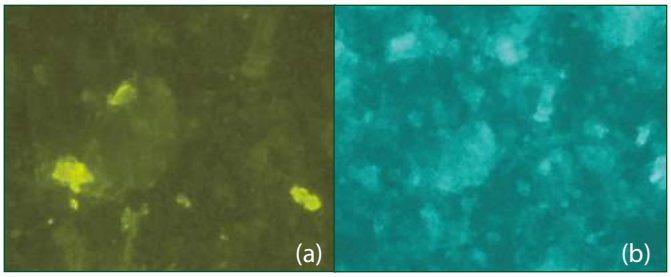



Fig. 6.5. Endophytic colonization of *Lecanicillium lecanii* in jute seed (a) and leaf (b). Scale 200 µm.

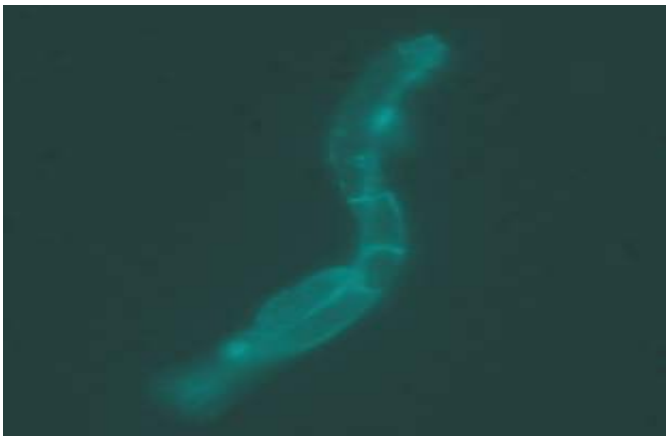


Fig. 6.6. Fungal hypha inside dead mealybug. Scale 200 µm.

Multiplex PCR assay was optimized to identify different fungal strains from dead mealybug sample. Two different sets of primers were used in this study. DNA was isolated from dead mealybug sample and was treated as template. Amplicons of different sizes were generated from different fungal strains viz. *L. lecanii* (VL8 and VL15) generated 560bp amplicon; *B. bassiana* (ITCC 5408) generated 205 bp amplicom and the new *B Bassiana* isolate produced 250bp amplicon (Fig. 6.7).

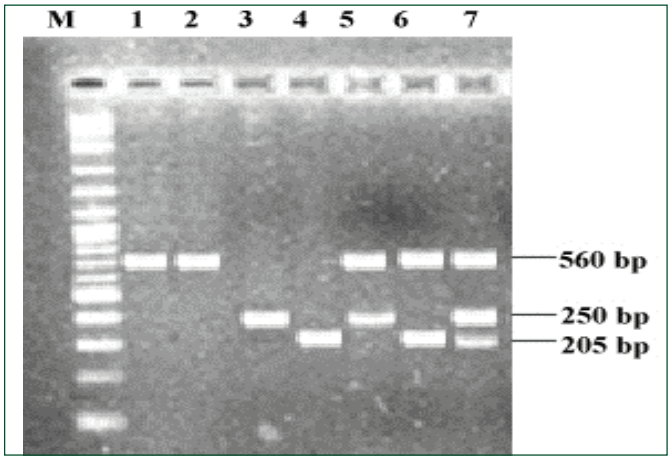



Fig. 6.7. Multiplex PCR amplification of *L. lecanii* and *B. bassiana.*

*Lane M: 100bp ladder; Lane 1: VL 8 infected mealybug sample; Lane 2 : VL 15 infected dead mealybug sample; Lane 3: New B. bassiana strain infected dead mealy bug sample; Lane 4 : ITCC 5408 strain infected dead mealybug samples; Lane 5: VL 15 + new B. bassiana isolate; Lane 5: VL 15 + ITCC5408; Lane 7: VL 15 + ITCC 5408 + new B. bassiana isolate*

### 6.1.3.2. Effect of combined application of *L. lecanii* and *B. bassiana* on jute mealybug

Infectivity of *L. lecanii* and *B. bassiana* was tested against jute mealybug singly as well as in combination. Conidial suspension of the fungal entomopathogen (s) was applied on the mealybug. The mortality of mealybug was 46.67% to 83.3% in different treatments. Combined application of endophytic *L. lecanii* VL 15 and *B. bassiana* isolated from dead mealybug recorded highest mortality of 83.3% followed by *L. lecanii* VL 15 + *B. bassiana* ITCC 5408 (73.3%). *(Source: JM. 8.8; Contributors: C.Biswas and S.Satpathy).*

### 6.1.3.3 Molecular identification of *Beauveria bassiana* isolated from dead mealybug

The DNA extract from an isolate of *B. bassiana* (Bb) isolated from naturally occurring dead mealybug was subjected to PCR amplification along with other *B. bassiana* isolates. Three sets of SCAR primers were used in this study. In case of SCA15, SCA14 and OPB9 all the existing isolates gave 205 bp, 250 bp, 1300 bp amplicons respectively. The new isolate generated 300 bp, 500 bp and 1000 bp amplicon (Fig. 6.8). Molecular identification of new *B. bassiana* (Bb) isolate recovered from dead mealybug confirms its distinctness from other existing Bb strains.

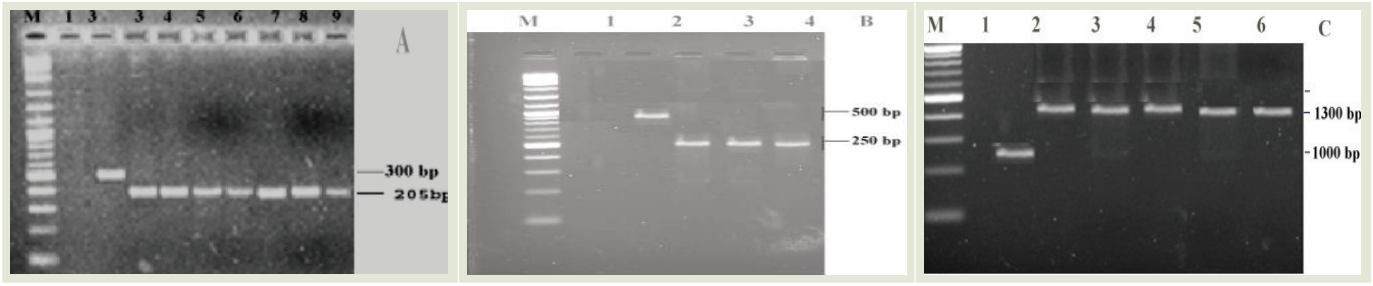



Fig. 6.8 A. PCR amplification by using SCA15 primer Lane M: 50 bp ladder; lane1: negative control; lane2: new *B. bassiana* isolate; Lane 3: ITCC 5409; Lane4: ITCC5408; Lane5: ITCC6063; Lane 6: ITCC 4796; Lane 7: ITCC 5562; Lane 8: ITCC 4705. B. PCR amplification by using SCA14 primer. Lane M: 50 bp ladder; lane1: negative control; lane2: new *B. bassiana* isolate; Lane 3: ITCC 5409; Lane 4: ITCC 5408; Lane 5: ITCC 6063. C. PCR amplification by using OPB9 primer: Lane M: 50 bp ladder; lane1: negative control; lane 2: new *B. bassiana* isolate; Lane 3: ITCC 5409; Lane 4: ITCC 5408; Lane 5: ITCC 6063; Lane 6: ITCC 4796

### 6.1.4. Evaluation of elite jute varieties against yellow mite

*On the basis of mite population and egg density*

Eight elite varieties of jute were evaluated against yellow mite under field condition. Mite population density was observed in the critical stage of infestation i.e., 35-65 DAS coinciding with the active growth stage of the jute crop. During all the observation period significant variation in population density among the varieties was evidenced. At 35 DAS, the mite population varied from 26.13 in JRO-524 to 38.06 / $cm^2$ leaf in S-19. Other least infested varieties at par with JRO 524 were JRO 204 (26.46 mite/ $cm^2$) and JBO 1 (26.66 mite/$cm^2$). Subsequently, at 45 DAS during the peak period of infestation, JR0 524, JRO 8432, JRO 204 harboured significantly less mite population (Table 6.3). These varieties recorded 26.66 to 34.90 mite/$cm^2$ leaf which was significantly less than JROM 1 and JRO 2407 (45.50 and 45.53 mite/$cm^2$). Same trend of infestation was also observed at 55 DAS.

The relative egg deposition by yellow mite on the elite varieties at 35 DAS and 45 DAS indicated JRO 524, JBO 1, JRO 8432 and JRO 204 to be least preferred for egg laying. Maximum egg density was observed at 55 DAS (Table 6.3). At this stage also JRO 204 (15.51), JBO 1 (17.06), JRO 8432 (19.39), JRO 524 (20.53) recorded lesser number of eggs

compared to 30.99 and 30.00 eggs/cm$^2$ leaf area of jute on S 19 and JROM 1 respectively.

**Table 6.3. Relative infestation of yellow mite (nymph, adult and eggs) on elite jute varieties**

| Varieties | Mite per cm$^2$ leaf area | | | |
|---|---|---|---|---|
| | 45 DAS | | 55 DAS | |
| | Nymph/adult | Egg | Nymph/adult | Egg |
| JRO 524 | 26.66$^{d}$ | 15.43$^{d}$ | 13.26$^{e}$ | 20.53$^{bc}$ |
| JROM 1 | 45.50$^{a}$ | 22.73$^{ab}$ | 33.83$^{a}$ | 30.00$^{a}$ |
| JROG 1 | 38.73$^{ab}$ | 16.60$^{cd}$ | 25.93$^{bc}$ | 20.69$^{bc}$ |
| JBO 1 | 41.50$^{ab}$ | 12.43$^{d}$ | 28.30$^{b}$ | 17.06$^{c}$ |
| JRO 2407 | 45.53$^{a}$ | 21.13$^{bc}$ | 30.83$^{a}$ | 25.67$^{ab}$ |
| S 19 | 39.43$^{ab}$ | 26.86$^{a}$ | 27.16$^{bc}$ | 30.99$^{a}$ |
| JRO 8432 | 34.90$^{bc}$ | 13.46$^{d}$ | 22.20$^{cd}$ | 19.39$^{bc}$ |
| JRO 204 | 31.53$^{cd}$ | 11.53$^{d}$ | 18.96$^{d}$ | 15.51$^{c}$ |
| CD (P=0.05) | 6.36 | 5.29 | 4.74 | 5.93 |

*On the basis of mite-days*

Till 50 DAS during the critical stage of infestation, JRO 524 recorded significantly less mite days (1326) which was 1755 and 1603 in JRO 8432 and JRO 204 respectively (Fig. 6.9). Cumulative mite days during the active growth period of the crop also recorded significantly least mite days in JRO 524 (1899) followed by JRO 204 (2276). JROM 1 and JROM 2407 recorded highest mite days indicating least susceptibility to yellow mite.

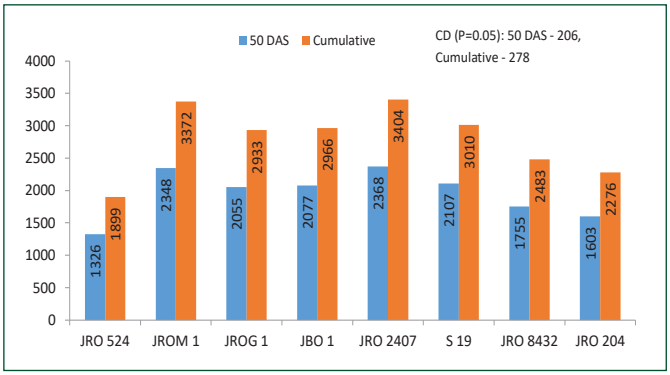



Fig. 6.9. Relative mite days on elite jute varieties

### 6.1.5. Effect of soil applied sulphur on mite population build up in jute

Preliminary experiments were conducted to study the effect of soil applied sulphur on yellow mite of jute. The jute plants grown in soil treated with sulphur had significantly less mite in higher dosages of S (Table 6.4). At all the stages i.e., 35, 45 and 55 DAS the mite infestation in S-45 kg/ha treatment was significantly less than the untreated control. At 45 DAS, the mite population density on plants grown in 45 kg S/ ha treated soil was 37.53/cm$^2$ being significantly less than control (46.91/cm$^2$). At this stage the mite infestation on plants with 15 and 30 kg S/ha did not differ significantly over control. Cumulative mite days was significantly less at 30 (1401) and 45 kg/ha (1236) sulphur application rate than 15 kg/ha (1630) and untreated control (1711).

**Table 6.4 Mite infestation on jute plants grown in different level of sulphur applied in pot soil**

| S appln rate | Mite population (per cm$^2$ leaf area) | | | Mite days |
|---|---|---|---|---|
| | 35 DAS | 45 DAS | 55 DAS | |
| 15 kg/ha | 27.06$^{a}$ | 48.53$^{a}$ | 43.71$^{ab}$ | 1630$^{a}$ |
| 30 kg/ha | 20.66$^{b}$ | 45.86$^{a}$ | 36.80$^{bc}$ | 1401$^{b}$ |
| 45 kg/ha | 18.33$^{b}$ | 37.53$^{b}$ | 31.99$^{c}$ | 1236$^{b}$ |
| Control | 28.99$^{a}$ | 46.91$^{a}$ | 47.59$^{a}$ | 1711$^{a}$ |
| CD(P=0.05) | 5.70 | 6.94 | 9.43 | 205.12 |

### 6.1.6. Infectivity of entomopathogenic fungal bioagents on yellow mite

The infectivity of talc based formulation of 3 entomopathogens i.e., *Lecanicillium lecanii* (*Ll*), *Paecilomyces fumosoroseus (Pf)* and *Beauveria bassiana (Bb)* at 4X10$^8$ CFU/l and 6X10$^8$ CFU/l concentrations were evaluated against yellow mite under laboratory condition (Table 6.5). In both the concentrations, *Pf* and *Bb* recorded significantly higher mortality of yellow mite than *Ll*. At 3-DPT significantly highest mortality was observed in *Pf* (30.35%) followed by *Bb* (21.59%) and *Ll* (4.87%). Later on at 4 and 5-DPT period the level of mortality in *Pf* and *Bb* treated population was at par but significantly higher than *Ll*. At 5-DPT, *Pf* recorded maximum cumulative mortality (40.92%) at par with *Bb* (35.99%) and significantly higher than *Ll* (12.92%).

**Table 6.5. Post-treatment infection of entomopathogens on yellow mite of jute**

| Bioagent | Mycosis/ mortality (%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 3-DPT | | | 4-DPT | | | 5-DPT | | |
| | C1 | C2 | Mean | C1 | C2 | Mean | C1 | C2 | Mean |
| Bb | 25.45 | 17.73 | 21.59$^{b}$ | 35.69 | 26.36 | 31.02$^{a}$ | 30.12 | 41.37 | 35.99$^{a}$ |
| Ll | 4.47 | 5.29 | 4.87$^{c}$ | 9.27 | 9.10 | 9.18$^{b}$ | 10.59 | 15.25 | 12.92$^{b}$ |
| Pf | 35.11 | 25.59 | 30.35$^{a}$ | 25.59 | 42.23 | 35.90$^{a}$ | 25.57 | 34.35 | 40.92$^{a}$ |
| Mean | 15.92$^{b}$ | 21.95$^{a}$ | | 21.73$^{b}$ | 29.01$^{a}$ | | 25.57$^{b}$ | 34.35$^{a}$ | |

Bb- *Beauveria bassiana*, Ll- *Lecanicillium lecanii*, Pf- *Paecilomyces fumosoroseus*, C1- 4X10$^8$ CFU/l, C2- 6X10$^8$ CFU/ml

### 6.1.7. Effect of abiotic factors on mite infestation

The effect of temperature, relative humidity and rainfall on infestation of mite in jute was determined during the active growth phase of the crop. Significant effect of temperature and relative humidity on mite infestation was evidenced. Both maximum and minimum temperature had positive correlation with mite infestation whereas the relative humidity and rainfall adversely influenced the population growth and establishment of mite in jute during the active growth phase of jute *(Source: JE. 1.9; Contributors: S.Satpathy, B.S.Gotyal and V. Ramesh Babu).*

### 6.1.8. Effect of temperature on life duration and fecundity of mealybug

The impact of variable temperature i.e., at 25, 30 and 35$^{O}$C on mealybug, *Phenacoccus solenopsis* was studied under laboratory condition. There was significant reduction in nymphal duration with increase in temperature being 26.53±1.19, 21.69±1.40 and 20.73±1.70 days at 25, 30 and 35$^{O}$C respectively (Fig 6.10). The fecundity varied from 96.36-152.10 per female when reared at different temperature ranges. The female longevity varied from 10-12 days in this temperature range. The egg laying rate was significantly high (152.10/female) at 35$^{0}$C temperature and lowest (96.36/female) at 25$^{0}$C. With increase in temperature, although the fecundity was high, the overall population growth may not be proportional as the female longevity was significantly reduced at higher temperature.

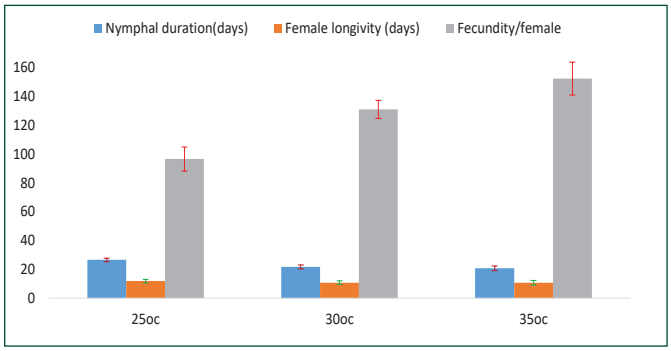



Fig 6. 10. Life stage duration and fecundity of mealy bug at different temperatures

## 6.2. Disease Management

### 6.2.1. Basic studies to understand the process of disease development in jute

Wide variations in stem rot disease symptoms and fungicidal control failures have been reported in farmers' field. Five different types of symptoms were observed in the field collected diseased plants. Lesions were dark brown or light brown in colour. Both of these were marked with numerous pycnidia. Dark black lesions were also noted. The fourth type of symptoms were characterized by rusty appearance. Die-back symptoms were also noted both under the experimental and commercial plots. Fungi associated with these lesions were isolated on PDA following standard microbial techniques. Based on their growth characters the pure cultures were broadly grouped into six categories (Fig.6.11). The first group had appressed mycelial growth with grey to black colony colour and black on reverse side of the plate. These groups produced microsclerotia on artificial medium. The second and third groups displayed cottony mycelial growth of grey colony colour. They did not produce microsclerotia on culturing. Next two groups of pathogens initially produced rhizoid type vegetative growth having white colonies. Reverse side of the plates were either white or black. The last group produced appressed white colonies and put forth numerous single celled conidia. Reverse side of the plates were light orange in colour. Fungi with cottony growth (second and third groups) were predominant. Individual members of these groups were inoculated into healthy jute stem and their pathogenicity was established.

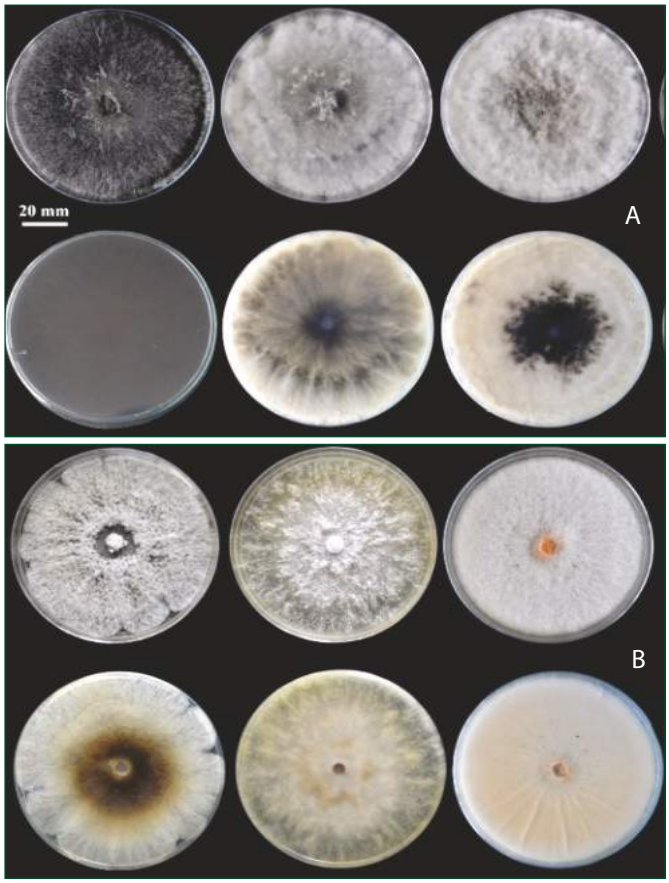



Fig. 6.11 (A &B). Six morphological groups of the pathogens isolated from jute stem lesions. Upper row shows colony morphology from top while lower row describes the reverse side of the same plates

Twelve members, two each from one group, were selected for further characterisation. Except the members from the last group, all produced pycnidia in host bark. However, members of last group produced acervulli with typical setae. Pycnidia from first three groups were almost identical (pitcher shaped) however, conidia from the first group was single celled and hyaline while those from the other

two groups were brown and two celled. Numerous single celled, minute conidia were produced inside more flattened pycnidia in case of members from fourth and fifth groups.

ITS regions of the rRNA genes from the genomic DNA was achieved using ITS1 and ITS4 primers. Amplicons showed minute variations in their sizes. Based on restriction fragment length polymorphism (RFLP) fungi from the second and third groups can be clubbed together. Similarly, members of the fourth and fifth groups had identical RFLP (Fig.6.12).

The selected isolates differed in their sensitivity towards three fungicides – carbendazim, hexaconazole and tebuconazole. However, tebuconazole was found best among the three fungicides. *(Source: JM 8.5 Contributor: K. Mandal and C.S. Kar).*

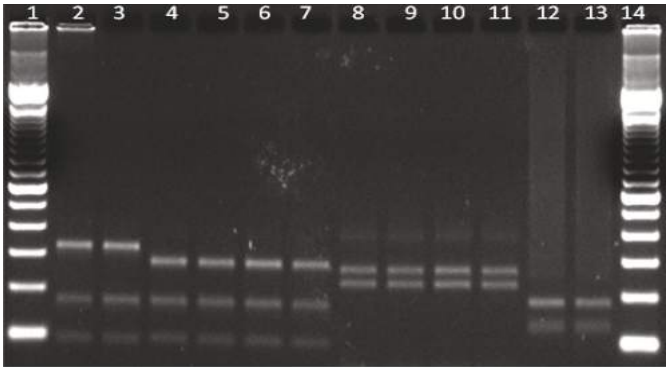



Fig. 6.12. Four ITS-RFLP patterns of the selected pathogens belonging to six morphological groups. Lanes 1 and 14 are 1 kb ladder while 2-3, 4-5, 6-7, 8-9, 10-11 and 12-13 represent each morphological groups.

### 6.2.2. Studies on effects of zinc, copper and silver nanoparticles against *Macrophomina phaseolina and Rhizoctonia bataticola*

The efficacy of ZnO, CuO and Ag nanoparticles was studied against *M. phaseolina* and *Rhizoctonia* spp. ZnO nanoparticles (NPs) were synthesized by base hydrolysis of 1mM zinc acetate. Copper Oxide (CuO) nanoparticles were synthesized by standard chemical precipitation of 0.5 M copper chloride dehydrate and silver nanoparticles were synthesized by chemical reduction of $AgNO_3$ (20 µM) by Sodium borohydride ($NaBH_4$). The synthesized nanoparticles were characterized through UV visible spectrophotometry, Powder X-Ray Diffraction (XRD) and Scanning Electron Microscopy (SEM). The average diameters of ZnO, CuO and silver nanoparticles were around 10 nm, 30 nm and 6.5 nm respectively as found in SEM images (Fig 6.13).

The seeds of *tossa* jute (*cv* JRO 524) and chickpea (Cv. Mahamaya I) were soaked in the colloidal suspension of nanoparticles of 0.01, 0.1, 0.5, 1.0 and 2.0 ppm concentration for 30 min. The treated seeds were sown in plastic pots filled with uniform soil mixture. 10 day-old seedlings of jute and chickpea were challenged inoculated with *M. phaseolina* and *R. bataticola* in different sets of experimentation. Seed

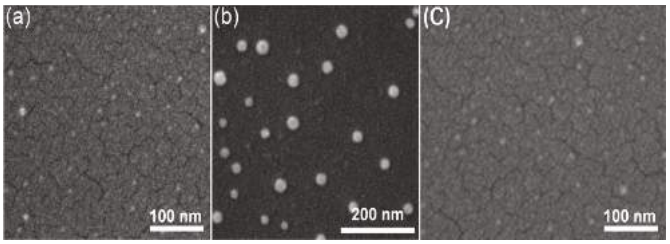



Fig 6.13. Scanning electron microscopy images for (a) ZnO (b) CuO (c) Ag nanoparticles

treatment with silver nanoparticles @ 2 ppm could contain the fungal infection at 33.33% in jute and 10% in chickpea seedlings under challenged inoculation compared to 90% and 96.66% infection in untreated crop of jute and chickpea respectively (Table 6.6).

**Table 6.6 Fungicidal effect of nanoparticles on disease infection (%) in jute and chickpea**

| Concentration (ppm) | Silver | | Copper | | Zinc | |
|---|---|---|---|---|---|---|
| | Jute | Chickpea | Jute | Chickpea | Jute | Chickpea |
| 0.01 | 73.33 | 80.00 | 90.00 | 90.33 | 00.00 | 00.00 |
| 0.1 | 30.00 | 63.33 | 83.33 | 66.66 | 00.00 | 00.00 |
| 0.5 | 23.33 | 56.66 | 00.00 | 10.00 | 00.00 | 00.00 |
| 1.0 | 50.00 | 16.66 | 00.00 | 00.00 | 00.00 | 00.00 |
| 2.0 | 33.33 | 10.00 | 00.00 | 00.00 | 00.00 | 00.00 |
| Control | 90.00 | 96.66 | 98.59 | 97.90 | 90.00 | 97.00 |

Absolute check on disease incidence through CuO nano particles was observed @ 0.5 ppm and @ 1 ppm in jute and chickpea respectively. The nanoparticles of ZnO were most effective which could completely suppress the pathogen even at 0.01 ppm concentration.

### 6.2.3. In-vitro toxicity studies with nanoparticles

In-vitro toxicity of ZnO, CuO and silver nanoparticles against *M. phaseolina* was studied through poison food technique with 0.01, 0.1, 0.5, 1.0, and 2.0 ppm concentrations. No significant toxicity was recorded at these concentrations. But these nanoparticles at the same concentrations were found effective against the target pathogen when applied in the plant system. This indicates involvement of different mode of action in case of nanoparticles. They might be influencing the host defense genes which may be unraveled through transcriptome analysis of nanoparticles treated plants. *(Source: ICAR-Extramural Project Contributors: C. Biswas and S. Bhattacharyya).*

### 6.2.4. Effect of *Trichoderma* strains on development of stem rot (*Macrophomina phaseolina*) lesion

Fresh culture (3 day-old) of *M. phaseolina* and five *Trichoderma* strains namely TVC-1, TH-1, TH-10, TVC-5 and TVC-6 were co-inoculated (at 5cm apart) in jute plant (cv. JRO 204) with

standard procedure. At the same time, plant inoculated with *M. phaseolina* were maintained for comparison as check. The lesion size ($cm^2$) were measured at 5 days interval up to 30 days after inoculation (DAI). TVC 1 gradually inhibited the lesion size (up to 47% at 30 DAI) whereas in other strains percent inhibition increased up to 15 DAI and reduced thereafter (Table 6.7, Fig 6.14). *(Source: TMJ 7 Contributor: S.K. Sarkar).*


Fig 6.14. Development of stem rot lesion with inoculation of *M. phaseolina* (A) and co-inoculation with *M. phaseolina* and *Trichoderma* strain (B)

**Table 6.7. Relative lesion size ($cm^2$) due to co-inoculation of jute plant (cv. JRO 204) with *Trichoderma* strains and *M. phaseolina***

| DAI | TVC-1 | | TH-1 | | TH-10 | | TVC-5 | | TVC -6 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | MP | Mp+ Tri | MP | Mp+ Tri | MP | Mp+ Tri | MP | Mp+ Tri | MP | Mp+ Tri |
| 5 | 2.90 | 2.00 | 3.57 | 2.10 | 3.33 | 2.00 | 3.33 | 2.17 | 3.33 | 2.37 |
| 10 | 3.50 | 2.29 | 3.67 | 2.11 | 3.83 | 2.00 | 3.83 | 2.58 | 4.00 | 2.37 |
| 15 | 4.00 | 2.47 | 3.67 | 2.11 | 3.83 | 2.00 | 3.83 | 2.58 | 4.67 | 3.22 |
| 20 | 4.80 | 2.65 | 5.00 | 2.95 | 5.00 | 3.35 | 4.67 | 3.67 | 5.00 | 3.22 |
| 25 | 4.80 | 2.65 | 5.00 | 2.95 | 5.00 | 3.35 | 4.67 | 3.67 | 5.00 | 3.22 |
| 30 | 5.00 | 2.65 | 5.00 | 2.95 | 5.00 | 3.35 | 4.67 | 3.67 | 5.00 | 3.22 |

## 6.2.5. Compatibility of fungicides with *Trichoderma* strains

Six fungicides (carbendazim 50WP, mancozeb 75WP, Cu-oxychloride 50WP, cymoxanil 8% + mancozeb 64% WP (Moximate), tricyclazole 75 WP and metalaxyl 35 WS) were tested at different concentration (50-200ppm) on growth inhibition of six different *Trichoderma* strains (TH-8,TH-1,TH-10,TV-H,TVC-1,TVC-2) under *in vitro* condition. Growth inhibition due to carbendazim @ 50ppm varied from 80-88% during 48-96 h of incubation in six different strains of *Trichoderma*. In other fungicides the growth inhibition stopped after 48 h of incubation in all the isolates. Even within 48 h of incubation, least growth inhibition of TVC-1 and TH-8 by tricyclazole, TH-10 and TVC-2 by copper oxychloride and TH-1 by moximte at 50 ppm was recorded. Therefore, considering the growth inhibition due to different fungicides at different period of incubation, tricyclazole was the best compatible fungicides with *Trichoderma* followed by copper oxychloride and moximate (Fig 6.15). *(Source: TMJ 7, Contributor: S.K. Sarkar).*

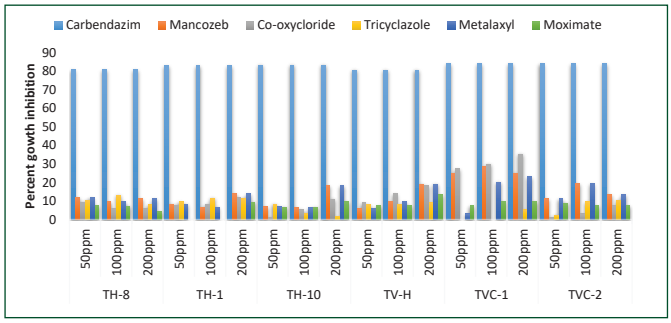



Fig. 6.15. Compatibility of different fungicides with *Trichoderma* strains

## 6.2.6. Field efficacy of soil application of bleaching powder and fungicides for management of stem rot of jute

Preventive control of jute stem rot by soil application of bleaching powder [Ca(OCl)Cl] and seed treatment (ST) as well as foliar spray of fungicides was evaluated in a field experiment (Table 6.8). In case of soil application of

**Table 6.8. Comparison between soil application of bleaching powder [Ca(OCl)Cl] and spraying of fungicides for management of stem rot of jute**

| Treatment | Incidence of stem rot (%) | | | |
|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | 120 DAS |
| Sowing after 2 days of soil application of [Ca(OCl)Cl] @ 20 kg/ha | 0.23 | 0.57 | 3.54 | 8.61 |
| Sowing after 7 days of soil application of [Ca(OCl)Cl] @ 30 kg/ha | 0.19 | 0.49 | 2.71 | 7.71 |
| Sowing after 7 days of soil application of [Ca(OCl)Cl] @ 50 kg/ha | 0.24 | 0.59 | 2.34 | 7.99 |
| Sowing after 10 days of soil application of [Ca(OCl)Cl] @ 80 kg/ha | 0.25 | 0.63 | 2.18 | 7.76 |
| ST + spraying with tebuconazole @ 0.1% at 45 DAS | 0.26 | 0.71 | 2.38 | 7.89 |
| ST + spraying with trifloxystrobin @ 0.1% at 45 DAS | 0.27 | 0.76 | 2.96 | 8.03 |
| ST + spraying with kresoxim methyl @ 0.1% at 45 DAS | 0.31 | 0.84 | 3.16 | 8.56 |
| ST + spraying with copper oxychloride @ 0.2% at 45 DAS | 0.35 | 1.69 | 10.91 | 14.22 |
| ST + spraying with carbendazim @ 0.1% at 45 DAS | 0.22 | 0.56 | 3.37 | 7.57 |
| Check | 0.54 | 2.47 | 16.22 | 24.04 |
| CD (P = 0.05) | 0.28 | 0.48 | 0.49 | 1.70 |

bleaching powder at different doses the sowing was done at different interval of 2-10 days after application. However, pre-sowing soil application of bleaching powder @ 20 - 80 kg/ha and sowing after 2-10 days performed at par with two modes of application of fungicides, namely, seed treatment and foliar spray at 45 DAS. Soil application of bleaching powder @ 30 kg/ha and sowing after 7 days was most effective in reducing stem rot incidence to 0.1 - 7.7% at all the dates of observation. ST along with one foliar spraying of tebuconazole, trifloxystrobin, kresoxim methyl, copper oxychloride 50 % WP at 45 DAS exhibited 7.8, 8.0, 8.5 and 14.2 % jute stem rot at the maturity of the crop (120 DAS). The check treatment without any intervention showed highest stem rot of 0.5 – 24 %. *(Source: JM. 9.0; Contributors: R. K. De, V. Ramesh Babu and Shamna, A.).*

### 6.2.7. Development of IPM module for jute

IPM module consisting of cultural [deep ploughing to expose soil to sun, sowing in line with 5 - 6 lakh plants / ha, NPK: 60:30:30, manual hand weeding once at 21 DAS]; chemical [soil application of $Ca(OCl)_2$ @ 30 kg/ha at 7 days before sowing (DBS), seed treatment with (a) carbendazim @ 2g/kg + (b) imidacloprid @ 4g/kg, application of pesticides: spiromecifen @ 1 ml/l, profenophos @ 2 ml/l]; biological [*Trichoderma viride* @ 10g/kg, soil application of *Pseudomonas fluorescens* @ 100g/ $m^2$ before sowing and spraying of neem oil @ 3 - 4 ml/l] components was effective against major insect pests of jute (cv. JRO 204).

Stem rot was reduced to 2.16% in complete IPM module (with cultural, chemical and biological components) compared to farmers' practice (16.5%). Yellow mite was reduced to 0.63% in IPM module (with cultural, chemical and biological components) from 7.23% in farmers' practice. Hairy caterpillar infested plants were 0.52 % in complete IPM module compared to 4.04% in farmers' practice. Higher fibre yield and benefit cost ratio of 29.25 q/ha and 1.61 were observed in IPM module. *(Source: JM. 9.0; Contributors: R. K. De, V. Ramesh Babu and Shamna, A.).*

### 6.2.8. Phenotypic and molecular screening of resistance source of mesta germplasms

Total 66 mesta $F_7$ generation germplasms including control were screened against mesta yellow vein mosaic virus (MeYVMV) under controlled glass house condition. Virus vector (whiteflies) were used for successful transmission of virus to all the mesta germplasms. All the germplasm exhibited yellowing symptoms of virus in phenotypic screening and the severity of virus infection was less compared to control plants. None of the germplasm was free from virus infection, although some germplasm showed very less symptoms of virus. Molecular screening of all $F_7$ germplasm were carried out with LAMP and HNB dye assay. The virus infected leaves of all the germplasm were used for isolation of viral DNA and used as a template in LAMP and HNB dyes methods. Both the assays showed positive results in all the germplasms. Phenotypic and molecular screening showed that none of the germplasms was resistance against MeYVMV. *(Source: J.M. 8.6, Contributors: P.N. Meena, L. L. Kharbikar, V. Ramesh Babu and S. K.Pandey ).*

### 6.2.9. Survey on incidence and intensity of zebra disease (*Phytophthora* spp.) of sisal (*Agave sisalana*)

The incidence of zebra disease of sisal in Jharsugura, Sambalpur and Sundargarh district of Odisha varied from 14.9 to 37.3% in *Agave sisalana* and 25.5 to 50.3% in Bamra Hybrid-1.

In Nursery stage, disease severity ranged from 3.4 to 47.1% in *Agave sisalana* and 3.0 to 50.6% in Bamra Hybrid-1. In case of 2-3 years old suckers, disease severity ranged from 2.8 to 45.7% in *Agave sisalana* and 3.6 to 46.9% in Bamra Hybrid-1 (Table 6.9). Maximum, minimum and average temperature showed significant negative correlation and minimum and average relative humidity showed significant positive correlation with disease severity in both the varieties in both nursery stages and 2-3 years old suckers.

**Table 6.9. Zebra disease (*Phytophthora* spp.) reaction in different sisal types**

| Date | Disease Severity in Nursery Stage (4-5 months old) | | Disease Severity in 2-3 years old suckers | |
|---|---|---|---|---|
| | *Agave sisalana* | Bamra Hybrid-1 | *Agave sisalana* | Bamra Hybrid-1 |
| 15th June 16 | 3.4 (10.6) | 3.0 (9.9) | 2.8 (9.6) | 3.6(10.9) |
| 30th June 16 | 7.5 (15.9) | 6.5 (14.8) | 7.9 (16.4) | 6.4 (14.6) |
| 16th July 16 | 23.5 (28.9) | 24.4 (29.6) | 21.9 (27.9) | 24.1 (29.4) |
| 31st July 16 | 28.9 (32.5) | 30.7 (33.6) | 29.0 (32.6) | 28.9 (32.5) |
| 16th Aug 16 | 36.7 (37.3) | 37.4 (37.7) | 33.7 (35.5) | 35.4 (36.5) |
| 31st Aug 16 | 40.7 (39.6) | 42.8 (40.8) | 39.3 (38.8) | 39.4 (38.9) |
| 15th Sept 16 | 44.1 (41.6) | 46.1 (42.8) | 42.6 (40.8) | 42.1 (40.5) |
| 30th Sept 16 | 46.3 (42.9) | 47.7 (43.7) | 45.2 (42.3) | 44.5 (41.8) |
| 15th Oct 16 | 47.1 (43.4) | 50.6 (45.4) | 45.7 (42.5) | 46.9 (43.3) |
| CD (P=0.05) | 1.8 | 2.3 | 2.2 | 1.7 |

Figures in parentheses are arc sine transformed value

### 6.2.10. Zebra disease (*Phytophthora* spp.) reaction in different sisal type and germplasm

Out of 11 spp. of sisal tested under natural epiphytotic condition, none was found resistant to the disease. One spp. (*A. miradorensis)* showed moderately resistant reaction and three spp. (*A. angustifolia*, *A. cantala* and *A. amaniensis*) showed moderately susceptible reaction and rest 7 spp. showed susceptible and highly susceptible reaction. Out of 61 germplasm tested under natural epiphytotic condition, 10 germplasm were resistant, 13 germplasm were moderately resistant and 38 germplasm were susceptible to highly susceptible.

### 6.2.11. Fungicidal evaluation for zebra disease management in sisal

All the 20 fungicides evaluated against zebra disease were effective in reducing the disease in both nursery and sucker stage (Table 6.10). However, fosetyl–Al @2.5g/l exhibited maximum efficacy followed by azoxystrobin and fenamidon 10% +mancozeb 50% WG. Among others, tebuconazole 50% + trifloxystrobin 25%, cymoxanil 8%WW + mancozeb 64% WW, metrim 55% + pyraclostrobin 5% WG were also effective to considerable extent. *(Source: SLM 1.0. Contributor: A. K. Jha).*

**Table 6.10. Efficacy of fungicides against zebra disease at nursery stage and suckers ( *A. sisalana* )**

| Fungicide | PDI | | Fungicide | PDI | |
|---|---|---|---|---|---|
| | Nursery | Sucker | | Nursery | Sucker |
| Mancozeb 75% WP @2.5g/l | 42.0 (40.4) | 41.1 (39.9) | Metrim 55% + Pyraclostrobin 5% WG | 27.3 (31.5) | 22.3 (28.2) |
| Metalaxyl 35% WS @2.0g/l | 37.0 (37.4) | 37.3 (37.6) | Propiconazole 25%EC | 40.9 (39.7) | 37.9 (37.9) |
| Matalaxyl 8% + Mancozeb 64% @2.5g/l | 32.7(34.9) | 26.7 (31.1) | Difenoconazole 25%EC | 34.4 (35.9) | 37.1 (37.5) |
| Carbendazim 12% + Mancozeb 63% WP @2.5g/l | 40.4 (39.4) | 40.1 ( 39.3) | Propiconazole 13.0 %WW + Difenoconazole 13.0 %WW | 29.0 (32.6) | 33.5 (35.3) |
| Copper oxychloride 50 WP@3.0g/l | 27.8 (31.8) | 31.7 ( 34.2) | Hexaconazole 5% EC | 37.0 (37.4) | 35.7 (36.6) |
| Chlorothalonil @ 2.5 g/l | 33.2 (35.2) | 35.9 (36.8) | Zineb 75% WP @2.5g/l | 42.1 (40.4) | 39.4 (38.9) |
| Tebuconazole 50% + Trifloxystrobin 25% @3.0g/l | 24.3 (29.4) | 24.2 (29.4) | Thiophanate Methyl 70% WP | 44.0 (41.6) | 42.1 (40.4) |
| Tebuconazole 250 EC @ 5.0 ml/l | 27.5 (31.5) | 31.2 (33.9) | Fosefyl–Al 80 WP @2.5g/l | 14.0 (21.9) | 16.8 (24.1) |
| Propineb 70 WP@2.0g/l | 31.2 (33.9) | 35.0 (36.2) | Cymoxanil 8%WW + Mancozeb 64% WW @2.0g/l | 23.9 (29.2) | 29.7 (32.9) |
| Azoxystrobin 23%SC @ 80 g a.i/l | 15.7 (23.3) | 17.1 ( 24.3) | Fenamidon 10% +Mancozeb 50% WG @2.0g/l | 15.7 (23.3) | 21.8 (27.8) |
| Check | 47.5 (43.5) | 45.5 (42.4) | CD (P=0.05) | 4.1 | 4.3 |

## 6.3. Weed Management

### 6.3.1 Eco-physiological studies of weeds in jute

Weed density and diversity under differential nutrient management levels in jute was studied under long term fertilizer experiment (LTFE). Higher weed density was recorded in 100% NPK + FYM compared to control and 100% N and it was at par with 100% NPK and 150% NPK (Table 6.11). A significant correlation was recorded among weed diversity, weed density, soil available N, P, K and soil organic carbon. Weed density was highly correlated (at both P<0.05 and 0.01) with soil N (0.91), P (0.89). Shannon diversity Index (Shanon H') was significantly correlated with soil organic carbon (0.90), soil available N (0.81) and P (0.91). While, Simpson dominance index was significantly correlated with soil organic carbon (0.84) and available N (0.77).

**Table 6.11. Pearson correlation coefficient of soil available N,P,K, soil organic carbon with weed density and diversity**

| Variables | OC (g/kg) | N (kg/ha) | P (kg/ha) | K (kg/ha) | Weed density (No/m2) | Shanon H' | Simpson D' |
|---|---|---|---|---|---|---|---|
| OC (g/kg) | 1.00 | 0.77* | 0.79* | 0.71 | 0.74 | 0.90** | 0.83* |
| N (kg/ha) | 0.77* | 1.00 | 0.71 | 0.76* | 0.91** | 0.81* | 0.77* |
| P (kg/ha) | 0.79* | 0.71 | 1.00 | 0.78* | 0.89** | 0.91** | 0.71 |
| K (kg/ha) | 0.71 | 0.76* | 0.78* | 1.00 | 0.85* | 0.76* | 0.40 |
| Weed density (no/m2) | 0.74 | 0.91** | 0.89** | 0.85* | 1.00 | 0.88** | 0.73 |
| Shanon H' | 0.90** | 0.81* | 0.91** | 0.76* | 0.88** | 1.00 | 0.81* |
| Simpson D' | 0.84* | 0.77* | 0.71 | 0.40 | 0.73 | 0.81* | 1.00 |

*. Correlation is significant at the P < 0.05 level (2-tailed).**. Correlation is significant at the 0.01 level (2-tailed).

#### 6.3.1.1 Determination of economic threshold (ET) of *Cyperus rotundus* for jute

Economic threshold (ET) of *Cyperus rotundus* was also calculated using Eq [1] and Eq [2] and presented in Fig. 6.17.

$$YL=id/(1+(i/A)*d \qquad [1]$$

Where, YL - yield loss (%); I = % yield loss per unit weed density as d-0; A = asymptotic value of maximum yield loss as d density-α

$$ET=[1+i/A\ \{2-H-(YAPH/C)\}T+(i/A)2(1-H)\ T2=0 \qquad [2]$$

Where, Y= weed free yield; P= unit price of crop; H= efficiency of herbicides/weed control treatment; C= cost of weed control; T= economic threshold

Fibre yield loss data observed from experiments was fitted well ($R^2$=0.92) in Eq [1]. The value of i and A was estimated by an iterative method for fitting data to nonlinear regression

in the 'SPSS' package. Maximum loss *i.e* A (asymptote) due to infinite density of *Cyperus* estimated to 69.02% and i - loss per unit of *Cyperus* was 0.26. Considering the price of jute fibre @ Rs 34 /kg, 80% herbicidal efficiency of glyphosate against *Cyperus* and cost involved @ Rs. 3400/ha, economic threshold of *Cyperus* was calculated to be 13.5 ~14/m$^2$. In this ET the fibre yield loss was estimated about 3% (Fig. 6.16).

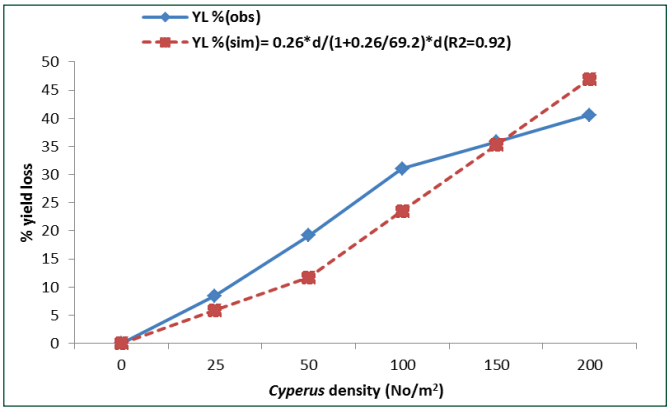



Fig. 6.16 Observed and simulated fibre yield loss at different *Cyperus* density

### 6.3.1.2 Determination of critical period for weed control (CPWC) in jute

Critical competition period of weed under different jute sowing method was also calculated by fitting relative fibre yield data of weed free crop obtained under the increasing duration of weed interference in the logistic equation [3]

$$Y=1/\exp (b*(t-d)+(f-1/f)*100 \qquad [3]$$

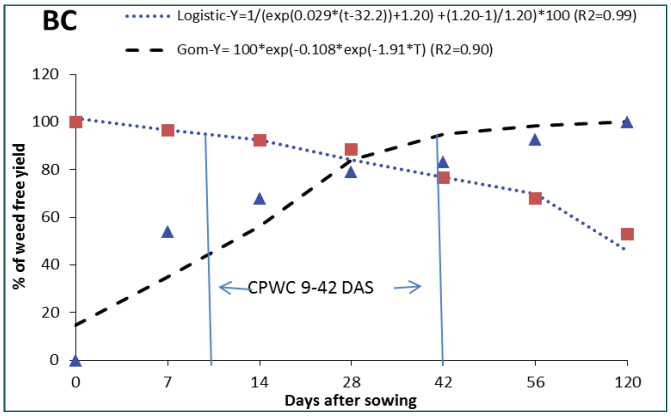
Where, Y is the yield (% of season-long weed-free yield), T is the time or days after sowing (DAS), d is the point of inflection (days), c and f are constants.

The Gompertz model showed a good fit to yield as it is influenced by increasing length of the weed-free period [4]

$$Y=A*\exp(-b*\exp(-k*t) \qquad [4]$$

Where, Y is the yield (% of season-long weed-free yield), A is the yield asymptote, b and k are constants, and t is the time (DAS)

The constant was calculated by iterative method for fitting data to nonlinear regression in the 'SPSS' package. By fitting these constant in logistic and gompertz equation the commencement of competition and end of weed crop completion (critical period of weed control) was calculated. Variation in the critical period of weed control (CPWC) was recorded under different sowing method of jute. CPWC at 5% fibre loss was 9-42 DAS for broadcast jute, 10-34 days for line sowing, 11-24 days for ridge and furrow sowing and 10-24 for paired row sowing (Fig. 6.17 & 6.18) *(Source: JA5.9; Contributors: M. Kumar, A.K. Ghorai and D.K. Kundu).*



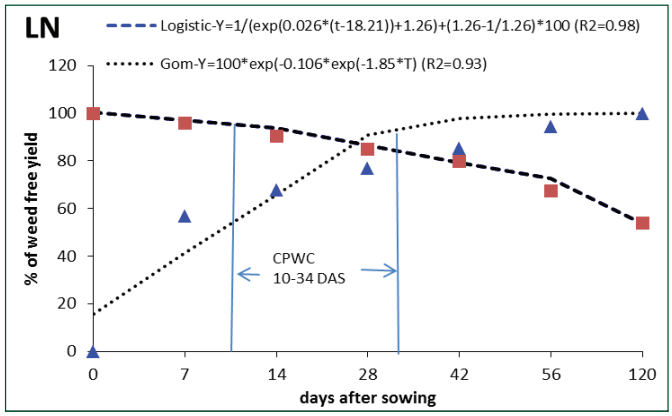
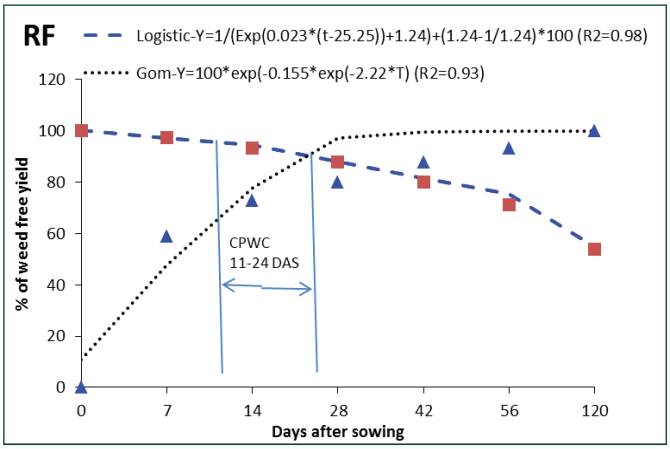




Fig. 6.17. Effect of weed competition on relative fibre yield of weed free jute under broadcast (BC) and line sowing (LN).



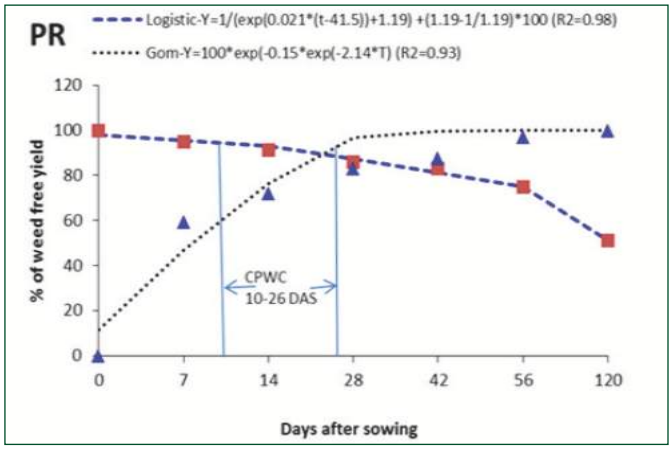




Fig. 6.18. Effect of weed competition on relative fibre yield of weed free jute under ridge furrow (RF) and paired row (PR).

### 6.3.1.3 Low cost eco-friendly technologies for weed management in jute and mesta

Pre-emergence and post-emergence herbicides were used for weed control in jute crop. Ipfencarbazone as pre-emergence herbicide recorded 77, 95 and 72 % lower grass, broad leaved and sedges density over control and it was at par with pretilachlor 50 EC for grass and broad leaved weed control. Among post-emergence herbicides**,** application of quizalofop ethyl 10 EC @ 38 g/ha with one manual weeding produced 3.83 q jute seed/ha (113 DAS), while two manual weeding recorded 3.04 q/ha jute seed.

Jute fibre yield in jute-green gram intercropping system varied from 27-34.7 q/ha along with 6 to 6.5 q/ha pulse grain (TMB-37). Small grain green gram cultivar 'Sukumar' was found effective as smother and intercrop in jute. In broadcast jute, CRIJAF Nail Weeder operation (at 4-7 DAE) could control composite weeds, thinned out excess jute seedlings, created soil mulching and developed line arrangement in jute field. Use of Nail weeder could save about 60-70 mandays per hectare in jute cultivation. *(Source: TMJ4; Contributors: A.K. Ghorai, M. Kumar and Samna A.)*

### 6.3.2. Integrated weed management practices in flax

The dominant weeds in flax crop were *Cyperus rotundus* L., *Chenopodium album* L., *Coronopus squamatus, Convolvulus arvensis L., Anagalis arvensis L., Vicia sativa L.* etc. Significantly lowest weed density was observed with the pre-emergence application of pendimethalin 30 EC @ 1.00 kg a.i./ha being at par with 0.75 kg a.i./ha dose (Table 6.12). The highest plant height, basal diameter, green biomass, dry biomass and fibre yield of flax were recorded with the application of pendimethalin 30 EC @ 0.75 kg a.i./ha. Although pendimethalin 30 EC @ 1.00 kg a.i./ha showed highest weed control efficiency, it was found phytotoxic to crop. Successive increase in nitrogen dose increased plant height, basal diameter, green biomass, dry biomass and fibre yield of flax up to the level of 90 kg N/ha. *(Source: SNHA 2.2 Contributors: M K Tripathi and Mukseh Kumar).*

**Table 6.12. Effect of weed control and nitrogen on weed at 60 DAS and flax fibre yield**

| Treatments | Weed density (no. $m^{-2}$) | Weed biomass (g $m^{-2}$) | Fibre Yield (q/ha) |
|---|---|---|---|
| **Weed control** | | | |
| Weedy check | 14.01 (196.92) | 5.09 (25.27) | 12.22 |
| Pendimethalin 30 EC @ 0.75 kg a.i./ha | 7.32 (53.50) | 2.87 (7.37) | 16.42 |
| Pendimethalin 30 EC @ 1.00 kg a.i./ha | 7.02 (49.17) | 2.72 (6.49) | 14.98 |
| Hand weeding at 20 and 40 DAS | 11.39 (129.58) | 3.17 (9.10) | 15.67 |
| CD (P=0.05) | 1.24 | 0.32 | 1.38 |
| **Nitrogen** | | | |
| 0 kg/ha | 9.33 (94.42) | 3.12 (9.24) | 12.32 |
| 30 kg/ha | 9.77 (105.00) | 3.38 (11.51) | 14.44 |
| 60 kg/ha | 10.19 (112.75) | 3.61 (13.20) | 15.96 |
| 90 kg/ha | 10.45 (117.00) | 3.74 (14.28) | 16.58 |
| CD (P=0.05) | 0.77 | 0.30 | 1.35 |

## 6.4. Abiotic Stress

### 6.4.1. Impact of rainfall and temperature change on productivity of jute, rice and wheat under long term fertilizer experiment

Pattern of temperature and precipitation changes has great impact on crop productivity. The yearly rainfall data for the 30 years (1982-2012, base data year-1972) were computed considering the crop growing season length based on planting and harvest dates. The data explained rainfall variability of 1.53%, 80% and 86 % during summer (Apr-July), *kharif* (Aug-Nov) and *rabi* (Dec-Mar) season, respectively. The analysis of jute yield with rainfall (CV=22.2) was observed and coefficient of correlation between rainfall and yield was 0.48, 0.52 and 0.73 in Control, $NPK_{100}$ and $NPK_{100+FYM}$ treatments. The jute and wheat yield with rainfall showed positive correlation. The current scenario of jute yield (65%) was observed with increasing trend of summer rainfall after the year 1992, whereas wheat productivity decreased due to decline in rainfall (Fig. 6.19). Although rice is grown during monsoon months, its production shows a rather weak and insignificant correlation with monsoon rainfall during the year 1982-2012.

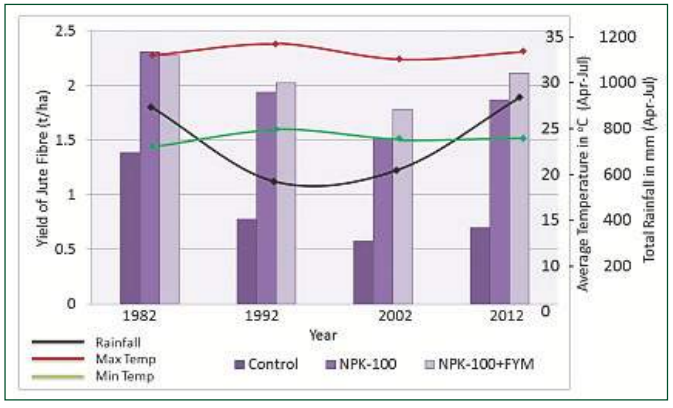



Fig 6.19 Yield of jute vis-à-vis rainfall & temperature distribution during 1982-2012 under jute-rice wheat cropping system

Seasonal changes in temperature was assessed to analyse its impact on jute fibre, rice and wheat yield (Fig. 6.20) while controlling for other variables at given conditions at the interval of 10 years during 1982-2012. Jute fibre and rice grain yields increased by 18-20% and 12-20%, respectively after the year 2002 in all the fertilizer treatments. An increase in temperature by 0.3°C during jute growing season and 0.45°C in case of *kharif* season was associated with increase in yield. Whereas in case of wheat crop, a decline in yield was observed due to increase in temperature by 3.4 °C in the year 1982 and 1.3 °C during the year 1992. It is due to the fact that the study area may be high of cumulative temperatures during the wheat growing season. *(Source: JA 6.0. Contributors: A.K. Singh, D. Barman and D.K. Kundu)*

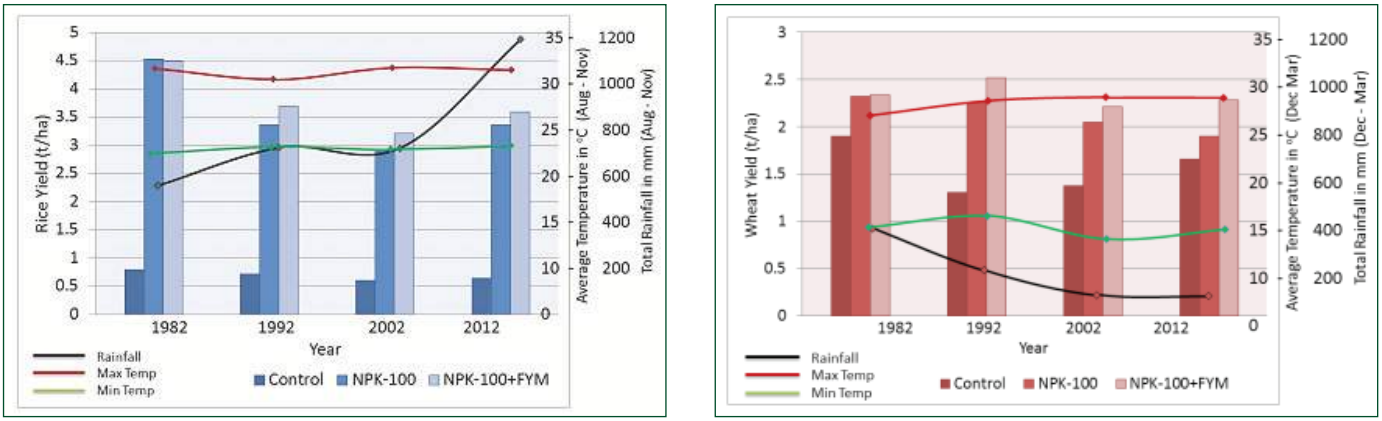



Fig 6.20 Yield of rice and wheat vis-à-vis rainfall & temperature distribution during 1982-2012 under Jute-Rice Wheat Cropping system (LTFE trials) at Barrackpore (W.B.)

# 7. Farm Mechanization and Post-Harvest Technology

## 7.1 Farm Mechanization

### 7.1.1 Development of multi-crop seed drill (Power Operated)

An experimental model of power operated seed drill has been developed for line sowing of jute and other small seeded crops (Fig 7.1). The machine is suitable to accommodate in the space between rotary tiller and depth control wheel of power tiller so that tillage and sowing can be done at a time. The machine uses metering mechanism to meter the seeds instead of gravity flow.

Fig. 7.1. Power operated multi-crop seed drill

Main parts of the machine are seed hopper, ground wheel, metering mechanism, frame/tool bar, furrow openers, seed covering device. The rectangular shape seed hopper is made of MS sheet of volume 0.0023 $m^3$. Two ground wheels of 340 mm diameter transmit power to the metering shaft through chain and sprocket drive. Seed from hopper is collected by metering device made of aluminium alloy (60 mm dia. having 8 grooves at 25 mm interval on its periphery) and drops behind the furrow opener near the ground through seed tubes. The machine has 4 furrow openers with spacing of 25 cm. Chains attached behind the furrow opener acts as ladder for covering the seeds. The laboratory calibration of seed drill showed seed rate of 2.5-3.0 kg/ha and 50-60% uniformity of seed distribution along the rows with seed spacing of 30-50 mm. On field trial at ICAR-CRIJAF farm with 15HP power tiller at 1.45-3.0 km/h average speed of operation the depth of seed placement was 25-30 mm and field capacity was 0.28-0.3 ha/h. No mechanical seed damage was observed (Fig. 7.2). *(Source: JAE3.4. Contributors: R.K. Naik, A.K. Ghorai, S. Sarkar and S.K. Jha).*

Fig. 7.2. Jute crop sown with power operated seed drill

### 7.1.2 CRIJAF-Single wheel jute weeder

A manually operated weeder suitable to cater the mechanical weeding of young composite weed flora in line sown jute and other similar crops has been developed (Fig. 7.3). The weeder operates on a cycle wheel (compact) of 40 cm diameter for its easy operation in the field with less rolling resistance. Weeding operation is push and pull type and removes weeds completely from its operational width. It is used in 15-30 days of crop age in between lines and about 80 to 85% weeds can be controlled. The rest 15 to 20% of the weed flora is to be removed manually. Weeding with this tool reduces drudgery, reduces labour and cost requirement in line sown crops. There is saving of more than 60% of weeding time and approx. Rs.14000-15000/ha over manual weeding and also reduces labour requirement of about 50-60 man-days/ha. Design of the machine in the name of "CRIJAF- Single Wheel Jute Weeder" has been registered in the Indian Patent Office, Kolkata (Application No. 289424 in Class 15-03 dt. 19/12/2016).

Fig. 7.3. CRIJAF single wheel jute weeder

Non-exclusive license has been awarded to private firm for manufacture and sale for a period of 10 years w.e.f. 01 March, 2017. The cost of the weeder is Rs. 1850/-. *(Source: JAE 3.4. Contributors: R.K. Naik, A.K. Ghorai, S. Sarkar and S.K. Jha).*

## 7.2 Post Harvest Technologies

### 7.2.1 Ribbon retting for jute and mesta

Fibre from 120 and 130-day old jute and mesta plants were extracted through bast fibre extractor, manual jute extractor and jute decorticator. The extracted ribbons were retted in polythene lined pond with varying retting conditions i.e. with and without microbial culture (CRIJAF SONA), vertical and horizontal steeping. The average retting duration of ribbons with bacterial retting culture was 7-10 days against 13-15 days without culture. Average fibre recovery for jute was 7.23% and 8.66% for 110 days and 120 days harvested plants, respectively. In case of mesta plant, fibre recovery was 7.08% on green weight basis against 5-6% in conventional method. Fibre from the ribbons extracted with manual jute extractor exhibited 10-20% more strength than other machines for both jute and mesta. The average fibre strength of 16.54 g/tex and 23.26 g/tex was recorded for 110 and 120 days harvested jute, respectively and it was 14.68 g/tex for mesta (Fig. 7.4). The fibre strength from vertically retted ribbon declined the strength by 7% and 40% for jute and mesta, respectively compared to horizontal retted ribbons. The average fibre fineness of 2.8 to 3.4 tex was obtained with ribbon retting. *(Source: JA 5.8. Contributors: R.K. Naik, B. Majumdar, S.P. Mazumdar and M. R.Naik)*

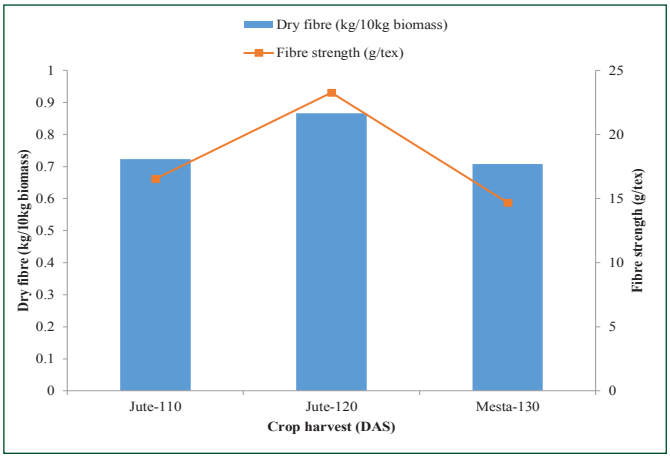



Fig. 7.4 Effect of crop harvest on recovery and strength of fibre

### 7.2.2 Upscaling and refinement of microbial retting consortium

The viability of endospore prepared from three different strains of *Bacillus pumilus* (MTCC 5573, MTCC 5574 and MTCC 5575) was tested by introducing into different temperature, pH, UV treatment and antibiotic sensitivity. After six months from preparation, spore counts remained stable ($10^9$/ml) whereas cfu count of talc-based microbial consortium decreases ($10^{10}$/ml to $10^6$/ml). Endospores showed higher resistance to temperature, pH, UV irradiation and antibiotic sensitivity than their vegetative forms. Endospore shows a wide range of pH tolerance from pH-3 to pH-12. Germination and growth of bacterial spores occurred even after 20 minutes of irradiation. Endospores used for fibre retting, germinated into vegetative cells, released pectinolytic and xylanolytic enzymes that facilitated retting, reduced the retting duration and produced good quality jute fibre. Retting of raw jute with bacterial endospores completed in 10 days, with fibre strength of 27.8 g/tex and fibre fineness of 2.61 tex. Twenty three ligninolytic strains have been selected based on Azure B test for lignin degradation assay. Large scale demonstrations (100) of improved retting were carried out with CRIJAF microbial formulation "CRIJAF Sona" under farmers' field condition in jute growing districts of West Bengal. The retting duration was reduced by 6 to 7 days with increase in fibre productivity by 10 to 12% and improvement in fibre quality compared to conventional retting. *(Source: TMJ 6.0 Contributors: B. Majumdar, A. R. Saha, S. Sarkar, S. K. Sarkar, S. K. Jha and S. Paul Mazumdar)*

### 7.2.3 Medium and large scale degumming of ramie fibre

The degumming consortium of the alkalophillic strains MTCC 5891 and MTCC 5892 (1:4, v/v) were used for degumming of ramie fibre in 5 kg batch (medium scale) and 15 kg batch (large scale) in room temperature. The degumming efficiency of the consortium ranged between 24.0 – 26.5% (weight loss basis) as compared to 27.2 - 28.5% in chemical degumming. The mean residual gum content of the microbial degummed fibre ranged between 4.15-4.35% which was comparable to the gum content of chemical degummed fibre (3.05%) (Fig. 7.5). In large scale (15 kg fibre batch) degumming, the average content of pectin (1.04%, weight basis) and hemicellulose (1.78%, weight basis) in the microbial degummed ramie fibre was comparable (Fig. 7.6) to that of chemical degummed fibre (pectin – 0.61%; hemicelluloses - 1.85%) and was significantly lower than that of undegummed ramie fibre (pectin – 6.40%; hemicellulose - 5.5%). The moisture absorption capacity of the microbial degummed fibre (8.05%) was also comparable to that of chemical degummed fibre (7.6%). The tensile strength of the degummed single ramie fibre using the microbial consortium ranged from 34.71 – 35.01 cN/tex which was comparable to that recorded with chemical degumming (36.03 cN/tex).

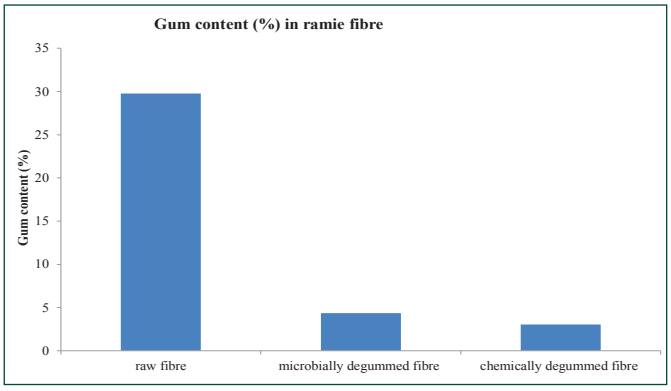



Fig. 7.5 Residual gum content of microbial and chemically degummed ramie fibre

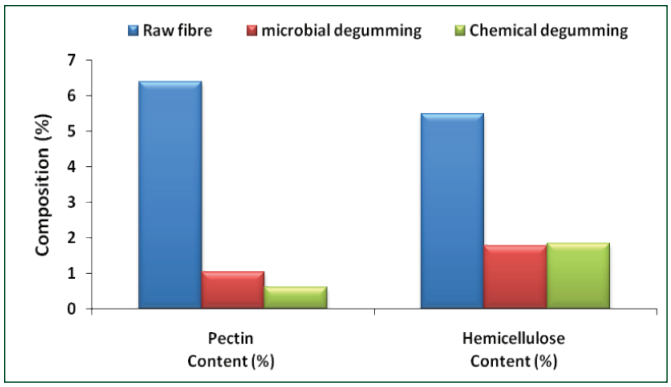



Fig. 7.6 Pectin and hemicellulose content of raw, microbially and chemically degummed ramie fibre

### 7.2.3 Talc based formulation with alkalophilic pectinolytic strains (MTCC 5891 and MTCC 5892)

The powdery state of the formulation was maintained up to the mixing ratio of 5:1 (w/v), i.e. pre-sterile talc powder (50 g) and culture liquid (10 ml). The initial bacterial count of the microbial degumming consortium (CFU count of 140.5 x $10^6$) was maintained up to 60 days (CFU count of 108 x $10^6$) when stored in room temperature (Fig. 7.7). *(Source: TMJ 8 Contributors: S. Mitra and Kunal Mandal).*

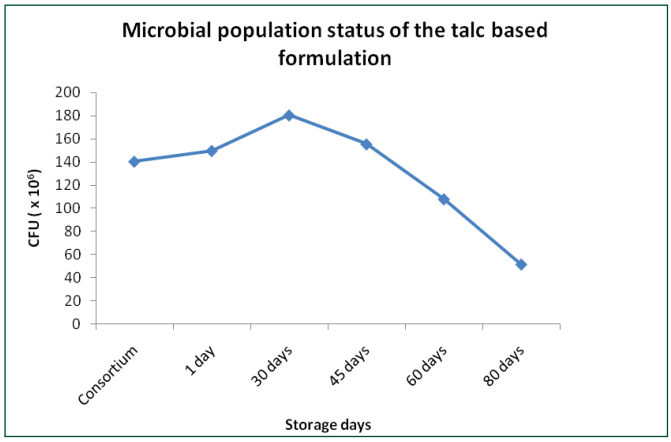



Fig. 7.7 Microbial population status of the talc based formulation under room temperature

# 8. Jute and Allied Fibre Informatics

## 8.1 Jute Expert System

JAFexpert is a web-based 3-tier expert system introduced and developed by CRIJAF containing jute and allied fibre crops growing practices. The website is now available at URL: http://jafexpert.crijaf.icar.gov.in/. The database of expert system for jute and allied fibre crops has been updated on the basis of recent developments in technologies. The expert system for Mesta, Sunnhemp, Sisal, Ramie and Flax crop information system has also been developed. *(Source: TMJ 3. Contributors: A. K. Chakraborty, A. K. Ghorai, R. K. De, Shamna A., D. Barman, C. S. Kar, K. Selvaraj, M. K. Tripathi, A. K. Jha, and A. Singh)*

## 8.2 Climate Change Risk Assessment in Jute Production

Climate change vulnerability analysis is a pre-requisite for the climate change risk assessment. The framework for climate change vulnerability of jute production was prepared on three aspects, viz. exposure to climate change, sensitivity, and adaptive capacity. Climate change analysis was done using seasonal long-term (1976-2016) meteorological data of Barrackpore region. Climate data analysis revealed that minimum air temperature, in general, was in increasing trend during winter, pre-monsoon, and monsoon seasons, but trend was reverse in post-monsoon. Maximum air temperature was in decreasing trend during winter, pre-monsoon, post-monsoon and it was reverse in monsoon. However, mean air temperature was in decreasing trend during winter and post-monsoon, but it was increasing in pre-monsoon and monsoon.

### 8.2.1 Agrometeorological Database Management System (DBMS)

A web-based database management system (DBMS)-cum-agroadvisory system has been developed for storing, updating, retrieving, and analysing the long-term temporal and spatial climatic data for agricultural advisory services to the farmers with special emphasis on jute growers. DBMS is a pre-requisite to handle huge temporal and spatial climatic data. Keeping the focal point towards farmers/jute growers, an agro-advisory module is also included in the DBMS, and the whole system is proposed to be called as JAFmet©. This DBMS-cum-agroadvisory system has been developed in .NET environment scripting in C++/Java/html language. The web pages has been designed and configured in such a way that all types of end users including farmers can understand and make use of it (Fig. 8.1). *(Source: JA 7.1. Contributors: D. Barman, A.K. Chakraborty, A.K. Singh and R. Saha).*

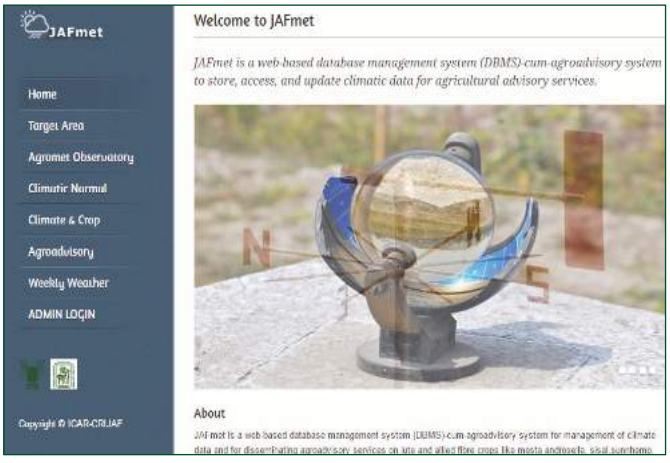



Fig. 8.1. Design and configuration of the first page of the DBMS-cum-agroadvisory system

## 8.3 Geo-Spatial Approach to Study of Agri-Horti Intercropping Model

Sisal-mango intercropping system was identified as suitable agri-horti intercropping model in red and laterite zone of West Bengal. To identify the potential areas of this intercropping system in red and laterite soils of Bankura district, multiple spatial information layers/maps were prepared for Bishnupur and Barjora blocks. These information layers, viz. land use/land cover map, waste land map, digital elevation model (DEM), agro-ecological sub-region maps and rainfall map were integrated in GIS environment for

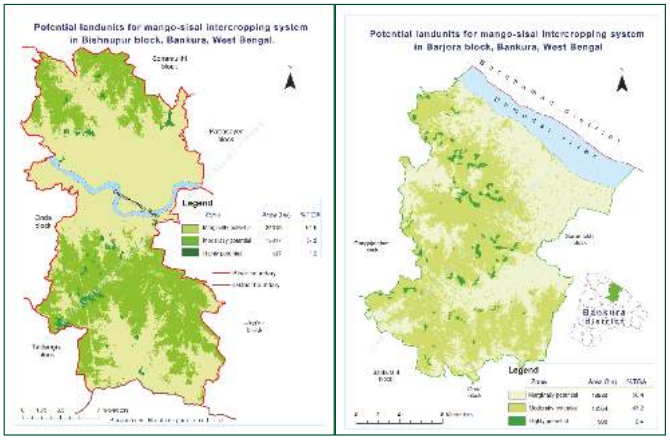



Fig. 8.2. Potential land unit maps for mango-sisal intercropping system in Bishnupur (a) and Barjora blocks (b)

principal component analysis (PCA). PCA resulted in two principal information layers of wasteland map and DEM that were used, by assigning equal weightage, in multi-criteria decision analysis (MCDA) tool in TNTmips® v. 2015 to postulate potential area for mango-sisal intercropping system. For this analysis, DEM was categorized into three classes, viz. 27 - 60, 60 - 80 , and 80 - 126 m for Bishnupur, and <71, 71-100, and > 100 m for Barjora, and the wasteland map was classified into two categories as scrubland and barren land, and the highest score was assigned to the scrub land

followed by barren land. MCDA generated three categories, viz. marginally potential, moderately potential, and highly potential land for Bishnupur and Barjora blocks (Fig. 8.2). *(Source: RKVY (Stream-II), Contributors: D. Barman, D.K. Kundu, and Sitangshu Sarkar).*

## 8.4 JuteMarkerdb: A database of markers on jute

Most of the recently developed genetic resource data of jute are confined to journal reports having restricted user access. From the existing jute genomic resources 2079 unigene-driven Simple Sequence Repeat (SSR) markers have been developed and integrated in a user-friendly database, named "JuteMarkerdb" along with detailed information on these markers. The objective is to provide access to jute breeders, biotechnologists, students for characterization of jute germplasm and varieties, and molecular breeding. The database is freely accessible to users at http://jutemarkerdb.icar.gov.in/index.aspx (Fig. 8.3 and 8.4).

Clicking on the above URL, users will be directed to the homepage of the database. The Relational Database Management System (RDBMS) and Microsoft-based SQL server with ASP.NET v4.5 environment was used to construct this database. The database uses SQL queries to provide users with the SSR primer data and other information through customized query mode and batch mode. The main dynamic database is located on the tab: 'ESSR DATABASE' with three drop-down menus: Browse all, Batch Download, Query access. 'Browse all' tab will show all the 2079 primers with their forward and reverse primer sequence to use in PCR amplifications. Users are also provided to download the primer sequences in batches from the 'Batch Download' tab menu and select from the drop down list to complete download categorized primer sequences in excel files. Query based searching of primer sequences using the 'Query Access' tab menu is also provided. This will allow users to search as per their own selection criteria to download the resultant primer sequences in excel file.

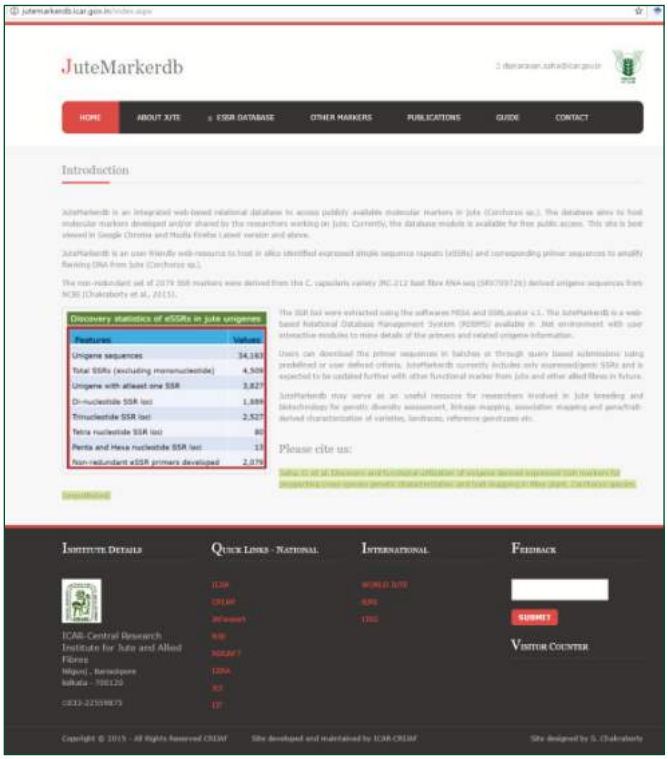



Fig. 8.3. Main menu of JuteMarkerdb

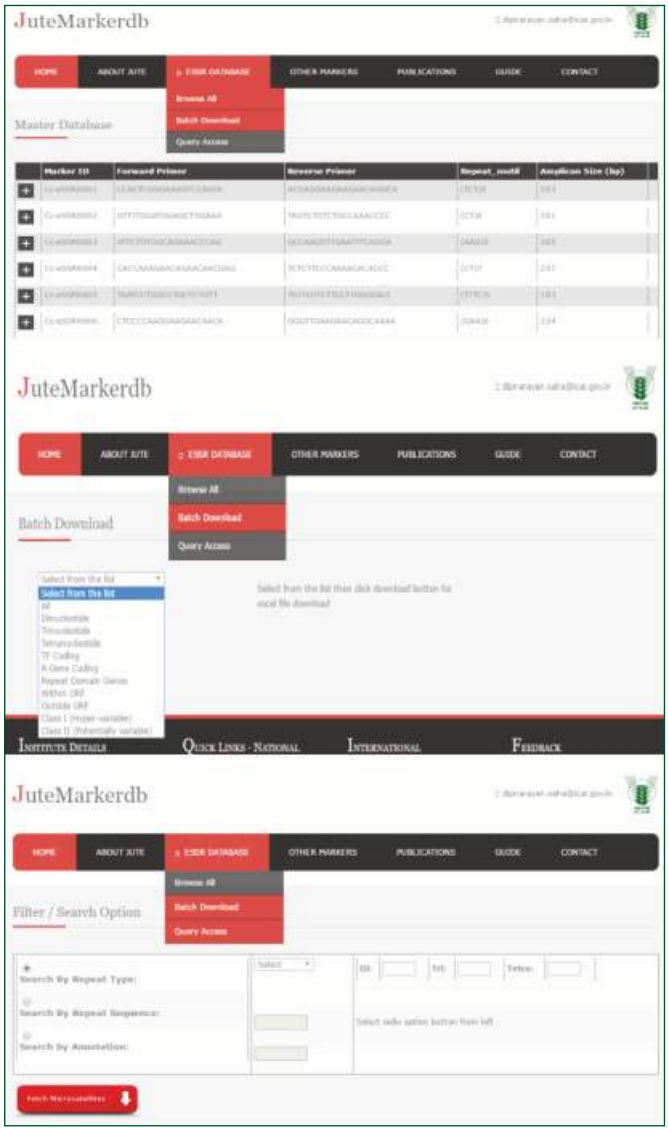



Fig. 8.4. Drop down menus of JuteMarkerdb

Besides main database, tabs with static pages were included to provide links to other molecular marker resources, an updated list of publications with hyperlink to the published journals and a guide to use the database. *(Source: CI-JBT 4.4. Contributors: D. N. Saha, S. Datta and A. K. Chakraborty)*

# 9. Transfer of Technology

## 9.1. Research

### 9.1.1. Impact of improved jute production technologies on productivity and economics of jute cultivation

Impact of jute production technologies on farmers' economy was assessed on the basis of production indicators, economic indicators and technical indicators through a structured interview–schedule in Hooghly, Malda, Murshidabad, Nadia and North-24 Parganas district. The socio-economic profile of the respondents revealed that majority of the beneficiary respondents (44%) as well as non-beneficiary respondents (43%) belonged to middle aged group (35–55 years). The literacy amongst the beneficiary respondents was higher (90%) as compared to non-beneficiaries (80%). More than 31% beneficiary respondents were matriculate or higher qualified. Similarly, 12% of the beneficiary respondents have annual income of > Rs. 5 lakhs compared to only 9% for non-beneficiaries. Improved jute production technologies have positive impact in achieving 25% yield enhancement, fibre grade improvement and additional return. The advisory provided by ICAR-CRIJAF was the credible source of information to the farmers for adoption of improved jute production technology (Fig. 9.1). Increased productivity enabled the farmers to spend more in agriculture and education (Table 9.1).

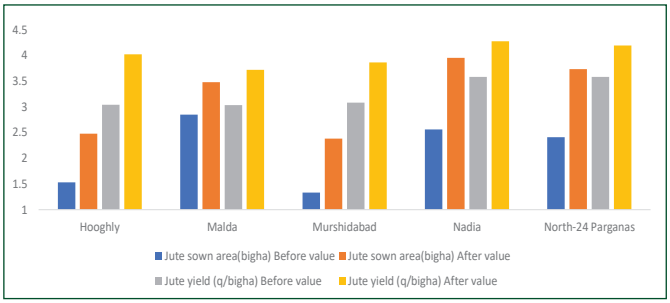



Fig. 9.1 Impact of ICAR-CRIJAF technologies on enhancement in area and productivity

**Table 9.1: Comparison of the selected parameters of the respondents**

| Parameters | Mean | | Paired 't' value |
|---|---|---|---|
| | Before contact | After contact | |
| Area under jute ( ha) | 0.28 | 0.43 | 12.10** |
| Yield of jute (q/ha) | 24.98 | 30.10 | 29.00** |
| Expenditure on agriculture (%) | 18.61 | 29.16 | 25.25** |
| Expenditure on education (%) | 6.66 | 12.04 | 15.39** |

** Significant at 1 %

The major constraints (in general) in jute cultivation perceived by the respondents were high cost of inputs, prevalence of the middlemen in the markets, lower prices, absence of assured market, lack of technical know-how, labour crisis during weeding and harvesting and lack of quality seeds *(Source: JEXA 5.3; Contributors: S.K. Jha, Shailesh Kumar, S. Sarkar, Shamna A., M.L. Roy and A.K. Chakraborty).*

### 9.1.2. Impact of technological interventions under Tribal Sub Plan in Makaltala and Farmania Villages

**Adoption of important technologies:** Extent of adoption of interventions like improved cultivation practices of jute, rice, mustard, coriander, vegetables in jute fabric based coloumns, poultry and duckery introduced among the tribal farmers of Makaltala and Farmania villages of North 24 Parganas district were evaluated. Out of all the interventions, the tribal farmers were highly satisfied with the interventions on jute. The highest jute yield recorded during last jute season was 38.6 q/ha. A study on the adoption of technology by farmers (Table 9.2) revealed that retting by CRIJAF Sona (84) and line sowing (82) have been adopted by majority of farmers followed by nail weeder and seed treatment (73).

**Table: 9.2 Adoption of improved jute production technologies by the tribal farmers**

| Technology | No. of farmers | | |
|---|---|---|---|
| | 2014 | 2015 | 2016 |
| Retting using CRIJAF Sona | 49 | 60 | 84 |
| Nail weeder | 5 | 46 | 73 |
| Line sowing | 4 | 28 | 82 |
| Seed treatment | 15 | 62 | 73 |
| Balanced fertilizer application | 22 | 56 | 64 |
| Vegetable cultivation in soil columns | 5 | 12 | 15 |
| Toria | 42 | 55 | 62 |

**Effect of technological intervention on tribal farm women's participation in farming activities:** Extent of change in physical participation of tribal farm women in farming activities were evaluated by scoring each activity by the farm women. Promotion of new technology improved the participation of farm women in all the farming activities but it was especially more in case of field preparation, sowing and weeding.

Drudgery was more in case of field preparation, weeding and retting with a score of 117 each which has decreased to 82, 66 and 56 respectively (Table 9.3). Farm women had expressed that the drudgery increased in case of sowing with seed drill but helped in decreasing the drudgery in other farm operations like weeding, plant protection and harvesting activities.

**Table 9.3 Extent of change in physical participation and drudgery**

| Activity | Physical participation | | Drudgery reduction (difficulty level) | |
|---|---|---|---|---|
| | Pre | Post | Pre | Post |
| Field Preparation | 17 | 42 | 117 | 82 |
| Sowing | 8 | 20 | 68 | 108 |
| Weeding | 44 | 63 | 117 | 66 |
| Irrigation | 12 | 17 | 95 | 91 |
| Plant protection | 1 | 10 | 107 | 84 |
| Harvesting | 39 | 48 | 88 | 78 |
| Retting | 3 | 25 | 117 | 56 |

**Impact of the interventions:** A list of seven factors under personality development of tribal farm women was prepared. The total score was calculated for all the farm women under each factor (Fig. 9.2). All the selected factors showed an increase from the initial score with a maximum change on the factor "self-confidence" of the tribal farm women *(Source: JEXA 5.4; Contributor: Shamna, A.).*

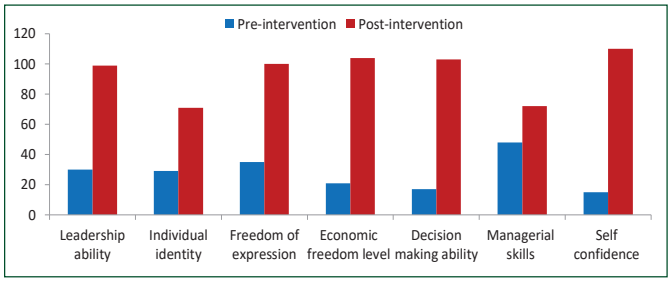



Fig. 9.2 Effect of intervention on different parameters of personality development of tribal farmwomen

### 9.1.3. Agro-economic studies on the effect of technological interventions on livelihood of tribal farm families of Dakshin Dinajpur

Agro and allied technological interventions were introduced among tribal farm families of Tapan block of Dakshin Dinajpur district. Major interventions were in agriculture (jute and lentil), animal husbandry (goat rearing), bird rearing (duck and chicken rearing) and fishery (desi magur). In case of jute the technologies were (i) improved variety– JRO 204, (ii) line sowing by CRIJAF Multi Row Jute Seed Drill, (iii) weeding by CRIJAF Nail Weeder and (iv) jute retting using microbial formulation (CRIJAF Sona). In case of jute, the improved production technologies increased the yield by 39.4%. In lentil (cv. Moitree) the yield was 1046 kg $ha^{-1}$ and the net return per rupee investment (NRPRI) obtained was 1.33 which was marginally better than jute (Table 9.4).

The goat (Black Bengal) rearing activity by the tribal farm women in Dakshin Dinajpur district was the most beneficial venture among all the technological interventions with maximum NRPRI of 3.84. The NRPRI was 3.56 and 0.28 in case of duck and chicken rearing respectively. The NRPRI for fish cultivation was better (2.07) than agricultural activities. *(Source: JEXA 5.5; Contributor: S. Sarkar)*

**Table 9.4. Economics of different technologies taken up under TSP in Dakshin Dinajpur**

| Activity | Unit | Cost (Rs) | Total output value (Rs) | Profit (Rs) | NRPRI (Rs) |
|---|---|---|---|---|---|
| Jute | 0.13 ha | 8,500/- | 18,400/- | 9,900/- | 1.16 |
| Lentil | 0.13 ha | 3,600/- | 8,400/- | 4,800/- | 1.33 |
| Duck rearing | 10 nos. | 850.70 | 3,885.70 | 3,035/- | 3.56 |
| Chicken rearing | 20 nos. | 2,120/- | 2,722.3 | 602.30 | 0.28 |
| Goat rearing | 2 nos. | 5,100/- | 24,685/- | 19,585/- | 3.84 |
| Fish (*desi magur*) | 1000 nos. | 9,780/- | 30,000/- | 20,220/- | 2.07 |

### 9.1.4. Analysis on adoption of selected CRIJAF technologies

A study was conducted among 300 selected jute growers of Debkundu (Murshidabad), Gopalpur (Nadia), Gauribati (Hooghly) and Manikchak (Malda) to find out the adoption behaviour of technologies demonstrated by ICAR-CRIJAF. Balanced fertilizer application (95%) and weed management through herbicide (pre and post emergence) was adopted by majority (67%) of jute growers followed by line sowing of jute through Multi Row Seed Drill (28.3%). The major factors in facilitation of adoption of technologies were availability of pre and post emergence herbicides, chemical fertilizers in the market and sharing of Multi Row Seed Drill by farmers. The major constraints for non-adoption of technologies by the respondents were non-availability of improved CRIJAF varieties (89.2 %), CRIJAF Sona (100%), CRIJAF Nail Weeder (85.3%) and Multi Row Seed Drill (80%) in local market. As per the level of adoption most of the clientele (75%) were in the low adoption category. Only 8% of the jute growers were in high adoption category.

The independent variables like sources of information utilization (0.33**), social participation (0.67**), risk orientation (0.29**), scientific orientation (0.50**) and marketing infrastructure (0.51**) had significant association with extent of adoption of improved jute production technologies (Table 9.5).

The adoption of improved technologies of jute, analyzed through regression analysis ($R^2$ = 0.68**) showed that there was significant relationship with age (-0.28*), farming experience (0.22*), annual income (0.46**), land holding (0.95**), sources of information utilization (2.39**), social participation (7.74**), risk orientation (2.31**), scientific orientation (2.84**) and marketing facilities (5.36**) (Table 9.6). *(Source: JEXA: 5.6; Contributors: Shailesh Kumar, S.K. Jha and Shamna A.)*

**Table 9.5: Relationship between socio-economic parameters with adoption level of selected CRIJAF technologies**

| Independent variables | Correlation coefficient |
|---|---|
| Age (X1) | -0.11 $^{NS}$ |
| Education (X2) | -0.06 $^{NS}$ |
| Farming experience (X3) | -0.09 $^{NS}$ |
| Annual income (X4) | 0.03 $^{NS}$ |
| Land holding (X5) | 0.02$^{NS}$ |
| Sources of Information utilization (X6) | 0.33** |
| Social participation (X7) | 0.67** |
| Risk orientation (X8) | 0.29** |
| Scientific orientation (X9) | 0.50** |
| Marketing facilities (X10) | 0.51** |
| Family size(X11) | -0.12$^{NS}$ |
| $R^2$=0.68, F=20.89** | |
| $Y= -65.92-0.07X_1-0.06\ X_2+0.057X_3+0.49X_4+0.27X_5+1.30X_6+3.03X_7+1.97X_8+1.53X_9+3.78\ X_{10}-0.85X_{11}$ | |

** significant at 1% level of probability

**Table 9.6: Multiple regression and extent of adoption of selected CRIJAF technologies**

| Independent variables | Partial regression co-efficient (b) | " t" value |
|---|---|---|
| Age (X1) | -0.07 | -0.28* |
| Education (X2) | -0.06 | -0.10$^{NS}$ |
| Farming experience (X3) | 0.06 | 0.22* |
| Annual income (X4) | 0.49 | 0.46** |
| Land holding (X5) | 0.27 | 0.95** |
| Sources of information utilization (X6) | 1.31 | 2.39** |
| Social participation (X7) | 3.93 | 7.74** |
| Risk orientation (X8) | 1.97 | 2.31** |
| Scientific orientation (X9) | 1.53 | 2.84** |
| Marketing facilities (X10) | 3.78 | 5.36** |
| Family size (X11) | -0.85 | -1.78$^{NS}$ |

** Significant at 1% level of probability, * Significant at 5% level of probability

## 9.2. Extension

### 9.2.1 Frontline demonstration (FLD)

Frontline demonstrations on latest high yielding varieties and other improved production technologies of jute were organized in villages of Nadia and North 24-Parganas, Murshidabad and Hooghly districts of West Bengal through the extension centres of the institute and KVK, Burdwan under National Food Security Mission (Commercial Crops). Altogether, 370 demonstrations covering 92.87 ha on jute were conducted in the above districts (Table 9.7).

**Table 9.7: Area covered under each component of frontline demonstration programme**

| Name of Village | No. of farmers | Area (ha) under different technologies | | | | |
|---|---|---|---|---|---|---|
| | | Improved varieties | Line sowing | Weed control | Improved retting | Total area (ha) |
| Kumra (North 24-Parganas) | 54 | --- | 4.23 | 15.00 | 0.50 | 19.73 |
| Madhusudanpur (Hoogly) | 102 | --- | 8.75 | 11.75 | 0.50 | 21.00 |
| Brahmapur (Nadia) | 80 | --- | 11.50 | 8.00 | 0.50 | 20.00 |
| Sargachchi (Murshidabad) | 79 | 21.50 | --- | --- | 0.50 | 22.00 |
| Bhasapur (Burdwan) | 55 | 9.64 | --- | --- | 0.50 | 10.14 |
| Total | 370 | 31.14 | 24.48 | 34.75 | 2.50 | 92.87 |

**Varietal evaluation:** The *tossa* jute varietiey *i.e.* JRO 204 (Suren) was demonstrated for assessing yield performance in the farmer's field in 32 ha area in Murshidabad and Burdwan. Sowing was done under irrigated condition in the month of April-May. Recommended package of practices were followed. The highest fibre yield of jute irrespective of the locations (Table 9.8) was obtained from the variety JRO 204 (30.35 q/ha) which gave a net return of Rs. 65,972 while local check (JRO-524) yielded 26.53 q/ha only giving a net return of Rs. 47,721. B:C ratio was maximum (2.01) in case of JRO 204 (Table 9.8).

**Table 9.8: Economics of jute varieties at different locations**

| Variety | FY (q/ha) | TCC (Rs./ha) | GR (Rs./ha) | NR (Rs./ha) | B:C ratio |
|---|---|---|---|---|---|
| JRO 204 | 30.35 | 65444 | 131416 | 65972 | 2.01 |
| Local Check | 26.53 | 67133 | 114854 | 47721 | 1.71 |

*FY-Fibre Yield, TCC-Total Cost of Cultivation, GR-Gross Return, NR-Net Return, B:C-Benefit Cost Ratio, Price of jute fibre - Rs.3,700/q ; jute stick - Rs.300/q*

Fig. 9.3 Field day at Dhobapara, Balagarh (Hooghly) on FLD

**Weed management:** In order to reduce the cost of weeding and increase profitability of jute cultivation, the demonstrations of herbicidal method (quizalofop ethyl @ 1.5 ml/l) and mechanical weed management through CRIJAF Nail Weeder were laid in the farmers' field in 34.75 ha in three districts (Table 9.9). Demonstration on weed management resulted in 2.48-3.15 q/ha more fibre yield over farmer's practice (25.94-26.12 q/ha). Saving on cost of labour was Rs.8,240-8,597/ha.

Fig. 9.4 FLD on use of plant protection chemicals

**Table 9.9: Economics of jute cultivation through weed management (Rs/ha)**

| Technology | IC (Rs./ ha) | HLC (Rs./ ha) | TCC (Rs./ ha) | FY (q/ ha) | GR (Rs./ ha) | NR (Rs./ ha) | B:C ratio |
|---|---|---|---|---|---|---|---|
| **Madhusudanpur** | | | | | | | |
| Nail weeder | 15967 | 47018 | 62985 | 29.27 | 126740 | 63755 | 2.01 |
| FP | 17010 | 55615 | 72625 | 26.12 | 113100 | 40475 | 1.56 |
| **Kumra** | | | | | | | |
| Quizalofop ethyl | 17962 | 44875 | 62837 | 28.42 | 123059 | 60222 | 1.96 |
| FP | 16815 | 53115 | 69930 | 25.94 | 112320 | 42390 | 1.61 |

*IC- Input Cost, HLC-Human Labour Cost, TCC-Total Cost of Cultivation, FY-Fibre Yield, GR-Gross Return, NR-Net Return, B:C-Benefit Cost Ratio, FP-Farmer's Practice; Price of jute fibre - Rs.3,700/q ; jute stick - Rs.300/q*

**Line sowing:** Demonstrations on manual 4-row seed drill were conducted in an area of 24.48 ha at three locations (Table 9.10). This technology increased the fibre yield by 1.60-2.63 q/ha. It also saved the cost of human labour in jute cultivation to the extent of Rs.4,203-4,807/ha over farmer's practice. The effect of this intervention was maximum at Brahmapur (Rs. 4,807/ha).

**Table 9.10: Economics of jute cultivation (Rs/ha) under line sowing through Multi Row Seed Drill**

| Technology | IC (Rs/ha) | HLC (Rs/ha) | TCC (Rs/ha) | FY (q/ ha) | GR (Rs/ha) | NR (Rs/ha) | B:C ratio |
|---|---|---|---|---|---|---|---|
| **Madhusudanpur (Hooghly)** | | | | | | | |
| MRS | 15967 | 51113 | 67080 | 28.75 | 124428 | 57348 | 1.86 |
| FP | 17010 | 55615 | 72625 | 26.12 | 113100 | 40475 | 1.56 |
| **Brahmapur (Nadia)** | | | | | | | |
| MRS | 16007 | 53155 | 69162 | 28.27 | 122410 | 53248 | 1.77 |
| FP | 17256 | 57972 | 75228 | 26.67 | 115871 | 40643 | 1.54 |
| **Kumra (North 24 Parganas)** | | | | | | | |
| MRS | 15911 | 48912 | 64823 | 27.89 | 120764 | 55941 | 1.86 |
| FP | 16815 | 53115 | 69930 | 25.94 | 112320 | 42390 | 1.61 |

*IC- Input Cost, HLC-Human Labour Cost, TCC-Total Cost of Cultivation, FY-Fibre Yield, GR-Gross Return, NR-Net Return, B:C-Benefit Cost Ratio, FP-Farmer's Practice; Price of jute fibre - Rs.3,700/q ; jute stick - Rs.300/q*

**Improved retting through CRIJAF Sona:** In comparison to conventional method of jute retting, application of CRIJAF Sona (@23 kg/ha) reduced the retting period by 6-9 days. At all the locations, there was improvement in quality (1-2 grade) and fibre colour *i.e.* yellowish to bright golden. Jute growers could earn additional income of Rs.300-400/q due to the higher price for the improved quality of fibre (Table 9.11). This method also reduced the fibre: water ratio (v/v) to 1:5 which is four times less than the conventional method of retting (1:20).

**Table 9.11: Qualitative evaluation of improved retting through CRIJAF Sona**

| Extension Centre | Retting method | Fibre quality | Retting duration ( days) | Additional income (Rs./q) |
|---|---|---|---|---|
| **Madhusudanpur** (Hooghly) | Improved | TD 3- 4 | 11 -15 | 400 |
| | Conventional | TD 5 - 6 | 18 -21 | - |
| **Bramhapur** (Nadia) | Improved | TD 3- 4 | 11 - 13 | 400 |
| | Conventional | TD 5 - 6 | 18 -21 | - |
| **Sargachhi** (Murshidabad) | Improved | TD 4 - 5 | 14 -17 | 400 |
| | Conventional | TD 5 - 6 | 21 - 24 | - |
| **Kumra** (North 24 Parganas) | Improved | TD 3- 4 | 11 - 14 | 400 |
| | Conventional | TD 5 - 6 | 18 -21 | - |
| **Bhasapur** (Burdwan) | Improved | TD 3- 4 | 12 - 14 | 300 |
| | Conventional | TD 5 - 6 | 18 -21 | - |

Farmers were satisfied with the performance of technological interventions like improved varieties of jute, line sowing through Multi Row Seed Drill, mechanical weed management through CRIJAF-Nail Weeder and improved retting through CRIJAF Sona. All these technologies reduced the cost of cultivation, increased yield and quality of fibre and net return in comparison to their traditional practice. *(Source: NFSM Sub-project, JEXA 4.7; Contributors: S.K. Jha, Shailesh Kumar, Shamna A., M.L. Roy and R.K. Naik)*

### 9.2.2. Mera Gaon Mera Gaurav (MGMG)

ICAR-CRIJAF adopted 55 villages of North 24 Parganas, Nadia, Hooghly and Medinipore districts under Mera Gaon Mera Gaurav (MGMG) programmes of the institute. All the scientists regularly visited the adopted villages, interacted with the farmers and provided literatures on improved production technologies of jute and other field crops. In number of villages, International Year of Pulses-2016 was also celebrated and the farmers were made aware about the benefits of growing pulses. The FAO document on International Year of Pulses-2016 (in English) was translated in Bengali for local farmers.

MGMG farmers displaying the Bengali leaflet of International Year of Pulses-2016

Scientists-farmers interaction in MGMG adopted village

The activities performed by the scientist groups of the institute under MGMG are–visit to the villages; about 1550 farmers were benefitted; total 16 gosthis/meetings were conducted in which 560 farmers were directly benefitted; in mobile based advisory, 12 SMS were sent to about 6600 farmers; about 2000 extension folders were distributed among the jute farmers; about 550 kg of jute seed of new varieties were distributed among 550 farmers through which 150 ha area was covered by new high yielding jute varieties; in 5 general awareness creation activities, 425 farmers were covered. Linkages of jute farmers with National Jute Board, Jute Corporation of India, Krishi Vigyan Kendra, State Department of Agriculture and NGO have been developed for benefit of the jute growers. *(Source: MGMG; Contributor: S. Sarkar)*

### 9.2.3. Jute-ICARE (Jute-Improved Cultivation and Advanced Retting Exercise)

With an aim for mass adoption of improved jute production technology by small and marginal jute farmers and enhancement of farmers' profitability from jute cultivation, phase-II of a collaborative project titled '*Jute-Improved Cultivation and Advanced Retting Exercise*' was implemented jointly by ICAR-CRIJAF, National Jute Board (NJB), Jute Corporation of India (JCI) during 2016-17. The project was implemented in intensively jute growing areas of West Bengal, Assam, Bihar, Odisha and Meghalaya covering an area of 25,897 ha encompassing 40,585 enlisted jute farmers. Mainly four important technologies of CRIJAF, namely, (i) certified quality seed of improved *tossa* jute variety (JRO 204), (ii) line sowing of jute by multi-row jute seed drill, (iii) mechanical weeding by CRIJAF Nail Weeder and (iv) improved microbial jute retting technology using 'CRIJAF Sona' were promoted under this project. CRIJAF had provided all the improved production technologies and extended scientific and technical expertise for essential HRD of the project (Table 9.12). *(Source: Jute ICARE; Contributor: S. Sarkar and B. Majumdar).*

Training of farmers at Astara village adopted under Jute-ICARE programme

**Table 9.12 Training/demonstration conducted under Jute-ICARE programme**

| Trainings/demonstrations | Place | Date | No. of participants |
|---|---|---|---|
| Training and demonstration on line sowing of jute by seed drill and improved jute cultivation | Juria, Nagaon, Assam | 07.04.16 | 55 |
| Training and demonstration on line sowing of jute by seed drill | Dakar Ghat, Nagaon, Assam | 07.04.16 | 48 |
| Training and demonstration on line sowing of jute by seed drill | Daulasal, Barpeta, Assam | 08.04.16 | 65 |
| Farmers' training and demonstration of improved microbial jute retting technology | Astara, Hooghly, WB | 30.06.16 | 196 |
| Training & demonstration of improved microbial retting of jute using CRIJAF Sona | Kaladanga and Rajdharpara, Murshidabad, WB | 04.07.16 | 135 |
| Training & demonstration of improved microbial retting of jute using CRIJAF Sona | Bethuadahari, Nadia, WB | 05.07.16 | 50 |
| Training & demonstration of improved microbial retting of jute | Nagaon & Barpeta, Assam | 13.07.16 to 14.07.16 | 130 |
| Training & demonstration of improved microbial retting of jute | Tura, Meghalaya | 15.07.16 to 16.07.16 | 100 |
| Training & demonstration on improved microbial retting of jute | Katihar, Bihar | 05.08.16 | 85 |
| Training & demonstration on improved microbial retting of jute | Purnea, Bihar | 06.08.16 | 94 |
| Training of farmers on improved jute production technology with special reference to improved variety, quality seed and line sowing | Jirat, Hooghly, WB | 05.01.17 | 100 |
| Farmers' training on improved production technology of jute | Dakshin Dinajpur, WB | 30.03.17 | 100 |

### 9.2.4 Other extension activities

The extension section also organised the scientists-farmers interaction, exposure visits, awareness camps to solve the problems related to jute cultivation faced by the farmers. Besides the technologies developed by the Institute were also showcased in exhibitions and agri-fairs in different parts of the country (Table 9.13)

**Table 9.13 Participation of the Institute in different agri-fairs**

| Agri-fair | Date | Location | No. of visitors |
|---|---|---|---|
| 31st Annual Titumeer Fair | 18-20 November, 2016 | Atghara, North 24 Parganas | 400 |
| Agricultural Exhibition | 22-26 November, 2016 | IARI, New Delhi | 3000 |
| Muzzafarnagar Agri-fair | 28-30 November, 2016 | Muzzafarnagar, Uttar Pradesh | 1000 |
| Bajarpore gramin pradarshani o mela | 16-19 December, 2016 | Purba Medinipur, West Bengal | 500 |
| Sundarban Krishi Mela-o-Lokasanskriti Utsav | 20-29 December, 2016 | Kultali, South 24 Parganas | 1500 |
| Golden Jubilee Celebration and Rural exhibition | 21 January, 2017 | Garifa, North 24 Parganas | 150 |
| 11th All India Peoples' Technology Congress | 5 February, 2017 | Salt Lake, Kolkata | 200 |
| Agri-Exhibition | 13 February, 2017 | CRIJAF, Barrackpore | 250 |
| Krishi Unnati Mela | 15-17 March, 2017 | IARI, New Delhi | 2000 |

Demonstration of improved microbial retting of jute using 'CRIJAF Sona' at Hooghly

CRIJAF exhibition stall in Northern Zone Agri-fair at Muzaffarnagar

# 10. Tribal Sub Plan

Under Tribal Sub Plan (TSP) programme, various activities were undertaken to enhance livelihood security of tribal farmers and farm women through jute and allied fibres (sisal and ramie) based cropping system along with animal husbandry, fishery, poultry and duck rearing in two blocks of North 24 Parganas (Habra and Baduria), one block of Dakshin Dinajpur (Tapan) of West Bengal. Sisal related agricultural activities were undertaken in Sambalpur and Jharsuguda districts of Odisha. Ramie cultivation based activities were conducted in Chirang district of Assam.

## 10.1. Enhancement of Livelihood Security of Tribal Farmers in North 24 Parganas

### *Makaltala and Farmania* Village

**Improved jute production technology:** All the improved jute production technologies were integrated and demonstrated to tribal farmers. Seeds of improved varieties of jute (JRO 204 and S 19) were distributed to the farmers for 18 ha area of land. Most of the farmers adopted the recommended jute production technologies. The widely accepted technologies were 4-row jute seed drill, nail weeder and retting with CRIJAF Sona.

**Microbial retting:** In order to improve fibre quality, retting of jute using talc based microbial formulation "CRIJAF Sona" was introduced among tribal farmers. Approx. 400 kg formulation of CRIJAF Sona was distributed to the tribal farmers. Increase in quality of jute fibre and additional economic benefit of Rs. 300-500 per quintal of fibre was reported as compared to conventional practices. The farmers of Makaltala also participated in training of retting programmes conducted under TSP programme.

Fig. 10.1. Demonstration of CRIJAF Sona application for retting

**Introduction of vegetable cultivation in jute based columns:** Jute fabric based soil columns enable growing vegetable/other crops as relay or simultaneously grown crop with paddy. In Makaltala village, the farmers cultivated vegetable crops like sponge gourd, snake gourd, pumpkin, and ash gourd in the columns prepared in the rice fields. Average rice yield was 5.4 t/ha and vegetable yield varied from 0.7-10 q/ha. This helped in increasing the net farm income per unit area in waterlogged rice field.

Fig. 10.2. Abundant fruiting of cucurbits grown on soil columns in rice field

**Improved production technology of mustard, rice, nigella and coriander:** To increase the income from unit area of land, the cropping intensity of the cultivated area was increased by introducing short duration tori in pre-rabi season followed by boro rice. The necessary inputs like seed and fertilizers were provided to the tribal farmers. The crop nigella (kalo jeera) was introduced during 2016-17 as many farmers showed keen interest in cultivating this crop. In addition to field visit and farmers'-scientist interactions, the farm inputs and technologies related to this crop were made available to the participating tribal farmers. *(Source: TSP. Contributor: A. Shamna).*

### *Paschim Simla Sardar Para* village

**Improved jute production technology and vegetable cultivation:** The technological interventions related to jute production like seeds of improved variety, seed drill, nail weeder, balanced fertilizer application and improved retting method using CRIJAF Sona were introduced in Paschim Simla Sardar Para village. All the farmers who adopted the CRIJAF technologies could improve the productivity of jute fibre by 22%. Farmers were also provided technical and farm input support for cultivation of paddy (*kharif* and *rabi*), mustard, coriander and potato. Results of TSP intervention and Farmers' feedback revealed that the technological interventions were very useful and helped them to increase farm income and self employment opportunities *(Source: TSP. Contributor: S.K. Jha).*

Fig. 10.3. Director, ICAR-CRIJAF distributing improved seed to the farmers

Fig. 10.4. Quality jute fibre by CRIJAF Sona-mediated retting

Fig. 10.5. Mustard grown by the tribal farmers following improved technology

**Improved paddy and mustard cultivation in Ghoshpur village :** Tribal farmers of Ghoshpur village of Baduria block of North 24 Parganas were provided with essential farm inputs for cultivation of paddy (*Kharif*). Interventions like high yielding variety (Sonamukhi) and plant protection measures resulted 3-5 q/ha higher yield over traditional practices (42-48 q/ha). In *Rabi* season introduction of mustard variety (B-54) yielded 24.1-26.5 q/ha over tori (12-13.50 q/ha). However, the crop duration was about 1 month more than tori. While variety B-9 of mustard yielded 16.5-18.7 q/ha. *(Source: TSP. Contributor: Shailesh Kumar).*

## 10.2. Enhancement of Livelihood Security of Tribal Farmers in Nadia District

To popularize the production of pulse crops in Brahmapur village in Nadia district, a training-cum-awareness programme was organized for tribal farmers. The farmers were made aware about the importance of growing pulse crops for improving soil health and ensuring nutritional security. Farmers were provided with improved variety of lentil (cv. Moitree), recommended fertilizers, rhizobium culture for seed inoculation, *Trichoderma viride* for seed treatment and required pesticides. Supported extension literatures were also distributed amongst the farmers. An average yield of 12.52 q/ha was obtained which was 25-30% higher than traditional variety grown by farmers. *(Source: TSP. Contributor: M. L. Roy).*

Fig 10.6 Demonstration of lentil (cv. Moitree) at Haringhata

## 10.3. Enhancement of Livelihood Security of Tribal Farm Families of Dakshin Dinajpur

To enhance the livelihood security of tribal farm families of Hazrabari, Dubahar, Mehur, Batdanga, Gurail and Shyampur villages of Tapan block of Dakshin Dinajpur district, improved jute based crop production technologies and other allied farming technologies were demonstrated.

**Dissemination of improved production technology of jute:** Improved production technology of jute comprising of high yielding *tossa* jute variety (JRO 204), line sowing by seed drill, weeding by CRIJAF nail weeder, balanced fertilizer use, need based crop protection measures, improved microbial retting using 'CRIJAF Sona' were introduced to increase jute productivity and higher profitability among the

tribal farmers of Tapan block. The jute fibre yield was higher (34.4 q/ha) as compared to the farmers' practice (24.6 q/ha). Profit from improved practice was Rs. 73,950/ha which was comparatively higher than farmers' practice (Rs. 9,500/ha).

Fig. 10.7 Distribution of certified jute seed (JRO 204) to the tribal farmer of Tapan block

Fig. 10.8 Line sowing of jute in tribal farmer's field

**Improved microbial retting of jute by 'CRIJAF Sona':** Improved microbial retting technology using 'CRIJAF Sona' was demonstrated among the 50 tribal jute farmers of Tapan

Fig. 10.9 Distribution of CRIJAF Nail Weeder among tribal farmers of Hili block

Fig 10.10 Demonstration of improved retting technology in Hili Block

block of Dakshin Dinajpur. The retting technology advanced the retting time 6-8 days over the conventional jute retting method resulting in improvement of quality by 1-2 grade and the farmers could earn additional amount of Rs. 10,320/ ha. Feedback data revealed that 94% of the participating farmers were '*highly-satisfied*' with the efficiency and ease of use in the improved retting technology.

**Dissemination of improved production technology of lentil:** To commemorate the International Year of Pulses (2016), the tribal farmers of Tapan block were made aware of the pulse crop cultivation and its benefits. Selected farmers of the block were provided essential inputs like seeds (cv. Moitree), rhizobium culture, essential macro and micro nutrients and plant protection measures were provided to the farmers before the crop sowing.

**Air-breathing fish (*desi magur*) cultivation:** Air-breathing fish (desi magur), 1000 fingerlings per pond were reared using improved technology in small water bodies owned by the tribal farm families of Tapan block. Mean body weight of each harvested fish was about 75 g within 5 ½ months of growing period. The total yield was about 75 kg in 0.07 ha pond area which had a market value of at least Rs 30,000/-. The air-breathing fish cultivation not only increased their farm income but also improved protein intake by the tribal population of the block *(Source: TSP. Contributor: S. Sarkar).*

## 10.4. TSP on Sisal in Odisha

Planting of sisal has been completed in 10 ha areas among the 9 tribal farm families of Jharsuguda and Sambalpur districts. Harvesting of sisal (1st harvest) in 4 villages covering an area of 8 ha yielded 42 q sisal fibre. Intercropping of sisal with green gram (cv.TMB-37) was done in approximately 14.2 ha area among the 18 farmers. Intercropping of sisal with sesame was done in 11 ha area among the 18 farmers in 4 villages of Sambalpur and Jharsuguda district. *(Source: TSP. Contributor: A.K. Jha).*

Fig 10.11. Tribal farmers of Odisha are harvesting sisal leaves

Fig. 10.12. Pits prepared for sisal plantation in Bamra

## 10.5. TSP on Ramie in NE States

Ramie was planted covering an area of 4 ha during 2015-16 under TSP in Uttar Burikhamar village (Chirang, Assam) for area expansion in ramie-based intercropping systems was maintained during 2016-17 cropping season as perennial crop. *(Source: TSP. Contributor: Amarpreet Singh).*

Fig. 10.13 Ramie plantation established under TSP at Chirang district of Assam

## 10.6. TSP under AINPJAF

The Tribal Sub Plan programme had been taken up by AINP units of BCKV, Kalyani; UBKV, Coochbehar; JRS, Kendrapara and RARS, Nagaon. The programme was conducted in 9 villages belonging to 5 districts of West Bengal, Assam and Odisha covering 59 ha area. About 288 tribal farmers participated in the programme. In South Bengal, the activities were carried out in Srikrishnapur and Matiagacha villages of North 24 Parganas district. In north Bengal, activities were carried out in Badalgir, Atialdanga and Jaigirbalabari villages of Dinhata II block of Coochbehar district. In Odisha, the TSP activities were taken up in Dihasahi and Beusahi villages of Anandapur block of Keonjhar district. In Assam, the TSP programme was taken up in Mazgaon Jajori village (Morigaon district) and Kotohguri village (Nagaon district).

At Srikrishnapur and Matiagacha villages of North 24 Parganas district, demonstration of line sowing in jute using CRIJAF Multi Row Seed Drill recorded 3.39-3.46 q/ha more fibre yield over broadcasting (25.57–28.93 q/ha. Similarly, demonstration of integrated nutrient management (INM), integrated weed management and intercropping of jute with green gram recorded additional yield of 4.66–7.63 q/ha with an additional net return of Rs. 8454 to Rs. 29422/ha over farmers' practices followed in the area.

In Keonjhar district of Odisha, the demonstration on weed management in jute at Dihasahi village recorded 3.6 q/ha additional fibre yield and Rs. 12770/ha additional net return over farmer practice whereas the demonstration on IPM in jute at Beusahii village recorded 4.6 q/ha additional fibre yield and Rs. 12690/ha additional net return over farmers' practice.

In Nagaon and Morigaon districts of Assam, the demonstration of new jute variety (Tarun) and line sowing with CRIJAF Multi Row Seed Drill along with mechanical weeding by CRIJAF Nail Weeder in jute recorded 6.15 to 9.22 q/ha of additional fibre yield of jute along with additional net return of Rs. 3277 to Rs. 15409/ha over farmers' practice. Similarly in rice crop, demonstration on balanced fertilizer application recorded 10.5–12.3 q/ha of additional fibre yield along with additional net return of Rs. 8100/ha to Rs. 12220/ ha over famers' practice.

## 10.7. TSP under NSP Crops

Quality seed of paddy (MTU 7029) was provided to take up 45 frontline demonstrations for paddy seed production in Choubata (30 farmers) and Ranjitpur (15 farmers) villages of Bankura district during *kharif* 2016.

Fig. 10.14 Exposure visit of tribal farmers at ICAR-CRIJAF, Barrackpore

Fig. 10.15 Distribution of Paddy Thresher at Kulabahal, Bankura

## 10.8. HRD programmes under TSP

HRD programmes conducted under TSP primarily intended to impart knowledge on improved crop production technologies, improved animal rearing and fishery related technologies, to accelerate technology adoption by the tribal farmers. The training programmes, field day and farmers' exposure visits conducted during 2016-17 are given in tabulated form (Table 10.1).

**Table 10.1 Training programmes, field day and farmers' exposure visits conducted under TSP during 2016-17**

| Programme details | Date | No. of Farmers | TSP unit |
|---|---|---|---|
| **Trainings** | | | |
| Jute production technology for the tribal farmers at Tapan, Dakshin Dinajpur | 07.06.16 | 50 | Institute/TSP |
| Jute production technology for the tribal farmers at Hili, Dakshin Dinajpur | 08.06.16 | 87 | Institute/TSP |
| Jute production technology for the tribal farmers at Kumarganj, Dakshin Dinajpur | 09.06.16 | 90 | Institute/TSP |
| Improved production technology of sisal at Bamra, Odisha | 29.06.16-01.07.16 | 35 | Institute/TSP |
| Improved microbial retting of jute at Garna, Hili, Dakshin Dinajpur | 21.07.16 | 110 | Institute/TSP |
| Improved microbial retting of jute at Hazrabari, Tapan, Dakshin Dinajpur | 22.07.16 | 50 | Institute/TSP |
| Improved microbial retting of jute at Kumarganj, Dakshin Dinajpur | 23.07.16 | 100 | Institute/TSP |
| Jute seed production technology by the farmers at Tapan, Dakshin Dinajpur | 07.09.16 | 50 | Institute/TSP |
| Improved production technology of sisal at Bamra, Odisha | 26.10.16-28.10.16 | 35 | Institute/TSP |
| Improved technologies for seed production and processing at Saltore, Bankura | 10.11.16 | 50 | NSP Crops/TSP |
| Improved production technology of lentil at Tapan, Dakshin Dinajpur | 06.12.16 | 50 | Institute/TSP |
| Improved production methods of *rabi* crops at Tapan, Dakshin Dinajpur | 04.01.17-05.01.17 | 80 | Institute/TSP |
| Importance of soil testing and prescription based fertilizer application at CRIJAF, Barrackpore | 28.01.17 | 50 | STCR/TSP |
| Maintenance and management of farm equipment at CRIJAF, Barrackpore | 02.02.17-04.02.17 | 50 | TMJ/TSP |
| Soil test and target yield based fertilizer application for increased crop productivity at Hili, Dakshin Dinajpur | 08.02.17 | 97 | STCR/TSP |
| Improved seed production technologies for *rabi* crops at Saltora, Bankura | 04.03.17 | 60 | NSP Crops/TSP |
| Improved production technology of jute and allied fibre crops at CRIJAF, Barrackpore | 20.03.17-22.03.17 | 50 | TMJ/TSP |
| Maintenance of soil health and fertility for field crops at CRIJAF, Barrackpore | 20.03.17-22.03.17 | 40 | STCR/TSP |
| Soil test and target yield based fertilizer application for increased crop productivity at CRIJAF, Barrackpore | 23.03.17 | 52 | STCR/TSP |
| Integrated pest and disease management at CRIJAF, Barrackpore | 23.03.17-25.03.17 | 50 | TMJ/TSP |
| **Extension activities** | | | |
| Farmers' exposure visit to Taldangra Horticultural and Development Farm at Taldangra, Bankura | 28.02.17 | 60 | NSP Crops/TSP |
| Field day on 'quality seed production of rabi crops' at Budbud, Burdwan | 03.03.17 | 60 | NSP Crops/TSP |
| Farmers' exposure visit to ICAR-CRIJAF at CRIJAF, Barrackpore | 17.03.17 | 60 | NSP Crops/TSP |

# 11. AINP on Jute and Allied Fibres (AINPJAF)

All India Network Project on Jute and Allied Fibres functions through 9 SAUs and 4 ICAR Institute based centres across 8 JAF growing states with its headquarter at ICAR-CRIJAF, Barrackpore, Kolkata. A sum of 72 projects comprising of 294 trials were conducted on jute, mesta, sunnhemp, ramie, flax and sisal during 2016-17 under crop improvement, crop production and crop protection programme.

## 11.1 Crop Improvement

Thirty-nine projects comprising of 176 trials were conducted on jute and allied fibre crops under crop improvement programme in different centres of All India Network Project on Jute and Allied Fibres.

### 11.1.1 Release and notification of JAF varieties

Six varieties of jute and allied fibre crops: JRO 2407 (Samapti) of *tossa* jute, KJC 7 (Shresthaa) and JRC 9057 (Ishani) of white jute, JRKM 9 1 (Satyen) and Central Kenaf JBMP 2 of kenaf, and CRIJAFR 5 (Roselle Ratna) of roselle were recommended for release and notification by the Central Sub-Committee on Crop Standard, Notification and Release of Varieties vide Gazette notification no. S.O. 2238 (E), dated, 29.06.2016. Beside, two varieties; KRO 4 and BCCO 6 (Kisan Pat) of tossa jute and one variety of white jute i.e. AAUCJ 2 (Kkhyati) have also been released and notified vide Gazette notification no. S.O. 1007 (E), dated, 30.03.2017.

### 11.1.2 Identification of JAF varieties for release

One variety each in tossa jute (NJ-7010), kenaf (JBMP-3) and roselle (JRR-17) have been identified for central release during the 29th Annual Workshop of AINPJAF held at ICAR-NIRJAFT, Kolkata on 10-11th March, 2017.

### 11.1.3 Evaluation of JAF germplasm

Seventy-five accessions each of tossa jute, white jute and roselle and 51 germplasm of kenaf were evaluated with respective check varieties at different locations of JAF growing states.

**White jute:** An overall mean of 10.4±1.5 g/plant was recorded for fibre yield with a range of 7.1 g/plant (CIN-39) to 13.4 g/plant (CIN-26). Seven genotypes outperformed best check JRC 698 (12.3 g/plant) for fibre yield. Among the six locations, Coochbehar centre recorded highest mean performance for fibre yield (23.52±5.89 g/plant).

**Tossa jute:** Average fibre yield over the locations was recorded to be 10.0±1.4 g/plant with a range of 7.07-13.44 g/plant. Accession OIJ-28 (13.44 g/plant) outperformed best check JRO 524 (13.36 g/plant) for fibre yield. Coochbehar centre recorded highest mean fibre yield of 16.77±4.32 g/plant.

**Roselle:** An overall mean of 11.45±2.75 g/plant was recorded for fibre yield over five locations with a range of 6.38 - 17.41 g/plant. Seven accessions outperformed best check HS 4288 (14.41 g/plant) for fibre yield. Barrackpore centre recorded highest mean performance for fibre yield (16.72±8.50 g/plant).

**Kenaf:** Average fibre yield over two locations was recorded to be 14.17±3.11 g/plant. Twenty-one accessions exhibited higher fibre yield than the best check HC 583 (15.85 g/plant). Accession KIN-039 (23.78 g/plant) showed highest fibre yield.

### 11.1.4 National hybridization programme (NHP)

**White jute:** The $F_6$ and $F_2$ progenies of white jute of different cross combinations were evaluated in Bahraich, Kalyani, Kendrapara and Katihar centre and the promising line have been identified and selected for further evaluation.

**Tossa jute:** The $F_5$, $F_3$, $F_2$, and $F_1$, progenies of different cross combinations were evaluated along with two check varieties (JRO 524 and JRO 204) at four locations, *viz.,* Kalyani, Rahuri, Katihar and Kendrapara. Promising cross combinations at different centres have been identified and selected for further evaluation.

**Roselle:** A total of 44 $F_6$ progenies were evaluated at Amadalavalasa centre. Out of them, 15 lines have been selected for further station trials.

### 11.1.5 Yield evaluation trials

#### *Tossa* jute (*C. olitorius*)

**IET:** Check variety JRO 204 recorded 35.91 q/ha fibre yield followed by test entries NOJ-27-26 (34.05 q/ha), JRO-15-22 (33.74 q/ha), BCCCO-13 (33.65 q/ha) and JROCS-6 (33.30 q/ha).

**AVT-I:** Three test entries with two check varieties namely; JRO 8432 and JRO 524 were tested for fibre yield at seven locations. Test entry NJ-7055 was found to be the best performer with 33.05 q/ha fibre yield.

**AVT-II:** Pooled analysis of average yield over locations and years revealed that test entry NJ-7050 recorded highest fibre yield (29.62 q/ha) followed by check variety JRO 8432 with fibre yield of 28.36 q/ha.

#### White jute (*C. capsularis*)

**IET:** This trial was constituted with nine test entries including two checks namely, JRC 517 and JRC 698 and conducted over seven locations. Test entry JRCJ-11 turned out to be the best performer with fibre yield of 39.27 q/ha.

**AVT-I:** The trial was conducted over seven locations. Check variety JRC 517 was best performer recorded 33.56 q/ha of fibre yield followed by test entry JRCJ-9 (32.67 q/ha).

**AVT-II:** Based on pooled analysis, check variety JRC 517 (32.39 q/ha) was the best performer followed by test entries NCJ-07-22 (32.00 q/ha) and BCCC-4 (31.42 q/ha).

### Kenaf (*H. cannabinus*)

**IET:** The trial was conducted with seven entries over six locations. Check variety AMC 108 (28.08 q/ha) was the best performer followed by test entry JRK-2015-2 (27.91 q/ha) and JRHC-4 (27.49 q/ha).

**AVT-I:** The trial was conducted with five entries including two checks at seven locations. The test entry JRHC-3 (26.41 q/ha) yielded better than best check AMC 108 (25.89 q/ha) for fibre yield.

**AVT-II:** Considering the mean performance over locations and year test entries JRK-2013-2 (25.44 q/ha), JRHC-2 (24.99 q/ha) and JRHC-1 (24.53 q/ha) found at par to best check AMC 108 (25.28 q/ha) for fibre yield.

### Roselle (*H. sabdariffa*)

**IET:** The trial was constituted with five entries including two checks and conducted over seven locations. Test entries AHS-298 (32.71 q/ha) and JRHS-5 (31.58 q/ha) were significantly superior over best check AMV 5 (29.14 q/ha).

**AVT-I:** Five entries including two checks were tested for fibre yield over seven locations. Test entry JRHS (28.36q/ha) outperformed best check HS 4288 (27.06q/ha) for fibre yield.

**AVT-II:** Mean performance across locations and years revealed that test entries JRHS-1 (28.26 q/ha) and AHS-255 (28.09 q/ha) out yielded the best check variety HS 4288 (26.0 q/ha) for fibre yield.

### Sunnhemp (*C. juncea*)

**IET:** Three test entries with two check varieties namely, SH 4 and SUIN 053 were evaluated over five locations. Check variety SH 4 (13.69 q/ha) was the best performer followed by test entry SUNC-3 (12.39 q/ha).

**AVT-I:** The trial was conducted with three test entries and two checks at five locations. Test entry Sanai-17 (10.50 q/ha) performed better than the superior check variety SUIN 053 (10.21 q/ha).

**AVT-II:** Pooled analysis of data showed that test entries JRS-2013-1 (9.27 q/ha), Sanai-12 (9.21 q/ha) and Sanai-11 (9.14 q/ha) outperformed the superior check variety SUIN 053 (9.00 q/ha).

### Flax (*L. usitatissimum*)

**IET:** The trial was conducted with five test entries and one check variety at six locations. Check variety JRF 2 performed better than almost all test entries for plant height (106 cm) and green biomass (187.4 q/ha) yield.

**AVT-I:** The trial comprising of eight test entries and a check variety was conducted at six locations. None of the test entries performed better than the check variety JRF 2 for plant height (113 cm) and green biomass (203.8 q/ha) yield.

### Ramie (*B. nivea*)

**AVT-I:** Test entry R-1414 (25.02 q/ha/yr) out performed check variety R-67-34 (24.68 q/ha/yr) for fibre yield at Sorbhog, whereas maximum green weight (936.7 q/ha/yr) was yielded by test entry R-1418.

## 11.2 Crop Production

Twenty-one projects comprising of 80 trials were conducted in jute and allied fibre crops at different AINP centers under crop production programme.

The *olitorius* entry under adaptive trial NJ 7005 recorded higher fibre yield at Kalyani (28.81 q/ha), Cooch Behar (29.31 q/ha) and Kendrapara (24.78 q/ha) while entry NJ 7010 recorded higher fibre yield at Katihar centre (28.43q/ha). The fibre yield of *oltorius* jute increased significantly upto 80:17.5:33.3 kg NPK/ha at Barrackpore and Katihar while at Kalyani and Kendrapara it increased significantly up to 100:21.8:41.7 kg NPK/ha. The *capsularis* entry under adaptive trial BCCC 3 recorded higher fibre yield at Kalyani (28.21 q/ha), Cooch Behar (28.39 q/ha) and Bahraich (25.31 q/ha) while at Nagaon, BCCC 3 recorded lower fibre yield than the check varieties. The fibre yield of *capsularis* jute increased significantly up to 100:21.8:41.7 kg NPK/ha at Kalyani and Bahraich while at Cooch Behar it increased significantly up to 60:13:25 kg NPK/ha.

The roselle entry under adaptive trial AHS 249 recorded higher fibre yield at Aduthurai, Tamil Nadu (20.79 q/ha) and Amadalavalasa, Andhra Pradesh (22.70q/ha). The fibre yield of roselle increased significantly upto 60:13:25 kg NPK/ha at Aduthurai and Amadalavalasa centres. The kenaf entry JRK 2011-2 recorded higher fibre yield at Kendrapara (28.96 q/ha) and Aduthurai (22.14 q/ha) under adaptive trial while at Amadalavalasa, entry JRK 2011-1 recorded higher fibre yield (28.24 q/ha). The fibre yield of kenaf increased significantly upto 60:13:25 kg NPK/ha at all the centres.

The sunnhemp entry Sanai-10 recorded significantly higher fibre yield under adaptive trial with fertilizer dose of 20:60:60 kg NPK/ha at Aduthurai (11.06 q/ha) whereas at Amadalavalasa, sunnhemp entry Sanai-9 recorded maximum fibre yield (5.52 q/ha) with fertilizer dose of 20:60:60 kg NPK/ha.

At Bahraich, application of fertilizer on ST-TY basis achieved the targeted yield (3.2 t/ha) of jute with (-)8.31% yield deviation. Incorporation of FYM along with ST-TY based fertilizer application further improved the fibre yield. At Katihar, ST-TY based fertilizer application in presence or absence of FYM could achieve the targeted yield of jute (3.2 t/ha) with (-)2.2 and (-)6.25% yield deviation, respectively. At Aduthurai, ST-TY based fertilizer application alone could not achieve the targeted yield of mesta (2.81 t/ha). However,

incorporation of FYM alongwith inorganic fertilizer (ST-TY) achieved the targeted yield of mesta with (-) 5.2% yield deviation. Application of fertilizer on soil test & targeted yield basis (100% NPK on ST-TY) in presence or absence of organic manure could achieve the targeted yield of rice (4.0 t/ha) with (17.4%) and (+8.7%) yield deviation. Application of FYM with ST-TY based fertilizer improved the B.C. ratio over ST-TY based fertilizer application.

In acidic soil of Amadalavalasa, application of fertilizer (100% NPK on ST-TY) could not achieve the targeted yield (2.8 t/ ha) of mesta. Application of fertilizer (ST-TY) along with lime in presence or absence of organic manure achieved the targeted yield of mesta. At Nagaon, application of inorganic fertilizer (ST-TY) in presence or absence of lime achieved the targeted yield of jute (3.5 t/ha). Incorporation of FYM further improved the fibre yield of jute.

Application of Nail weeder twice at 5 days after crop emergence (DAE) and 10 DAE with one hand weeding within the rows at 15 DAE effectively suppressed the weed biomass and recorded maximum plant height (354.7cm), basal diameter (1.64 cm), jute fibre equivalent yield (40.25 q/ha) and net return (₹ 94540/ha) at Kalyani. Application of pretilachlor 50 EC either @ 450 or 900 g/ha or butachlor @ 1.5 kg/ha with one hand weeding effectively reduced the weed biomass and recorded 5-9 q/ha higher fibre yield compared to unweeded control at Coochbehar and Nagaon. Jute + green gram (variety; Pant mung-5 and TMB-37) intercropping system recorded the highest weed control efficiency (74.7 %) thereby leading to more plant height (357 and 359 cm), basal diameter (2.26 and 2.29 cm), jute fibre equivalent yield (29.96 and 27.70 q/ha) and B:C ratio (3.46 and 3.1) compared to other weed control treatments at Bahraich. Two hand weeding recorded higher fibre yield (27.41 q/ha) and net return (₹ 45452/ha) and it was at par with mechanical weeding (Nail weeder twice at 5-6 and 10 DAE + one hand weeding at 15 DAE) at Kendrapara and Katihar centres. Application of pretilachlor 50 EC @ 900 g/ ha with one hand weeding recorded the highest mesta fibre yield (25.43 q/ha), net return (₹ 88993/ha) and B: C ratio at Amadalavalasa and Aduthurai. Mesta+groundnut intercropping system had relatively lesser suppressive effect on weeds but recorded higher mesta fibre yield (19.84 q/ha) and mesta equivalent yield (32.07 q/ha) at Rahuri.

Among fifteen weed species recorded, *Echinochloa colonum* was the dominant one (density-37.3/$m^2$ and IVI- 34.4%) in experimental farm of ICAR-CRIJAF, Barrackpore, and Gwaldah (density-36/$m^2$ and IVI- 60 %) block of North 24 Parganas district of West Bengal. *Trianthema portulacastrum* and *Cyperus rotundus* were dominant weed species in Nawada, Murshidabad in West Bengal. In Kendrapara region, *Echinochloa colonum* was the dominant weed species (density-55.7-112/$m^2$ and IVI- 69-104%) among 16 weed species recorded in experimental farm as well as in different blocks. In Katihar region, out of 15 weed species, *Cyperus rotundus* was the dominant one (density-17-106/ $m^2$ and IVI- 71-162.5%) in experimental farm and farmers' fields of all the surveyed blocks. Among eight weed species recorded in Dinhata (Coocbehar), *Phyllanthus niruri* and *Amaranthus viridis* were the dominant weeds. In Nagaon region, out of 18 weed species, *Cynodon dactylon* grass weed was the dominant one (density 13.7/$m^2$ and IVI-31%) in the experimental farm while *Digitaria sanguinalis* and *Mimosa pudica* were dominant in farmers field of Nagaon. Weed diversity indices were higher in Morigaon block. At Kalyani, among ten weed species recorded, *Cyperus rotundus* was the dominant one (density 45.3-89.3/$m^2$ and IVI – 56-89.3) in experimental farm as well in farmers field of Amdanga, Chakda and Lalgola blocks.

In mesta-vegetable intercropping system, *Cynodon dactylon* was the dominant weed in all the surveyed blocks of Aduthurai. *Amarathus viridis* and *Parthenium hysterophorus* were the dominant broad leaved weed species in farmers' field of Thirupananthal and Udaiyarapalyam, Tamil Nadu. At Amadalavalasa, *Digitaria sanguinalis* was the dominant weed (density-33/$m^2$ and IVI -38.4%) in the experimental farm while *Cynodon dactylon* was the dominant weed species (density 19-43/$m^2$ and IVI-22-40%) in farmers' field of Amadalavalasa and Jalumuru blocks of Andhra Pradesh.

The analysis of soil samples of the jute and mesta growing areas near by the AINP centres revealed that the organic carbon contents were significantly higher in soil samples collected in Nagaon, Assam (mean 1.10%), followed by Kalyani (0.60%), Cooch Behar (0.53%), Kendrapara (0.45%), Katihar (0.43%), Rahuri (0.42%), Baharaich (0.36%) and Amadalavalasa (0.35%). In general, soils from Kalyani and Kendrapara had better labile C pools status than that of Srikakulam and Rahuri. The soils from Kendrapara had higher total sulphur content than that of Kalyani and Bahraich, organic sulphur being the dominant form among all other forms of sulphur.

The pooled analysis of 2015 and 2016 revealed that maximum value of seed yield of mesta were recorded when the crop was sown on 5$^{th}$ June at Kendrapara, Odisha (6.19 q/ ha) and on 1$^{st}$ August at Amadalavalasa (8.56 q/ha). Similarly, maximum seed yield of mesta was recorded with 45 cm x 10 cm spacing at Kendrapara (6.25 q/ha) and at Amadalavalasa (7.70 q/ha). The pooled data also revealed that topping at 45 DAS recorded significantly higher seed yield of mesta at Kendrapara, (6.19 q/ha) and Amadalavalasa (7.07 q/ha).

Intercropping of mesta with rice in 3:4 row ratio recorded significantly higher system mesta equivalent yield (MEY) (31.10 q/ha) over other intercropping systems at Bahraich, Uttar Pradesh while at Amadalavalasa, intercropping of mesta with pulses like groundnut, mungbean and urdbean increased the mesta equivalent fibre yield of the cropping systems (21.51 – 22.97 q/ha) over sole crop of mesta (20.90 q/ha).

Maximum seed yield of sunnhemp (19.6 q/ha) along with highest net return (₹ 41006 - 46923/ha) and B:C ratio (1.92 - 2.04) was recorded with $S_1F_3$ (spacing of 30 cm x 10 cm along with 20:40:40 kg NPK/ha) at Rahuri, Maharashtra. At Aduthurai, the pooled data of 2015 and 2016 revealed maximum seed yield of sunnhemp with spacing of 60 cm x 15 cm (5.75 - 9.6 q/ha) and fertilizer dose of 20:60:60 kg NPK/ha along with highest net return (₹ 20148 - 30560/ha) and B:C ratio (1.50 - 1.73) and was recommended for the region. At Amadalavalasa, higher spacing (60 cm x 15 cm) along with fertilizer dose of 20:60:60 kg NPK/ha recorded maximum seed yield in 2016 (11.77 q/ha) and was recommended for the region.

Significantly higher fibre yield of ramie was recorded with ridge and furrow planting method (13.92 q/ha) over other planting methods at Barrackpore, West Bengal. Ramie crop receiving 125% N from RDF (inorganic) and 25% N from ramie compost recorded fibre yield (12.29 q/ha) at par with that of 150% RDF (inorganic) ((12.73 q/ha) at Barrackpore. The interaction of nitrogen and potassium on fibre yield of ramie revealed maximum fibre yield recorded with $N_{80}K_{60}$ treatment (17.88 q/ha) which was statistically at par with yield of $N_{120}K_{60}$ (17.14 q/ha) at Barrackpore, West Bengal.

The integrated nutrient management in sisal revealed that maximum dry fibre yield of sisal (18.13 q/ha) was recorded with application of NPK @ 90:30:60 kg/ha + sisal waste @ 20 t/ha which was statistically at par with fibre yield (17.33 q/ha) recorded with plots receiving NPK @ 60:30:60 kg/ha + sisal waste @ 20 t/ha and both the INM treatments recorded significantly higher fibre yield over the highest fertilizer dose of 120:30:60 kg NPK/ha (9.09 q/ha) at Bamra, Odisha.

Among the sisal based intercropping systems tested at Bamra, sisal + green gram system recorded significantly higher system sisal equivalent yield (10.31 q/ha) over other intercropping systems followed by sisal + cowpea (9.39 q/ha), sisal + black-gram (8.95 q/ha) and sisal + horse-gram (8.40 q/ha). The oilseed crops when intercropped with sisal gave a comparatively lesser sisal equivalent yield (6.77 – 7.31 q/ha) compared to the pulse crops.

Maximum dry biomass of flax was recorded at Pratapgarh, Uttar Pradesh with 30$^{th}$ October sowing and when the plant received nitrogen @ 80 kg/ha (61.34 – 64.77 q/ha). At Coochbehar, the green biomass of flax increased significantly up to 40 kg N/ha (35.80 q/ha) only beyond which biomass showed a decreasing trend up to 120 kg N/ha. The interaction effect of nitrogen and potassium on fibre yield of flax was found significant and maximum fibre yield was recorded with $N_{120}K_{30}$ treatment (13.67 q/ha) which was statistically at par to fibre yield recorded with $N_{80}K_{60}$ (13.50 q/ha) and $N_{80}K_{60}$ (13.08 q/ha) treatments at Barrackpore, West Bengal but the effect of both the nutrients were found non-significant on fibre fineness of flax.

## 11.3 Crop Protection

Twelve projects comprising of 38 trials were conducted in jute and allied fibre crops at different AINP centers under crop protection programme.

Survey and surveillance of insect pests and diseases of jute were conducted in all the AINP centers except Budbud. In jute, yellow mite, semilooper, Bihar hairy caterpillar (BHC) and stem weevil were the most common insect pests. The yellow mite infestation was more consistent across the centres with maximum infestation of 49.38, 8.40, 17.64, 43.75 and 4.44 mite population/cm$^2$ leaf area on 2$^{nd}$ unfolded leaf at Barrackpore, Nagaon, Kendrapara, Bahraich and Coochbehar, respectively coinciding at 55 DAS to 65 DAS during last week of May to end-June. Maximum infestation of BHC was noticed at Barrackpore where >90% infestation occurred during mid-July at 100-110 DAS. The BHC damage at Nagaon was 34.24% followed by Coochbehar (5.72%) occurred at 105 and 55 DAS, respectively. Infestation of indigo caterpillar (6.4 %) and grey weevil (92.15%) was specific to Nagaon and Barrackpore centre, respectively.

Jute semilooper infestation was observed at Barrackpore, Nagaon, Kendrapara and Coochbehar with maximum of 94.66, 20.80, 21.56 and 14.30% plant damage, respectively from 45 DAS to 82 DAS. The period of semilooper infestation was from second fortnight of June to last week of August. Stem weevil infestation was noticed in all the centers except Bahraich and Coochbehar. At Barrackpore, Nagaon, and Kendrapara, maximum stem weevil infestation was found from May to mid-July with 33.33%, 2.20%, and 10.56% plant damage at 35-92 DAS. In general yellow mite, grey weevil, indigo caterpillar and stem weevil were more prevalent during the early crop growth period whereas Bihar hairy caterpillar and semilooper were active during the latter part of the crop period. During July, peak activity of the larval parasite was recorded to be 37.50-44% on BHC at Nagaon.

Incidence of stem rot, root rot, anthracnose and mosaic diseases were common in jute. The infestation of leaf mosaic of white jute was very specific to Katihar center with incidence of 7.80% at 95 DAS. Seedling blight incidence was observed only at Nagaon with 3.60% plant damage at 35 DAS. Incidence of anthracnose was observed at Nagaon, Bahriach and Katihar centers from May to July with maximum incidence of 13.80%, 8.10% and 2.60%, respectively. The maximum incidence of stem rot was observed from mid-June to September with 15.87%, 4.30%, 15.27%, 2.28%, 7.50% and 2.71 % at Barrackpore, Nagaon, Kendrapara, Bahraich, Katihar and Coochbehar, respectively. The incidence of root rot disease was maximum 3.50%, 9.6%, 12.13%, 11.20% and 2.75% at Barrackpore, Nagaon, Kendrapara, Bahraich, Katihar and Coochbehar, respectively. At Amadalavalasa, maximum infestation of aphids, whiteflies and leafhoppers were 16.40, 5.10 and 0.48/plant respectively, in mesta. The infestation of semilooper and mealybug was 72% and 45% at 45 DAS and 75 DAS, respectively.

In Budbud, the effect of sowing date on seed infection was significant. Mid-June sown seed crop of jute recorded significantly more infected seed (3.00%) which was gradually reduced in subsequent sowings. However, application of fungicides at pod setting could significantly reduce the seed infection. The spraying of fungicides at both times (pod setting and pod maturation) produced more seed yield (9.02 and 10.14 q/ha). Mid–June sown seed crop of jute with fungicidal spray either at pod setting or pod maturation stage yielded maximum healthy seeds.

The promising germplasm lines of *tossa* jute with least susceptibility to yellow mite were OIN-24, OIJ-04, OIN-46 at Kendrapara, OIJ-18, OIN-23, OIN-13 at Coochbehar and OIN-51, OIN-67, OIJ-06 at Nagaon. Some of the lines exhibiting relatively more resistance against stem weevil were OIN-36 at Nagaon and OIN-13 and OIN-14 at Kendrapara. Germplasm with less than 10% root rot incidence were OIN-7 (7.00%), OIN-11 (3.90%), OIN-14 (4.2%), OIN-7 (8.7%), OIN-33 (9.9%), OIN-34 (8.00%) and OIJ-28 (6.8%) at Nagaon. Accession OIN-02, OIN-05, OIN -07, OIN-12 and OIN-64 were free from both stem rot and root rot at Kendrapara.

Among the *white* jute germplasms, CIN-29 (2.22%), CIN-21 (2.27%) and CIN-03 (2.36%) were least susceptible to semilooper at Nagaon, Coochbehar and Kendrapara respectively. The lines CIN-01, CIN-03, CIN-04, CIN-21, CIN-28, CIN-31, CIN-51 and CIJ-14 were found to be resistant to yellow mite with <1 mite/cm$^2$ of leaf at Nagaon .Whereas, at Katihar less susceptible lines against yellow mite were CIN-38, CIN-39, CIN-44, CIN-74, CIJ-10, CIJ-22, CIJ-25 and CIJ-26. The least susceptible germplasm lines against mite at Kendrapara were, CIN-01, CIJ-25, CIJ-21, CIJ-13, CIJ-74 and CIN-12 where as CIN-01, CIN-51, CIN-14, CIN-27, CIN-28, CIN-37, CIN-83, CIJ-06, CIJ-10 and CIJ-11 were least susceptible at Bahraich. In Nagaon, the white jute germplasm CIN-05, CIN-07, CIN-14 and CIN-16 had least (<5%) infestation and CIJ-14 was free from stem weevil infestation. Two promising lines against stem weevil with least infestation were CIJ-04 and CIN-44 at Kendrapara and CIN-14 and CIJ-09 at Bahraich. The white jute accessions, CIN-01, CIN-03, CIN-04, CIN-05, CIN-07, CIN-08, CIN-12, CIN-14, CIN-16, CIN-18, CIN-19, CIN-21, CIN-22, CIN-23, CIN-24, CIN-25, CIN-27, and CIN-28 were resistant to stem rot and root rot at Kendrapara. Most promising lines against stem rot and root rot were CIJ-09 and CIN-19 at Bahraich.

Among the *Hibiscus sabdariffa* germplasm accessions at Barrackpore, the superior lines against foot and stem rot disease were AR-80 (12.70 %) and ER-27 (13.42 %). At Amadalavalasa, none of the germplasm was completely free from insect pests and disease incidence and the lowest infestation of mealybug (0.22 %) was recorded in AR-20. The roselle lines AS-81-12, AS-81-12, AS-80 and REX-6 exhibited less susceptibility to foot and stem rot disease (FSR) at Amadalavalasa.

On the basis of disease incidence in the elite germplasms and varieties, JRO 2407 was found to be least susceptible to stem rot i.e. 0.60, 1.33 and 2.08% at 60, 75 and 90 DAS, respectively at Coochbehar. At Barrackpore, lowest PDI of 1.56 was recorded in case of JBO 1 whereas at Kendrapara, the lowest PDI was recorded on OIN-125 (2.70).

For the management of foot and stem rot disease of mesta at Barrackpore, seed treatment with cymoxanil 8% WP @ 3g/kg and 0.3% foliar spray at 30 and 45 DAS was found most effective in reducing disease incidence and enhancing the yield. While seed treatment with trifloxystrobin 25% WG @ 0.5 g/kg and 0.05% foliar spray at 30 and 45 DAS was found most effective at Amadalavalasa.

Foliar application of Spiromesifen 240 SC @ 0.7 ml/l at 35 DAS + Neem (Azadiractin 10,000 ppm) @ 3 ml/l at 50 DAS or Spiromesifen 240 SC @ 0.7 ml/l at 35 DAS and 50 DAS was found most effective for management of yellow mite in jute at Nagaon, Kendrapara and Coochbehar with highest fibre yield of 30.86, 26.17 and 37.44 q/ha, respectively.

Treatment of mineral oil @ 3 ml/l + neem oil @ 3ml/l at 35 and 50 DAS against yellow mite, *Polyphagotarsonemus latus* Banks in jute was most effective at Coochbehar with highest fibre yield of 34.69 q/ha whereas at Kendrapara, the treatment consisting of mineral oil @ 9 ml/l at 35 and 50 DAS was found to be effective against yellow mite with highest fibre yield (25.53 q/ ha).

Among the new fungicide molecules for management of *Macrophomina phaseolina* caused disease complex in jute, seed treatment with azoxystrobin + difenoconazole 325 SC @ 1.0 ml/kg seed + spraying of azoxystrobin + difenoconazole 325 SC @ 0.075% at 45 DAS of crop age was most effective against stem rot at Kendrapara, Coochbehar, Nagaon and Katihar with maximum fibre yield of 24.06, 30.05, 30.19 and 29.17 q/ha, respectively.

Seed treatment with azoxystrobin (25% SC) @ 1.0 ml/kg was found to be effective against flax wilt at Barrackpore and Nagaon centres.

In mesta, compared to the botanicals and bio-agents, profenophos @ 2ml/l foliar spray at 35, 50 and 65 DAS was most effective against sucking pests by recording low infestation of aphids (0.12/plant), whiteflies (0.23/plant), leafhoppers (0.01/plant) and mealybug (0.12% infestation) at Amadalavalasa.

At Barrackpore, numerically the mite infestation and disease incidence was less in the line sown crop protected with seed treatment and foliar spray of fungicides and insecticides. At Nagaon, plant population of (6 lakhs/ha) line sown crop with seed treatment of carbendazim 50WP @ 2g/kg seed + spraying of spiromesifen 240 SC @ 0.7 ml/l at 35 DAS + spraying of tebucanazole @ 0.15% at 45 DAS + spraying of λ-cyhalothrin 5 EC @ 0.6 ml/l at 55 DAS reduced the insect pests and disease incidence and increased the yield to


Inaugural address by ADG (CC), ICAR


Director, CRIJAF addressing the delegates of AINP workshop

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Presentation of achievements by I/c AINPJAF

maximum extent. At Coochbehar, the highest fibre yield was observed in line sowing (5 lakhs/ha) and seed treatment with *Trichoderma* @ 10g/kg seed + soil drenching of *Pseudomonas fluorescence* @ 100 g/l at 15 DAS + spraying of Azadiractin (10000 ppm) @ 3 ml/l at 35 DAS and 55 DAS (29.66 q/ha).

At Barrackpore, in AVT-I and AVT-II of *tossa* jute the entries NJ-7055 AND NJ-7650 were identified to be superior over check with least infestation of yellow mite and incidence of stem rot, respectively whereas among the AVT-I and AVT-II of *capsularis* jute, entries JRCJ-9 and NCJ-33-7 were least susceptible to yellow mite and stem rot, respectively. The *kenaf* entries JRHC-3 (AVT-I) and JRHC-2 (AVT-II) were found less susceptible to FSR than check. The *roselle* entries JRR-2014-1 (AVT-I) and AHS-267 (AVT-II) were least susceptible to mealybug, whereas JRHS-4 (AVT-I) and AHS-255 (AVT-II) were significantly least susceptible to FSR at Amadalavalasa.

# 12. Krishi Vigyan Kendra

Krishi Vigyan Kendra (KVK) is a district level institution of ICAR engaged in transfer of latest agricultural technologies to the end users for bridging the gap between production and productivity. It works through partnership mode with farmers, allied departments and concerned agencies. The KVK, Burdwan (BudBud) was established in April 2005 and KVK, North 24 Paragnas (Nilganj) was recently established in 2016 under the administrative control of the ICAR-CRIJAF. Major activities of KVK are to implement On Farm Trials (OFT) for evaluation of location specificity of various technologies, Front Line Demonstrations (FLD) of established technologies and trainings for farmers, farm women, rural youths and extension workers. Besides, exposure visits, field day, method demonstration and other activities are also conducted for the farmers.

## 12.1 On Farm Trials (OFT)

To assess and refine the generated technologies to suit the local situations, 'On Farm Trials' were carried out with farmers' participation. During 2016-17, altogether 5 technologies in different disciplines were assessed for its suitability in farmer's field/condition of Burdwan district. The salient findings of these OFTs are illustrated below:

- *Evaluation of effectiveness of different retting methodologies on yield and economics of jute*: Retting of jute using sand bag alone or in combination with CRIJAF-Sona was found more profitable than conventional retting methods as practiced by the jute growers. The yield of jute fibre under CRIJAF-Sona retting was about 10% higher (31.2 q/ha) than conventional retting (28.2 q/ha) and steeping of jute jak with sand bag (29.1 q/ha). Maximum economic return was Rs 3200/q for 'CRIJAF-Sona along with sand bag' and Rs. 3000/q in case of sand bag alone. The economic return under conventional Farmer's practice was only Rs. 2800/q which was 11.28% less than improved retting practices
- *Assessment of different control measures for Fusarium wilt in lentil*: Integrated control of fusarium wilt through basal application of *Trichoderma* and *Pseudomonas* with chemical control was found best with increase in 19.73%, 12.34% and 13.75% yield over traditional method, chemical method and bio-control methods, respectively. Disease incidence was only 6.5% in integrated control method.

Fig 12.1 OFT on IMC fish productivity

- *Effectiveness of split application of fertilizers on paddy productivity under SRI in red and laterite soils*: Application of nitrogen in 3-4 splits and potassium in 2-3 splits achieved highest yield of rice (65.5-67.2 q/ha) as compared to conventional method (55.2 q/ha).
- *Effect of post stocking of stunted fingerlings at different time regime on IMC fish productivity*: Highest fish production (23.03 q/ha) was recorded when post stocking is done before early rainy season @7500 fingerling/ha and harvesting is done after 200 days. The B:C ratio was also highest (1.94) in post stocking of early rainy season. In case of late rainy season, the BCR was only 1.25.

## 12.2 Front Line Demonstration (FLD)

The FLD were conducted to increase the productivity of jute, onion, tomato, onion, brinjal, moringa, kitchen garden, fodder and fishery by way of introducing low-cost technologies including introduction of new varieties, IDM, plant nutrition, value addition, etc. In the year 2016-17, altogether 188 demonstrations were undertaken. The details of FLDs are given below:

Fig 12.2 FLD on groundnut crop

Fig 12.3 FLD on lentil crop under NFSM

**Table 12.1. FLD conducted during 2016-17**

| Crop/breed/ enterprise | No. of demo | Output | |
|---|---|---|---|
| | | Yield (q/ha) | % increase over FP |
| **Improved variety/breed** | | | |
| Jute (cv. JRO 204) | 55 | 31.6 | 10.6 |
| Onion (cv. Agrifound Red) | 22 | 197 | -- |
| Brinjal (cv. Bhangar) | 15 | 260 | 20.93 |
| Oat (cv. JHO-822) | 10 | 422 | 14.51 |
| Berseem (cv. Mascavi) | 10 | 516 | 12.3 |
| Fishery (*Monosex tilapia*) | 10 | 350 | 150 |
| Fishery (Magur) | 1 | 7.5 | 42.3 |
| Fishery (Koi) | 1 | 8 | 60 |
| **Improved retting with 'CRIJAF Sona'** | | | |
| Jute | 10 | 31 | 18 |

**Clustered FLDs under NFSM and NMOOP:** KVK, Burdwan conducted 97 FLD on lentil (20 ha) and 153 FLD on green gram (21 ha) with integrated disease management technology under NFSM. Under NMOOP, 175 FLD on nutrient management in mustard (53 ha, var. Pusa Mustard 26), 59 FLD on groundnut (20 ha, var. TG 37A) and 281 FLD on sulphur and boron management in sesame (54 ha) were conducted in the Bhatar, Galsi-I, Galsi-II, Purbasthali-I, Purbasthali-II, Kalna- I and Kalna- II blocks of the district.

## 12.3 Training

Training are offered by KVK for knowledge upgradation and skill development of farmers, farmwomen and youths on various improved technologies in the fields of agronomy, soil science, horticulture, plant protection, animal and fishery science, farm machinery and home science.


Fig 12.4 Training programme of KVK

## 12.4 Extension Activities

Krishi Vigyan Kendra organizes number of extension activities at its campus and in farmers' field. During 2016-17, following extension activities were conducted by the KVKs.

**Soil testing awareness camps:** KVK, Burdwan conducted 9 soil health camps to make farmers aware about soil health and its role for sustainable crop production. The methods for soil sample collection and use of Soil Health Card were demonstrated to 286 farmers of the district. A total of 885

**Table 12.2 Training programmes conducted by KVK (2016-17)**

| Target group | No. of programme | No. of participants | | | | | |
|---|---|---|---|---|---|---|---|
| | | General | | | SC/ST | | |
| | | Male | Female | Total | Male | Female | Total |
| **Farmers & Farm women** | | | | | | | |
| KVK, Burdwan | 98 | 562 | 41 | 603 | 982 | 904 | 1886 |
| KVK, North 24 Prg | 3 | 37 | 36 | 73 | 24 | 11 | 35 |
| **Rural youths** | | | | | | | |
| KVK, Burdwan | 40 | 38 | 00 | 38 | 98 | 159 | 257 |
| **Extension personnel** | | | | | | | |
| KVK, Burdwan | 12 | 274 | 27 | 301 | 49 | 19 | 68 |
| KVK, North 24 Prg | 1 | 16 | 1 | 17 | 9 | 4 | 13 |
| **Total** | **154** | **927** | **105** | **1032** | **1162** | **1097** | **2259** |

**Table 12.3. Vocational and sponsored training programmes conducted by KVK, Burdwan**

| Target group | No. of programme | No. of participants | | | | | |
|---|---|---|---|---|---|---|---|
| | | General | | | SC/ST | | |
| | | Male | Female | Total | Male | Female | Total |
| Vocational training | 2 | 00 | 00 | 00 | 00 | 40 | 40 |
| Sponsored training | 34 | 600 | 41 | 641 | 85 | 21 | 106 |
| Total | 36 | 600 | 41 | 641 | 85 | 61 | 146 |

soil samples were analysed and 450 soil health cards were distributed during 20016-17.

Fig 12.5 Soil testing awareness camp in Burdwan

**Clean India Campaigns:** A series of 14 awareness camps on environmental cleanliness were conducted in adopted villages. Farmers were made aware of different activities, like conversion of agricultural wastes into organic manures, maintaining cattle and other livestock environment hygienic, regular pond management, etc.

**Sansad Adarsh Gram Activities:** KVK, Burdwan conducted a series of activities related to agriculture and allied aspects in Sidhabari village of Salanpur block as adopted by Hon'ble MP under Sansad Adarsh Gram programme. Training for farmers and farm women for skill development, frontline demonstrations in agriculture, animal science, fisheries and home science, soil health camps, vaccination camps, vermicomposting and farm mechanization were conducted in this village.

Fig 12.6 Sansad Adarsh Gram Activities

**Kisan Sammelans:** Rabi crop Sammelan-cum-World Soil Day was organized by KVK Burdwan on 5th December 2016 at Bengal Rice Mill, Pursa in Galsi-I block of the district for sustainable crop production. About 250 farmers from different parts of the district participated in the event.

**Advisory services:** KVK regularly provides advisory services to large number of farmers of Burdwan and North 24 Paragnas district on cultivation of crops, livestocks farming, weather advisory, market information, crop pest/disease, soil testing etc. Altogether 225 SMS based advisory services benefited all the registered farmers of the district.

**Exposure visits:** Tribal farmers of the Burdwan district were taken for exposure visits to Govt. Horticultural Farm, Bankura; Nanur Ficus Farm, Nanur and RRI during 2016-17. Altogether 75 male and 15 women farmers participated in these three exposure visits.

Fig 12.7 Hon'ble Minister of Agriculture & Farmers' Welfare, Sri Radha Mohan Singh visiting Agriculture Exhibition at KVK, North 24 Pgs (Nilganj)

**Agricultural fair:** Agriculture Exhibition and Kissan Gosthi were organized in the occasion of Stone Laying Ceremony of KVK, North24 Paragnas (Nilganj) by Union Minister of Agriculture and Farmer's Welfare. Eight KVKs of adjoining districts, six ICAR institutes and two SAUs participated in this programme. The function was attended by more than 300 farmers along with 100 scientists and extension personnel. KVK, Burdwan participated in number of agriculture fairs like Sansad Mela, Asansol and Indian Science Congress, New Delhi. Five progressive farmers of the district also participated in the KRISHI UNNATI MELA nominated by the KVK.

Besides above mentioned extension activities, KVK also organized number of Field day (jute, paddy, lentil, mustard, green gram, berseem, oat, *kharif* onion and brinjal crops), meetings (SHGs, Farm Science Club, Mahila Mandal), Farmer-Scientist Interaction, etc.

## 12.5 Collaborative Programmes

Various technology transfer activities were organized in collaboration with NABARD and ATMA. About 12 training programmes for Farmers' Club and PAC members were


Fig 12.8 Collaborative programs of NABARD

organized in which 360 farmers and farm women participated. Frontline demonstrations on technologies like GIFT Tilapia, okra, cucurbits, greengram and azolla were also conducted in collaboration with NABARD. Under ATMA programme, 9 training programmes for 225 farmers, 3 OFTs and 3 exposure visits for 90 farmers were organised.

## 12.6 Tribal Sub Plan (TSP) Activities

Under TSP, about 1250 tribal farmers and farm women were trained by the KVK, Burdwan. Frontline demonstration on crops like paddy, chick pea, lentil, green gram, TCB were taken up. Vermi pit unit, azolla pit, nail weeders and


Fig 12.9 KVK training programme under TSP

portable carp hatchery were also distributed to TSP farmers. Two vocational trainings on 'Jute handicraft' and 'Kantha stitch' were organized at Chandipurdanga and Avirampur respectively for tribal rural youth and farm women.

## 12.7. Human Resource Development (HRD)

Skill development training (200 hrs.) was organized under Pradhan Mantri Kaushal Vikas Yojana (PMKVY) for rural youth of the Burdwan district. The programme was organized on "Solanaceous Crop Cultivation" and "Quality Seed Production" in which scientific cultivation practices as per climate zone, soil types and rainfall pattern were discussed with practical demonstration. Seed production of major crops was also discussed by involving subject matter expert during the training programmes.

## 12.8 Scientific Advisory Committee Meeting

The XIII$^{th}$ meeting of Scientific Advisory Committee of KVK, Burdwan was held on 27$^{th}$ September 2016. Village seed productions, inclusion of disease resistant varieties in FLD, convergence with ATMA are to be prioritized in the progarmmes. The meeting was chaired by Dr. P.G. Karmarkar, Director, ICAR-CRIJAF in presence of Dr. P.P Pal, Pr. Scientist, (ATARI, Kolkata), Deputy Director (Extension Education BCKV), DDA and PD (ATMA), District Veterinary Officer (Burdwan), DFO (Burdwan), AFO (Burdwan), AGM-DD of NABARD (Burdwan), and representatives of farmers and farm women. HoDs and Principal Scientists of ICAR-CRIJAF were also present in the meeting.

Fig 12.10 SAC meeting of KVK

# 13. Training and Capacity Building

## 13.1 Human Resource Development (HRD)

In 2016-17, a total of 43 employees (29.9 %) of ICAR-CRIJAF were trained for skill enhancement through various training activities. For better implementation of training activities, an annual training plan was prepared by the HRD cell of ICAR-CRIJAF followed by approval from ICAR. Training was mostly as per plan; 92.3% of scientific and 100% of other planned cadre trainings were implemented. A total of 12 scientists were trained on various special aspects of molecular techniques, data analysis, weed management and extension methodologies. Seven administrative staffs from finance and purchase sections were trained on e-procurement, knowledge enhancement and internal finance. A total of Rs. 2.55 lakh was allocated for training in 2016-17, of which 95.6% was utilized for HRD activities. A training programme for technical staffs was organized at ICAR-CRIJAF on "Skill Enhancement for Production and Processing of Fibre Crops" during 17-23 January, 2017 by Dr. Mukesh Kumar, training coordinator and three other co-coordinators. A total of 15 technical staffs were trained on various aspects of jute and allied fibre production and fibre processing. Another training programme on "Computer Application Skill Enhancement" was organized during 16-18 March, 2017 for skilled support staffs of ICAR-CRIJAF. Dr. Asim Kumar Chakraborty and Dr. Dhananjay Barman were the course coordinator and co-coordinator, respectively. Eleven skilled support staffs participated in the training. Detailed hands-on training was given on fundamentals of computer system including hardware and software, introduction on networking system with emphasis on internet and local area network, creation of mail accounts using free electronic mailing system, use of Microsoft Office specifically Microsoft Word and Power Point; checking ICAR and CRIJAF websites; operation of MIS-FMS portal to apply leave and generation of pay slips.

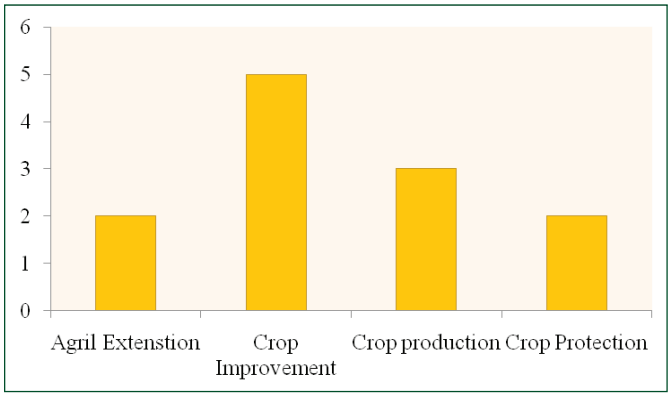


Fig. 13.1. Discipline-wise distribution of trained scientific cadre in 2016-17

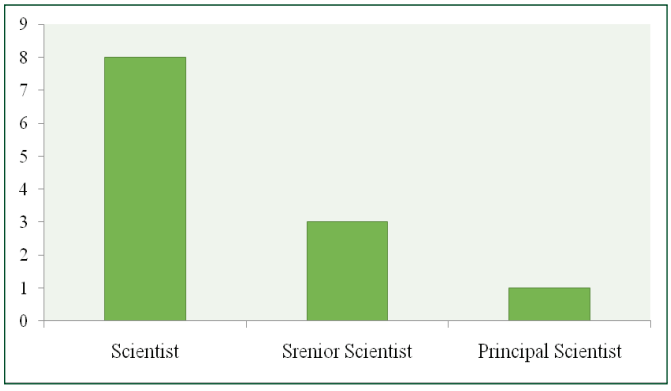


Fig. 13.2. Category-wise distribution of trained scientific cadre in 2016-17

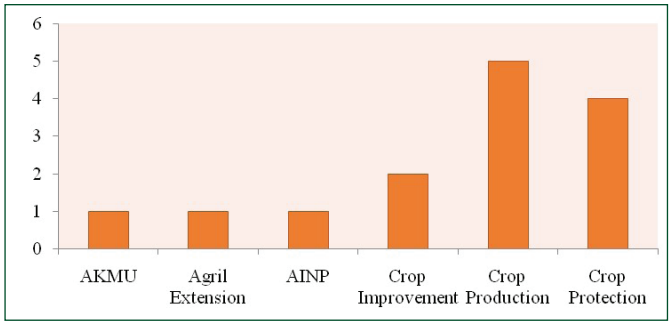


Fig. 13.3. Discipline-wise distribution of trained technical cadre in 2016-17

Fig. 13.4. Training of SSS of ICAR-CRIJAF on computer application skill enhancement

Fig. 13.5. National level training on Improved Production Technologies of JAF

**Table 13.1. Trainings organised by ICAR-CRIJAF and its sub-stations**

| Name of the Programme/Training | Date | No. of participants |
|---|---|---|
| **ICAR-CRIJAF (HQ)** | | |
| Training on "Improved retting technologies of jute and allied crops for quality fibre production" (NFSM) | 9-11 August, 2016 | 25 |
| Training programme on "Skill enhancement for production and processing of fibre crops" | 17-23 January, 2017 | 20 |
| State level officers training on "Improved jute production technology" | 27-28 January, 2017 | 20 |
| Trainers training programme on "Improved production technology of jute" | 27-28 February, 2017 | 29 |
| National Level Training on "Improved production technology of jute and allied fibre crops" (NFSM) | 7-9 February, 2017 | 25 |
| Trainers' training on "Improved production technology of jute" | 8-9 March, 2017 | 25 |
| National level training on "Improved seed production technology of jute and allied fibres" (NFSM) | 16-17 March, 2017 | 25 |
| Training on "Computer application skill enhancement of skilled supporting staff of ICAR-CRIJAF" | 16-18 March, 2017 | 11 |
| **Sisal Research Station, Bamra** | | |
| Farmers training on "Improved production technology of sisal" | 29 June- 1 July, 2016 | 30 |
| Training on "Improved production technology of sisal" | 26-28 October, 2016 | 25 |


Fig. 13.6. Trainer's training on Improved jute production technologies of jute under Jute I-CARE


Fig. 13.7. Skill enhancement training for technical personnel

Fig. 13.8. State level officers training programme under NFSM Commercial Crops (Jute)


Fig. 13.9. Training Programme on "Improved production technology of sisal"

**Table 13.2. Seminar/Symposium/Conference/Workshop attended by the scientists**

| Programme | Place | Name of the participant/s |
|---|---|---|
| All India Seminar on "Post-harvest Management of Fruits and Vegetables". | The Institution of Engineers, Kolkata<br>1-2 June, 2016 | Dr. M.S. Behera<br>Dr. R.K. Naik |
| Regional Workshop on "Improvement and Development of Emission Factor for Nitrous oxide" | ICRISAT, Hyderabad<br>14-17 June, 2016 | Dr. P. Bhattacharyya |
| Academia-Industry Interaction Meet for Eastern Region "To Access The Region Specific Needs of Agro-Industrial Sector" | ICAR-RCER, Patna<br>28 June, 2016 | Dr. R.K. Naik |
| International Conference on "Agriculture, Food Science, Natural Resources Management and Environmental Dynamics: The Technology, People and Sustainable Development" | BCKV, Mohanpur<br>13-14 August, 2016 | Dr. A.K. Singh<br>Dr. B S. Gotyal<br>Dr. R.K. Naik<br>Mr. P.N. Meena |
| National Symposium on "How to Write and Present the Research Papers" | BHU, Varanasi<br>2 September, 2016 | Dr. H.R. Bhandari |
| DBT Workshop on "GM Crops and Food and Environmental Safety" | Bose Institute, Kolkata<br>7 September, 2016 | Dr. S. Datta |
| State Level Workshop on "Sustainable Management of Himalayan Agro-Ecosystem" | ICAR-RC for NEH Region, Tripura Centre, Lembucherra<br>10 September, 2016 | Dr. S. Biswas |
| 4th South Asian Biosafety Conference (SABC- 2016) | BCIL, Hyderabad<br>19-21 September, 2016 | Dr. S. Datta |
| 3rd National Meet of Entomologists | ICAR-IIHR, Bangalore<br>7-8 October, 2016 | Dr. B S. Gotyal<br>Dr. S. Satpathy |
| National Seminar on "Developments in Soil Science" | RVSKVV, Gwalior<br>20-23 October, 2016 | Dr. R. Saha<br>Dr. D.K. Kundu |
| 1st International Agrobiodiversity Congress | ICAR-NBPGR, New Delhi<br>6-9 November, 2016 | Dr. D. Saha<br>Dr. S. Datta |
| 10th International Conference on "Controlled Atmosphere and Fumigation in Stored Products" | Ashoka Hotel, New Delhi<br>6-11 November, 2016 | Dr. B S. Gotyal |
| International Conference on "Integrated Land Use Planning for Smart Agriculture- an Agenda for Sustainable Land Management" | ICAR-NBSSLUP, Nagpur<br>10-13 November, 2016 | Dr. A.K. Singh |
| International Conference on "Climate Change and its Implications on Crop Production and Food Security" | BHU, Varanasi<br>12-13 November, 2016 | Dr. H.R. Bhandari |
| 4th International Agronomy Congress on "Agronomy for Sustainable Management of Natural Resources, Environment, Energy and Livelihood Security to Achieve Zero Hunger Challenge" | ICAR-IARI, New Delhi<br>22-26 November, 2016 | Dr. A.K. Ghorai<br>Dr. S. Mitra<br>Dr. M.S. Behera<br>Dr. Amarpreet Singh<br>Dr. S.K. Pandey<br>Dr. Mukesh Kumar<br>Dr. M.K. Tripathi |
| National Symposium on "Recent Trends in Agriculture and Allied Sciences for Better Tomorrow (NSRTAS – 2016)" | Visva Bharati, Sriniketan<br>4 December, 2016 | Dr. S. Datta |
| National Conference on "Innovative and Current Advances in Agriculture & Allied Sciences ( ICAAAS- 2016)" | PJTSAU, Hyderabad<br>10-11 December, 2016 | Dr. A.K. Jha<br>Dr. Amarpreet Singh |
| National Symposium on Impact of Climate Change, Biodiversity and Good Plant Protection Practices on Crop Productivity | BCKV, Kalyani<br>22-23 December, 2016 | Mr. P.N. Meena |
| National Symposium on "New Horizons in Pest Management for Sustainable Developmental Goal" | OUAT, Bhubaneswar<br>23-24, December, 2016 | Dr. S. Satpathy |
| International Conference on "Emerging Technologies in Agricultural and Food Engineering (ETAE-2016)" | IIT, Kharagpur<br>27-30 December, 2016 | Dr. R.K. Naik |
| International Symposium on "Eco-efficiency in Agriculture and Allied Research (EEAAR'17)" | BCKV, Kalyani<br>20-23 January, 2017 | Dr. H.K. Sharma<br>Dr. S.B. Chaudhary |

| Programme | Place | Name of the participant/s |
|---|---|---|
| 2nd Workshop of Nodal Officers of ICAR Research Data Repository for Knowledge Management | ICAR-IASRI, New Delhi<br>24-25 January, 2017 | A.K. Chakarborty |
| International Conference on "Bio-Resources, Environment and Agriculture Sciences". | Visva-Bharati, Santineketan<br>4-6 February, 2017 | Dr. R. Saha<br>Dr. A.K. Singh<br>Dr. S.P. Mazumdar |
| National Conference on "Advances in Agriculture through Sustainable Technologies and Holistic Approaches". | International Centre, Goa<br>15-17 February, 2017 | Dr. A.K. Singh |
| 51st Annual Convention of ISAE and National Symposium on "Agricultural Engineering for Sustainable and Climate Smart Agriculture". | CAET, CCSHAU, Hisar<br>16-18 February, 2017 | Dr. R.K. Naik |
| 28th Technological Conference on "New Developments and Future Strategies for Jute Industry". | IJIRA, Kolkata<br>1 March, 2017 | Dr. S. Datta |
| National Seminar on "Maximizing Fertilizer use Efficiency & Environmental Health for Posterity" | RKMVU, Narendrapur<br>8 March, 2017 | Dr. D.K. Kundu<br>Dr. A.R. Saha<br>Dr. R. Saha<br>Dr. S.P. Mazumdar |
| 29th Annual Workshop of All India Network Project on Jute and Allied Fibres (AINP on JAF) | ICAR-NIRJAFT, Kolkata<br>10-11 March, 2017 | All Scientists of ICAR-CRIJAF |
| National Conference on "Enhancing Nutritional Security through Climate Smart Farming Practices". | UBKV, Darjeeling<br>17-18 March, 2017 | Dr. S.K. Jha<br>Dr. B. Majumdar Dr. R. Saha<br>Dr. R.K. De<br>Dr. M.S. Behera<br>Dr. R.K. Naik |

**Table 13.3. Training undergone by the Scientists/Staff Members**

| Training Programme | Place & Date | Name of Participants |
|---|---|---|
| **Scientists** | | |
| Training on "Impact Assessment of Agricultural Extension" | ICAR-NAARM , Hyderabad<br>6-10 June, 2016 | Dr. Shailesh Kumar |
| Training on "Big Data Analytics in Agriculture" | ICAR-NAARM, Hyderabad<br>13-22 June, 2016 | Dr. A.K. Chakarborty |
| Training on "Analysis of Experimental Data" | ICAR-NAARM, Hyderabad<br>19-23 August, 2016 | Dr. Rajib Kr. De |
| Winter School on "Genomics and Phenomics for Enhancement of Crop Nutrient use Efficiency" | ICAR-NRCPB, New Delhi<br>1-21 September, 2016 | Mr. Monu Kumar, |
| ICAR-Sponsored Short Course on "Techniques in Insect Molecular Biology and Toxicology" | ICAR- SBI, Coimbatore<br>7-16 September, 2016 | Dr. B.S. Gotyal, |
| Training on "Quality Rice Seed Production" | BHU, Varanasi<br>17-20 October, 2016 | Dr. H.R. Bhandari |
| Training on "Geospatial Analysis for Natural Resource Management" | ICAR-NAARM, Hyderabad<br>18-27 October, 2016 | Dr. D. Barman |
| Training for Nodal Officers of the Public Authority related to RTI online Portal of DoP&T, i.e. RTI Request/Application and Appeal Management System (RTI-MIS) | NASC, New Delhi<br>21 October, 2016 | Dr. M.S. Behera |
| Training on "Farmer Field School (FFS) Methodology". | NIPHM, Hyderabad<br>7-11 November, 2016 | Dr. Manik Lal Roy |
| Training on "Advances in Weed Management" | DWSR, Jabalpur<br>30 November-9 December, 2016 | Dr. Mukesh Kumar |
| Centre for Advanced Faculty Training (CAFT) on "Advanced Computational and Statistical Tools for Omics Data Analysis" | ICAR-IASRI, New Delhi<br>1-21 December, 2016 | Dr. S.B. Choudhary |

Fig. 13.10. Training Programme on "Improved Production Technology of sisal"

Fig. 13.11. Farmers-scientist interaction on ramie cultivation

| Training Programme | Place & Date | Name of Participants |
|---|---|---|
| **Scientists** | | |
| Training on "Integrated Soil Nutrient and Weed Management" | NIPHM, Hydrabad<br>6-12 December, 2016 | Dr. M.S. Behera |
| CAFT training programme on "Computational Approches for Next Generation Sequencing (NGS) Data Analysis in Agriculture" | ICAR-IASRI, New Delhi<br>8-28 February, 2017 | Dr. S.B. Choudhary |
| Competency Enhancement Programme for "Effective Implementation of Training Function by HRD Nodal officers of ICAR" | ICAR-NAARM, Hybderabad<br>23-25 February, 2017 | Dr. Pratik Satya |
| Winter School on "Advanced Statistical Techniques in Genetics and Genomics" | IASRI, New Delhi<br>2-22 March, 2017 | Dr. H.K. Sharma |
| **Administrative and Technical Staffs** | | |
| Knowledge Enhancement Training Programme | ICAR-IASRI, New Delhi<br>9-10 June, 2016 | Mr. Chandan Kr. Verma,<br>Mr. Soumya Roy |
| Training Programme on "Enhancing Efficiency and Behavioural Skills" | ICAR-NAARM, Hyderabad<br>28 July -3August, 2016 | Mr. Subrata Biswas |
| Training Programme on "Implementation of NIC's E-Procurement Solution Through CPP Portal" | ICAR-NAARM, Hyderabad<br>26-28 September, 2016 | Mr. Ravi Mishra,<br>Mr. Chandan Kr. Verma,<br>Mr. Soumya Roy |
| Training Programme on "Production Protocol for Bio Pesticides and Biofertilizer" | NIPHM, Hydrabad<br>6-12 December, 2016 | Sr. K.P. Debnath |
| Training programme on " Skill Development of Laboratory Work" | BCKV, Kalyani<br>19-21 December, 2016 | Sh. Sandipan Garai,<br>Sk. Golam Rasul |

# 14. Meetings and Events

## 14.1. Mera Gaon Mera Gaurav (MGMG), ICAR-CRIJAF, Barrackpore

ICAR-CRIJAF scientists adopted 55 villages of North 24 Parganas, Nadia, Hooghly and Medinipore districts under Mera Gaon Mera Gaurav (MGMG) programme of the institute. During the visit to the adopted villages the scientists regularly interacted with the farmers to create awareness about the new farming technologies among the farmers. The extension literature pertaining to specific crops were


Farmers-scientists interaction under MGMG programme

also distributed. In general the benefit of the government schemes related to the farmers like *Pradhan Mantri Fasal Bima Yojana*, *Swachha Bharat Mission*, *Pradhan Mantri Krishi Sinchayee Yojana* etc. were also highlighted among the farmers during interaction meetings in MGMG villages.

## 14.2 Celebration of National Productivity Week

National Productivity Week (12-18 February, 2017) was celebrated at ICAR-CRIJAF on the theme 'From Waste to Produce through Reduce, Reuse and Recycle'. An essay competition was organised for the technical staffs, research fellows and young professionals of the Institute on 'Strategies for Small Scale Recycling and Reuse of Crop Products'. A panel discussion on 'Recycling and Waste Utilization of Fibre Crops' was organized involving multiple stakeholders including expert scientists from ICAR-CRIJAF, ICAR-NIRJAFT, member from National Jute Board, representatives from Jute Industry, NGOs, and progressive farmers.


Successful participants of essay competition being awarded by the Guest

## 14.3 Foundation Stone laying of CRIJAF - Krishi Vigyan Kendra in North 24 Parganas

Hon'ble Union Minister of Agriculture and Farmers' Welfare, Sri Radha Mohan Singh unveiled the foundation stone of new Krishi Vigyan Kendra-II of North 24 Parganas district in the North Farm premises of ICAR-CRIJAF, Barrackpore on 13th February, 2017. In his address, Sh. Radha Mohan Singh greeted the gathering and said that the prime objective

Shri Radha Mohan Singh, Hon'ble Union Minister of Agriculture and Farmers' Welfare unveiled the foundation stone of KVK

of KVKs is two-way interaction between the agricultural scientists and the farmers. Establishment of one more KVK


Shri Radha Mohan Singh, Hon'ble Union Minister of Agriculture and Farmers' Welfare addressing the farmers at ICAR-CRIJAF

in North 24 Parganas district will play important role for upliftment of the livelihood of the farmers. He advised the farmers to pursue scientific agriculture which would certainly prove fruitful. He also appealed farmers to become the part of all development programmes like Soil Health Mission, Pradhan Mantri Fasal Beema Yojana & E-NAM. He reiterated that ICAR schemes like Mera Gaon Mera Gaurav (MGMG), Attracting Rural Youth in Agriculture (ARYA), Farmers' First, Oilseeds & Pulses demonstration, etc. launched by Govt. of India will benefit farmers. He lauded the role of ICAR-CRIJAF for the relentless efforts put in by its scientists for serving the jute farming community. Dr Ashok Kumar Singh, DDG (Agril. Extension) articulated the role of KVK for the overall development of farmers. Dr. Jiban Mitra, Director of ICAR-CRIJAF, Dr. S.K. Roy, Director of ICAR-ATARI (Kolkata) and Directors of other ICAR Institutes of Kolkata also participated in the programme.

## 14.4 Celebration of World Soil Day

On 5th December, 2016 awareness Camp on 'World Soil Day' was organised at Paschim Simla village, North 24 Parganas. Dr. P.G. Karmakar, Director, ICAR-CRIJAF highlighted the


Director, CRIJAF addressing the farmers on World Soil Day

importance of soil testing and urged the farmers to make use of the soil health cards for sustaining the soil fertility and


Soil scientist, CRIJAF interacting with farmers on World Soil Day

crop productivity. The scientists of the institute discussed in detail on soil health/quality and demonstrated the soil testing kit and leaf colour chart. Fifty farmers got practical hands on training on soil testing. A booklet on World Soil Day emphasizing the basics of soil sampling and testing was distributed among the farmers in this occasion.

## 14.5 Foundation Day

The 65th Foundation Day of the Institute was celebrated on 9th February, 2017. Director (Acting), Dr. J. Mitra cut the cake on the occasion to commemorate the Foundation Day.


Director's address on the occasion of Foundation Day of CRIJAF

He greeted all the staffs and their family members in this special occasion. Director, HoDs and other senior officials deliberated on the achievements and golden history of the

Cake cutting by the Director during Foundation Day

Institute. The great contributions of promising scientists were also recalled. Sports and game competitions were organized among the staff and their family members and the winners were awarded with prizes.

## 14.6 IRC Meeting

The Institute Research Council (IRC) meeting for 2016-17 was conducted under the chairmanship of the Director to review the proposal of new projects as well as progress of the on-

going in-house projects and achievements of externally funded research projects during 10-11 April, 2017.

IRC meeting is in progress

## 14.7 Swachchha Bharat Abhiyan

As per the directives of Government of India, *"Swachchha Bharat Abhiyan"* was implemented from 16 to 31 October,


Swachchhata pledge administered by Director, ICAR-CRIJAF

2016 at ICAR-CRIJAF, Barrackpore. During the period many activities like awareness on National Sanitation Campaign, special cleanliness drive in the residential area, office campus and guest house, installation of litterbin/dustbin in common places were taken up. Besides periodical cleaning activities were also undertaken to keep the work place and the campus clean.


Swachchhata Aviyan at RRS, Sorbhog


Swachchhata Aviyan at ICAR-CRIJAF (HQ), Barrackpore

## 14.8 Celebration of Framers' Day

'Farmers' Day-2016' was organised on 20.8.2016 to sensitize the farmers about the recent developments on improved production technologies of jute and allied fibre crops. More

Felicitation of progressive farmer during Farmers' Day 2016

than 150 progressive farmers from major jute growing districts of West Bengal participated in this programme. Farmer-scientist interaction, field visit and exhibitions on improved technologies were also arranged for the farmers. Progressive farmers were awarded for innovative cultivation of jute. Besides, the farmers participated in the JUTE-QUIZ and won the prizes.


Dr. J. Mitra, HoD, Crop Improvement addressing to the farmers

## 14.9 Vigilance Awareness Week

Vigilance Awareness Week (VAW) was observed during 31 October to 5 Nov, 2016, which started with the pledge of vigilance administrated by the Director to all the staff of the


Dr. P.G. Karmakar, Director addressing the staffs during VAW


Vigilance Awareness Week celebration at RRS, Sorbhog

institute. Debate competitions were organized on the theme "Public participation in promoting integrity and eradicating corruption". Innovative slogans on vigilance were printed and pasted at various points. Prizes were distributed for essay writing competition. All the sub-stations of the institute also celebrated the week to create awareness among the staff on vigilance.


Dr. S. Satpathy, Vigilance Officer, ICAR-CRIJAF addressing the staffs during VAW

## 14.10 Hindi Pakhwara

Hindi Pakhwara was organised at HQ and all the substations during 14-28 September, 2016 to create awareness on use of Hindi language and to generate interest among officials and staffs to use Hindi in official works. The staffs of the Institute and its substations participated on various programmes with great enthusiasm.

Winner of events organised during Hindi Phakwara is awarded


Dr. S.K. Pandey, I/C, Hindi Cell addressing during the Hindi Pakhwara

## 14.11 International Women Day

On the occasion of International Women's Day, the Women's Cell of ICAR CRIJAF organised a training programme for empowering farm women during 7–10 March, 2017 at CRIJAF, Barrackpore. The training was on *"Value addition of jute fabrics for making decorative, fancy jute bags for entrepreneurship development"*. The main objective of this training was to alleviate the economic condition of farm women through skill improvement and formation of self-help groups. Twenty farm women from Nadia district had actively participated in this residential training programme.

Participants of International Women Day-2017

## 14.12 Review Meeting of Hon'ble Minister of Agriculture in Kolkata

Shri Radha Mohan Singh, Hon'ble Minister of Agriculture and Farmers Welfare, GOI, chaired a meeting to review the SAUs, performance of the Institute, KVKs, SAUs of Eastern India at Hotel Lalit Great Eastern, Kolkata, on 21.06.2016. He urged for strengthening of manpower in all the ICAR institutes and its regional stations and emphasized the KVKs

Review meeting of Hon'ble Minister of Agriculture and Farmers' Welfare in Kolkata

to increase the area under pulses and oilseeds through different programmes. Hon'ble Minister urged for speedy implementation of different central schemes like Lab to Land, *Pradhanmntri Fasal Bima Yojana*, Integrated Farming and Soil Health Card in collaboration with State Government. The meeting was attended by representatives of ICAR Institutes, KVKs and SAUs of Eastern India.

## 14.13 Visit of Dr. Trilochan Mohapatra, Secretary, DARE and DG, ICAR, New Delhi to ICAR-CRIJAF

Dr. Trilochan Mohapatra, Secretary, DARE and DG, ICAR visited ICAR-CRIJAF on 15 June, 2016. Hon'ble DG, ICAR addressed the staff members of the Institute and congratulated the scientists of the institute for development of various technologies like HYVs of jute, CRIJAF-SONA and the jute genomic studies. However, he underlined the issues like utilization of germplasm, development of efficient mutants of retting microbes, utilization of molecular information, enhancing water use efficiency, biomass conversion; jute based intercropping, linkage and transfer of technologies.


Dr. Trilochan Mohapatra, Secretary, DARE and DG, ICAR interacting with staff members of CRIJAF

Field visit of Hon'ble Secretary, DARE and DG, ICAR at CRIJAF

## 14.14 Agricultural Education Day

Agricultural Education Day was celebrated on 03.12.2016. More than 50 participants including students from Barasat Govt. College, North 24 Parganas, West Bengal participated in the programme. Heads of different Divisions deliberated on scope of Agricultural Educations, pertinent to higher studies, entrepreneurship skill development and job opportunities in Agricultural sectors. Later, students were apprised of different laboratories explaining on-going research works and library facilities. In the afternoon session, a quiz competition based on agriculture was organized. Besides, a debate competition was also held on the subject "Climate change will boost agriculture". Successful participants were awarded.


Director, CRIJAF addressing the students during Agriculture Education Day, 2016

Students are getting acquinted with farm machinaries during Agriculture Education Day, 2016

## 14.15 Celebration of Constitution Day

Constitution Day was celebrated on 26.11.16 at ICAR-CRIJAF and its sub-station. The preamble of the constitution was read out on the occasion. The Director discussed the importance of Constitution for nation building and elaborated its great role in maintaining the democratic fabric of the country.

Constitution day celebration at ICAR-CRIJAF

## 14.16 Hindi Workshop

One day Hindi workshop was organised on 27.08.2016 at ICAR-CRIJAF. About 75 staffs from all categories participated in this workshop.


Dr. P.G. Karmakar, Director, CRIJAF addressing the participants of Hindi Workshop

## 14.17 International Yoga Day

On the occasion of International Yoga Day two lectures by Bhramha Kumaris, Shyamnagar and by Maharaj of


Staffs of ICAR-CRIJAF participating in yoga


Maharaj, RKM, Belur being honoured by Dr. Jiban Mitra, HoD, Crop Improvement

Ram Krishna Mission, Belur Math, Kolkata were organised on 21.06.2016. Various aspects of Yoga and spirituality were discussed on the occasion. About two hundred staff members participated in the programme and acquainted about the importance of yoga in keeping the mind and body healthy.

## 14.18 Inauguration of KVK, North 24 Parganas

An additional KVK of North 24 Parganas under the administrative control of ICAR-CRIJAF was inaugurated on 16 December 2016 at North Farm of ICAR-CRIJAF, Barrackpore. Dr. P.G. Karmakar, Director, ICAR-CRIJAF along


Inauguration of KVK, North 24 Parganas at ICAR-CRIJAF, Barrackpore

with Additional Director & Assistant Director of Agriculture Department (Govt. of West Bengal), Scientists and Staffs of ICAR-CRIJAF, ICAR-ATARI, ICAR-CIFRI, In-charges of KVKs (Burdwan & North 24 Parganas) were present in this inaugural function. This KVK has been assigned to serve the agriculture blocks of Hingalganj, Sandeshkhali, Minakhan, Hasnabad, Barasat, Haroa, Barrackpore and Rajarhat of North 24 Parganas district. The second KVK in the district of North 24 Parganas will play an important role in improving the skills and income of farming community through introduction of suitable models of peri-urban and rural agriculture, horticulture, fishery and animal husbandry. A profile of KVK was also released on this occasion.

## 14.19 Field day at CSRSJAF, BudBud

A field day was organized under TSP of NSP (Crops) at CSRSJAF, BudBud on 3rd March, 2017. The tribal farmers

Field visit of farmers at CSRS JAF Bud Bud

(100 in number) from the districts of Burdwan and Bankura attended the field day. The technique of quality seed production and seed processing was demonstrated and deliberated during the field day.

Demonstration of seed processing unit to farmers

# 15. Awards and Recognitions

## 15.1 Awards

- Dr. Ritesh Saha, Principal Scientist received the "ISSS - Dr. J S P Yadav Memorial Award for Excellence in Soil Science" (as Team Member) for the year 2016 for outstanding contribution in the field of Soil Science on the occasion of Annual Convention of Indian Society of Soil Science, New Delhi at RVSKVV, Gwalior during 20-23 October, 2016.
- Dr. Amarpreet Singh, Scientist In-Charge, RRS, Sorbhog received the Indian Society of Agronomy (ISA) Best Ph. D. Thesis Award, 2014 during the 4th International Agronomy Congress on "Agronomy for Sustainable Management of Natural Resources, Environment, Energy and Livelihood Security to Achieve Zero Hunger Challenge" organized by Indian Society of Agronomy, New Delhi, during 22-26 November, 2016.
- Dr. Ranjan Kumar Naik, Sr. Scientist (FMP), received the "Outstanding Scientist Award" (in the field of jute and allied fibre crops) conferred by Venus International Foundation, Chennai, during Annual Research Meet-VIFARM 2016, Chennai on 03 December, 2016.
- Dr. Dhananjay Barman received the "Young Scientist Award-2016" in the field of Natural Resource Management conferred by Venus International Foundation, Chennai during Annual Research Meet-VIFARM 2016, Chennai, on 03 December 2016.
- Dr. Maruthi, R.T., Scientist (Plant Genetics) was awarded the Young Scientist Award by Venus International Foundation during Annual Research Meet-VIFARM 2016, Chennai, on 03 December 2016.
- Dr. A. Anil Kumar, Scientist (Plant Breeding) was awarded the Young Scientist Award by Venus International Foundation during Annual Research Meet-VIFARM 2016, Chennai, on 03 December 2016
- Dr. Amarpreet Singh, Scientist In-Charge, RRS, Sorbhog received the Young Scientist Award from Astha Foundation for his outstanding contribution in the field of Agronomy during the National Conference on "Innovative and Current Advances in Agriculture and Allied Sciences" at Hyderabad during 10–11 December, 2016.
- Dr. Ranjan Kumar Naik, Sr. Scientist (FMP), received the "Distinguished Service Certificate Award-2016" (in the category of Post-Harvest Engineering and Technology) conferred by Indian Society of Agricultural Engineers (ISAE), New Delhi during 51st Annual Convention of ISAE held at CAET, CCSHAU, Hisar, Haryana during 16-18 February, 2017.
- Dr. Ranjan Kumar Naik, Sr. Scientist (FMP), received the "K C Das Memorial Award" conferred by the Institution of Engineers (India), Odisha State Centre, Bhubaneswar for the research paper "Development of sisal fibre extractor for small farmers of Odisha" during 58th Annual Technical Session held on 19 February, 2017.
- The exhibition stall of Ramie Research Station, Sorbhog awarded with Third prize under the category of Traditional Farming Exhibition during Exhibition-cum-workshop on "Traditional farming and indigenous food of North East" held during 25-27 February 2017 at ICAR Research Complex for NEH Region, Umroi Road, Umiam, Meghalaya
- The ICAR-CRIJAF sports contingent participated in ICAR Eastern Zone Sports Tournaments -2016, during 6-9 March, 2017 at ICAR-NRRI Cuttack and won the 1st position in volleyball. Among individual events, Sri Uma Shankar Das, Sr. Technician won Gold Medal in high jump and long jump. Sanjay Sethi, Sr. Technician won Bronze Medal in high jump.

## 15.2 Recognitions

- Dr. D.K. Kundu, Principal Scientist was Invited Speaker at the Annual General Meeting-cum-Seminar of the Indian Society of Soil Science, Kolkata Chapter held on 27.8.2016
- Dr. D.K. Kundu, Principal Scientist, was nominated as Co-Chairman of the Soil Fertility-III Session at the 81st Annual Convention of the Indian Society of Soil Science held at RVSKVV, Gwalior on 20-23 October 2016.
- Dr. S.K. Sarkar, Pr. Scientist, ICAR-CRIJAF received 'Reviewers' Excellence Award' for the year 2016 from Agricultural Research Communication Centre (ARCC), Haryana.
- Dr. S. Datta Principal Scientist was Invited Speaker in the National Symposium on Recent Trends in Agriculture and Allied Sciences for Better Tomorrow (NSRTAS – 2016) at Visva Bharati, Sriniketan, on 4 December, 2016.
- Dr. S. Satpathy, Principal Scientist and HoD Crop Protection Division was Lead Speaker in the National Symposium on New Horizon in Pest Management for Sustainable Developmental Goal at OUAT, Bhubaneswar, 23-24 December, 2016.
- Dr. S. Satpathy, Principal Scientist and HoD Crop Protection Division was the Expert Member of the Committee to test the effectiveness of treatments for pest free export of vegetables to EU constituted by Directorate of Plant Protection Quarantine and Storage (GoI), Regional Plant Quarantine Station, Kolkata.

- Dr. S. Satpathy, Principal Scientist and HoD Crop Protection Division was nominated as Member, Board of Studies, Department of Entomology, BCKV, Mohanpur.
- Dr. Sitangshu Sarkar, Principal Scientist, ICAR-CRIJAF has been elected as Councillor (West Bengal) of Indian Society of Coastal Agricultural Research (ISCAR), Canning Town for 2016-18.
- Dr. Sitangshu Sarkar, Principal Scientist, ICAR-CRIJAF has been selected as Editorial Board Member (2016-20) of Indian Journal of Science and Technology and ARPN Journal of Science and Technology.

Dr. D.K. Kundu being felicitated by ISSS, Kolkata Chapter

Dr. R.K. Naik receiving K.C. Das Memorial Award

Dr. Amarpreet Singh receiving Young Scientist Award from Astha Foundation


CRIJAF Volleyball Zonal Champion team with Director, NRRI and Secretary, ICAR in ICAR Eastern Zone Sport Tournaments -2016

# 16. Research Projects

## 16.1 In-house Research Projects

| Project no. | Project title and investigator(s) | Duration | Results cited in page no. |
|---|---|---|---|
| **Crop Improvement** | | | |
| **CI-1: Genetic resource management and utilization of jute and allied fibre crops** | | | |
| JB 1.1 | Introduction, maintenance, characterization and conservation of jute, mesta and flax germplasm: *S.B. Choudhary* (w.e.f. Feb. 2011), *H.K. Sharma* (w.e.f. April 2012), *A. Anil Kumar* (w.e.f. 22.11.2012), *D. Saha* (w.e.f. 04.09.2014), *S. Datta* (24.04.2015) Amarpreet Singh (26.06.2015) and Monu Kumar (26.06.2015) | 1997-Long term | 1,2,3 |
| **CI-2: Breeding jute for higher fibre productivity and quality** | | | |
| JB 9.4 | Utilization of pre-breeding materials for genetic improvement of jute and kenaf: *P. Satya, S.K. Pandey and Maruthi R.T.* | 2014-17 | 3 |
| JB 9.9 | Selection and evaluation of genotypes with high yield and quality in *C. olitorius*: *C.S. Kar* | 2014-17 | - |
| JB 9.5 | Development of DNA fingerprint for varietal identification in jute: *J. Mitra, C.S. Kar and A. Anil Kumar* | 2014-18 | 5,6 |
| JB 9.8 | Development of screening technique for prediction of jute fibre quality: *C.S. Kar and Mukesh Kumar* | 2014-17 | - |
| JB10.1 | Genetic improvement of jute genotypes to biotic stresses: *A. Anil Kumar, H.K. Sharma, K. Mondal and B.S. Gotyal* | 2015-18 | 4 |
| **CI-3: Breeding mesta for higher fibre productivity and quality** | | | |
| JB 9.6 | Evaluation and selection for high fibre yield and other diversified uses in roselle (*H. sabdariffa*): *H.K. Sharma, A. Anil Kumar, Maruthi R.T. and A.R. Saha* | 2014-17 | 6,7 |
| JB10.0 | Genetic enhancement of kenaf using conventional and molecular approaches for fibre yield and quality improvement: *S.K. Pandey, P. Satya and P.N. Meena* | 2015-20 | 3,6 |
| **CI-4: Breeding allied fibre crops for higher fibre productivity and quality** | | | |
| JB10.2 | Genetics of self-incompatibility and development of improved fibre yielding populations in sunnhemp (*Crotalaria juncea* L.): *Maruthi, R.T., S.B. Choudhary and S. Datta* | 2015-18 | 7 |
| JB10.3 | Genetic improvement of flax (*Linum usitatissimum*) for higher fibre productivity and fibre quality *J. Mitra, D.N. Saha, Monu Kumar and Kunal Mandal* | 2016-22 | 20 |
| **CI-5: Genetic improvement of jute and allied fibre crops through biotechnology** | | | |
| JB 9.3 | Towards harnessing cell technological approaches for the enhancement of jute and allied fibre: *A.B. Mandal, Kanti Meena and R.K. De* | 2013-18 | 17,18 |
| JBT 4.3 | Bio-prospecting of jute and allied fibre crops for disease and water associated stress signaling genes through computational characterization of micro RNA: *L.L. Kharbikar, A.B. Mandal, R.K. De, H.K. Sharma and D. Sarkar* | 2014-17 | - |
| JBT 4.5 | Genetic purity testing and varietal fingerprinting in mesta using molecular markers: *Kanti Meena, P. Satya, S.K. Pandey and H. K. Sharma* | 2016-19 | 18 |
| **CI-6: Bio-informatics of jute and allied fibre crops** | | | |
| JBT 4.4 | Development and utilization of resources for bioinformatics and database in jute and allied fibres: *D. Saha, S. Datta and A.K. Chakraborty* | 2015-18 | 20,47 |
| JST 6.1 | Estimation of competition effects in Jute-Mungbean intercropping system: *A.K. Chakraborty and A.K. Ghorai* | 2016-18 | 30 |
| **Crop Production** | | | |
| **CPDN-1: Studies on integrated management of weeds and ecofriendly agro-chemicals for JAF crops** | | | |
| JA 5.9 | Eco-physiological studies for weeds in jute: *Mukesh Kumar, A.K. Ghorai, S. Sarkar and D.K. Kundu* | 2015-18 | 40 |
| JC 6.4 | Studies on combined efficacy of plant extracts with synthetic insecticides and fungicides against pest and diseases of jute and mesta: *H. Chowdhury, S.K. Sarkar, R.K. De and K. Selvaraj* | 2012-17 | - |

| | | | |
|---|---|---|---|
| JC 6.6 | Pesticide residue analysis in soil, plant and water to identify environmentally safer molecules for jute and allied fibre production system: *H. Chowdhury, A.K. Ghorai, Mukesh Kumar, S.K. Sarkar and K. Selvaraj* | 2016-21 | - |
| JC 6.7 | Study on extraction of useful bio-molecules from jute and sisal wastes: *H. Chowdhury, M.S. Behera, Mukesh Kumar, D.K. Kundu and A.K. Jha* | 2016-19 | - |
| **CPDN-2: Development of sustainable JAF-based cropping systems for increased farm income** | | | |
| JA 5.6 | Assessment of productivity and nutrient management for selected jute based cropping system: *Mukesh Kumar, A.K. Ghorai, S. Mitra and B. Majumdar* | 2012-17 | 26 |
| JA 6.9 | Prospect of growing medicinal and aromatic plants in jute and sisal based cropping system: *M.S. Behera, S. Satpathy, D.K. Kundu, A.K. Jha, R.K. Naik and Amarpreet Singh* | 2014-17 | 30 |
| SLA 1.6 | Use of drip irrigation for improving productivity of sisal based fruit-fibre system in central plateau region of India: *M.S. Behera, D.K. Kundu and A.K. Jha* | 2015-19 | 30 |
| JA 5.7 | Conservation agricultural practices of jute based cropping systems under climate change scenario: *R. Saha, M.S. Behera, Mukesh Kumar, A.R. Saha, B. Majumdar, S. Paul Mazumdar, D. Barman, D.K. Kundu and R.K. Naik* | 2015-20 | 25 |
| **CPDN-3: Studies on soil-water-plant relationships in JAF crops** | | | |
| JA 6.7 | Use of jute fabrics and gunny bags in agricultural fields: *A.K. Ghorai, D.K. Kundu and D. Barman* | 2014-17 | 29 |
| JA 6.8 | Studies on the effect of salinity stress on capsularis and olitorius jute: *M. Ramesh Naik, R.T. Maruthi, D. Barman, U.K. Mandal [ICAR-CSSRI (RRS)]* | 2014-17 | - |
| JA 6.0 | Modelling carbon sequestration under jute based agro-ecosystem: *A.K. Singh, S. Paul Mazumdar, D.K. Kundu, A.R. Saha, M.S. Behera and D. Barman* | 2015-18 | 22,6 |
| JA 7.2 | Soil health characterization and carbon sequestration potential in ramie based cropping system in Eastern India: *Sonali Paul Mazumdar* | 2016-19 | 25 |
| **CPDN-5: Farm mechanization and by-product utilization in JAF agriculture** | | | |
| JAE 3.4 | Development of manual multi-crop seed drill and dry land weeder for Gangetic alluvial soil: *R.K. Naik, A.K. Ghorai, S. Sarkar and S.K. Jha* | 2014-17 | 43 |
| JA 7.0 | Quantification of carbon balance in jute-rice based cropping systems: *P. Bhattacharyya, R. Saha, M.S. Behera, D. Barman, S.P. Mazumdar, B. Majumdar, S. Mitra, A.R. Saha, D.K. Kundu and A.K. Nayak (ICAR-NRRI, Cuttack)* | 2016-21 | - |
| JA 7.1 | Climate change risk assessment in jute production and related advisory services through Decision Support System: *D. Barman, P. Bhattacharyya, P. Satya, K. Selvaraj, A.K. Singh, A.K. Chakraborty, R. Saha, S. Paul Mazumdar, Shamna A. and S. Mitra* | 2016-21 | 46 |
| **CPDN-6: Development of improved water-saving methods for retting jute and mesta** | | | |
| JA 5.8 | Studies on ribbon retting methods for quality fibre production in jute and mesta: *R.K. Naik, B. Majumdar, S. Paul Mazumdar and R. Naik* | 2015-18 | 44 |
| **Crop Protection** | | | |
| **CPTN-1: Insect pests-plant interaction and the pathogen system in JAF crops** | | | |
| JM 8.6 | Molecular detection and management of mesta yellow vein mosaic virus: *P.N. Meena, V. Ramesh Babu and S.K. Pandey* | 2014-18 | 38 |
| JM 8.3 | Studies on variability and management of *Macrophomina phaseolina* infecting jute: *R.K. De and C.S. Kar* | 2012-17 | - |
| JM 8.5 | Basic studies to understand process of stem rot disease development in jute: *K. Mandal, C. Biswas and C.S. Kar* | 2014-17 | 36 |
| JE 1.8 | Studies on the role of VOCs conferring host plant resistance in jute: *B.S. Gotyal, Rajasekhara Rao (ICAR-CTCRI, Bhubanewsar), S. Satpathy and V. Ramesh Babu* | 2015-17 | 32 |
| JE 1.9 | Bio-ecology and management of sucking pests in jute<br>*S. Satpathy, B.S. Gotyal and K. Selvaraj* | 2016-21 | 35 |
| **CPTN-2: Investigation on PGPR and Bio-control for pest and disease management in JAF crops** | | | |
| JM 8.8 | Studies on entomopathogenic endophytes for pest management in jute with special reference to *Lecanicillium lecanii*: *C. Biswas and S. Satpathy* | 2015-18 | 33 |

| | | | |
|---|---|---|---|
| **CPTN-3: Ecological, behavioural and epidemiological studies on pests and diseases of JAF crops** | | | |
| JE 1.6 | Preliminary studies on sex pheromones of major insect pests of jute and allied fibre crops: *V. Ramesh Babu, B.S. Gotyal and S. Satpathy* | 2014-17 | 31 |
| JM 8.7 | Investigation on diseases of mesta seed crop and seed health testing: *S.K. Sarkar and Amit Bera* | 2014-17 | 8 |
| **CPTN-4: Standardization and validation of IPM technologies in JAF crops** | | | |
| JM 9.0 | Development of IPM module for jute: *R.K. De, K. Selvaraj and Shamna A.* | 2015-20 | 38 |
| **Agricultural Extension** | | | |
| **EXTN-1:Impact assessment of various technology transfer programme of CRIJAF** | | | |
| JEXA 5.3 | Impact of improved jute production technologies on farmers' economy in major jute growing districts of West Bengal: *S.K. Jha, S. Kumar, S. Sarkar, Shamna A and A. Chakraborty* | 2014-17 | 48 |
| JEXA 5.4 | An analysis on outcome of technological interventions under TSP in Makaltala: *Shamna A, S.K. Jha, S. Kumar and S. Sarkar* | 2014-17 | 49 |
| JEXA 5.5 | Agro-economic studies on the effect of technological interventions on livelihood of selected tribal farmers of Dakshin Dinajpur: *S. Sarkar, S. Saha, C. Jana, B. Goswami and J. Dutta* | 2015-18 | 49 |
| JEXA 5.6 | Analysis on adoption of selected CRIJAF technologies: *Shailesh Kumar, Shamna. A. and S.K. Jha* | 2015-17 | 49 |
| **Sisal Research Station, Bamra, Odisha** | | | |
| **Sisal-1: Development of improved production and protection technologies of sisal** | | | |
| SLM 1.0 | Studies on disease distribution, intensity and identification of sources of resistance against *Phytophthora* spp. causing zebra disease of sisal (*Agave sisalana*): *A.K. Jha, S. Sarkar and R.K. De* | 2012-17 | 39 |
| **Ramie Research Station, Sorbhog, Assam** | | | |
| **Rami-1: Collection maintenance, evaluation and utilization of ramie germplasm** | | | |
| RB 1.0 | Collection, maintenance and evaluation of ramie germplasm: *Monu Kumar and Amarpreet Singh* | Long term | 1 |
| RB 2.4 | Development of high yielding genotypes with enhanced fibre quality through hybridization: *Monu Kumar and Amarpreet Singh* | 2013-Long term | - |
| RB. 2.5 | Development of improved cultural and weed management practices to enhance productivity of ramie *Amarpreet Singh, Monu Kumar, S. Mitra, S. Sarkar, and B. Majumdar* | 2018-19 | - |
| **Sunnhemp Research Station, Pratapgarh, U.P.** | | | |
| **SNH-1: Development of improved production technologies of sunnhemp and flax** | | | |
| SNHA 2.2 | SNHA: Effect of weed management practices and nitrogen on growth and fibre yield of flax: *M.K. Tripathi, S. Mitra and Mukesh Kumar* | 2015-18 | 41 |

## 16.2 Externally Funded Projects

| Sponsor | Project Title and Principal Investigator | Duration | Results cited in page no. |
|---|---|---|---|
| Mega Seed Project (MSP) | Seed production in agricultural crops and fisheries: *C.S. Kar* | Long-term | 10,11 |
| DAC | Protection of jute varieties and DUS testing project: *Amit Bera* | Long-term | 5 |
| NFSM | Commercial crop-jute: *C.S. Kar* | 2014-17 | 11 |
| NFSM Sub-project | Frontline demonstration (FLD) on jute: *S.K. Jha* | 2014-17 | 52 |
| AICRP, LTFE (JC 5.2) | To study changes in soil quality, crop productivity and sustainability under jute-rice-wheat cropping system (LTFE): *D.K. Kundu* | Long-term | 22 |
| AICRP-STCR (JC 5.6) | Soil test and resource based integrated plant nutrient supply system for sustainable agriculture: *A.R. Saha* | Long-term | 22 |

| Sponsor | Project Title and Project Investigator | Duration | Results cited in page no. |
|---|---|---|---|
| AICRP-STCR (JC 5.6a) | Long term effect of ST-TY equation based INM on yield, value addition, nutrient budgeting and quality of soil under jute-rice-lentil sequence: *A.R. Saha* | Long-term | 23 |
| RKVY | Geo-spatial approach to study of agri-horti intercropping model in red & laterite soil of West Bengal: *D. Barman* | 2014-17 | 46-47 |
| BRNS | A study on the influence of species and sulphur levels on yield, sulfur use efficiency and changes in different forms of sulphur in jute and mesta using ($^{35}S$) tracer: *S. Paul Mazumdar* | 2013-16 | 24 |
| BRNS | Induction and characterization of *tossa* jute (*Corchorus olitorius*) mutants for fibre yield attributes and quality parameters: *S.B. Choudhury* | 2014-17 | 3 |
| ICAR-NPTC Subproject 3082 | Herbicide tolerance in jute: *S. Datta* | 2015- 17 | 15 |
| ICAR-NPTC Subproject 3070 | Genome sequencing and functional genomics of bast fibre quality: *D. Sarkar* | 2015-17 | 14 |
| ICAR-Extramural Project | Introgression of stem rot resistance from wild jute to cultivated *olitorius* through wide hybradization: *A. Anil Kumar* | 2016- 17 | 4 |
| ICAR-Extramural Project | Application of engineered nano-particles in controlling *Rhizoctonia*/*Macrophomina phaseolina* (Sub-project): *C. Biswas* | 2016- 17 | 36 |
| MSME | IP facilitation centre for jute products and other regional handicrafts of West Bengal: *C. Biswas* | 2016-21 | - |
| DST | Natural Resource Management for Climate Smart Jute Farming through Capacity building of scheduled caste farmers in West Bengal: *A.K. Singh* | 2016-19 | - |
| DST (WB) | Development of an efficient in vitro micro-propagation protocol for production of healthy propagules in ramie (*Boehmeria nivea* L. Gaud) as planting material for enhanced productivity in sustainable scale: *A.B. Mandal* | 2016-19 | - |

## 16.3 Technology Mission on Jute

| Sponsor | Title of the project & Principal Investigator | Duration | Results cited in page no. |
|---|---|---|---|
| TMJ 1 | Development of high yielding and better quality jute genotypes by integrating conventional and advanced strategies: *P. Satya* | 2013-17 | 4 |
| TMJ 2 | Genetic enhancement of jute and mesta for drought response and fibre quality: *J. Mitra* | 2013-17 | - |
| TMJ 3 | Development of jute and allied fibres informatics: *A.K. Chakrabarty* | 2013-17 | 46 |
| TMJ 4 | Development of low cost eco-friendly technologies for weed management in jute and mesta: *A.K. Ghorai* | 2013-17 | 41 |
| TMJ 5 | Improving water productivity of jute and mesta and its retting under low volume water: *A.K. Ghorai* | 2013-17 | 28 |
| TMJ 6 | Up-scaling and refinement of microbial retting consortium and popularization of microbial formulation mediated retting among farmers: *B. Majumdar* | 2013-17 | 44 |
| TMJ 7 | Management of stem rot disease and major insect pests of jute: *C. Biswas* | 2013-17 | 37 |
| TMJ 8 | Refinement and upscaling of eco-friendly microbial degumming technology in ramie: *S. Mitra* | 2013-17 | 45 |
| TMJ 9 | Improvement of nitrogen use efficiency (NUE) in jute in relation to bast fibre yield: *S. Mitra* | 2013-17 | 25 |
| TMJ 10 | Seed quality enhancement for mitigating biotic and abiotic stresses in jute (*Corchorus olitorius*): *Amit Bera* | 2013-17 | 8 |

# 17. Publications

## 17.1 Research Papers


Barman, D., Kundu, D.K., Pal, S., Pal, S., Chakraborty, A.K., Jha, A.K., Mazumdar, S.P., Saha, R. and Bhattacharyya, P. (2017). Soil temperature prediction from air temperature for alluvial soils in lower Indo-Gangetic plain. *International Agrophysics*, 31(1): 9-22.

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Singh, Amarpreet, Monu Kumar, Sarkar, S., Mitra, S. and Kumar, M. (2017). *Gaoje thakhani khunkhura mavdehunthay* (in Bodo). Extension Leaflet, ICAR-CRIJAF, Barrackpore.

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Behera, M.S., Kundu, D.K., Satpathy, S., Jha, A.K. and Singh, A. (2016). Integration of spices, medicinal and aromatic plants for crop diversification and enhancing farm income in jute seed based cropping system. National Conference on "Enhancing Nutritional Security through Climate Smart Farming Practices". 17-18 March 2017, UBKV, Kalimpong. pp. 46-47.

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*Phytophthora nicotianae*. National Conference on "Innovative and Current Advances in Agriculture & Allied Sciences (ICAAAS-2016)". 10-11 December, 2016, PJTSAU, Rajendranagar, Hyderabad. P.117

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Tripathi, M.K., Mitra, S., Chaudhary, B., Saha, A.R., Bhandari, H.R., Pandey, S.K. and Karmakar, P.G. (2017). Effect of micronutrient zinc and boron on fibre yield of sunnhemp. 4th International Agronomy Congress, 22-26 November, 2016, New Delhi, India. Vol. 2, pp. 826-827.

## 17.9 Radio Talks

All India Radio, Kolkata broadcast the message of Dr. D. K. Kundu on 'Role of the newly established Krishi Vigyan Kendra in transfer of ICAR-CRIJAF technologies to the farmers of North 24 Parganas district, West Bengal' on 20.12.2016 at 6:40 PM under the segment *Krishi Kothar Asor*.

# 18. Library, AKMU, ITMU and PME Cell

## 18.1 Library, Information and Documentation Unit

The institute library performs and maintains its designated services and activities such as acquisition of books and journals, exchange of literature, classification and cataloguing of documents and other documentation works. The library has rich collection of books and journals of different agricultural and basic sciences especially on jute and other fibre crops like sisal, ramie, flax, sunnhemp and mesta. The library procures documents on different subjects like Agronomy, Plant Breeding, Genetics, Soil Science, Agricultural Statistics, Seed Science and Technology, Plant Pathology, Environmental Sciences, Plant Physiology, Entomology, Nematology, Agricultural Engineering, etc. The library holds popular magazines, newsletters and annual reports of various research organizations, proceedings, research highlights of the ICAR institutes, SAUs and other useful reading materials received from different relevant organizations. The library has a collection of over 10,305 books and 11,720 bound volume of journals during 2016-17. AGRIS CD is available in the library from 1971 to 2005 for easy access of abstracts of different publications. CRIJAF publications were provided to over 350 different organizations in India and abroad. The institute Annual Report, AINPJAF Annual Report, JAF News, Resha Kiran (Hindi), Vision 2050 and other institute publications were distributed to different institutes, stakeholders of jute and allied fibres and visitors. Library also provides the internet and reprography service to the readers along with Document Delivery Services (DDS) system by Consortium for e-Resources in Agriculture (CeRA) to access different journals online. Under the DDS system the library had sent copies of publications as per request to researchers/academicians of different agricultural institutes and SAUs. *(Source: Mukesh Kumar, OIC Library).*

## 18.2 Agricultural Knowledge Management Unit (AKMU)

The Agricultural Knowledge Management Unit provides 24×7 internet connectivity at CRIJAF through the National Knowledge Network (PGCIL 100 Mbps NKN Edge Link) high-speed internet connectivity established during 2014, routed through National Informatics Centre (NIC). The network links different departments with gateway level security (Sonic Wall) centrally controlled from AKMU cell. To implement online ICAR-ERP solution computer systems has been provided to all categories of staffs of Headquarters and its four research stations and the system is functioning satisfactorily. Password protected secured Wi-Fi systems are available inside the campus.

The institute web site http://www.crijaf.org.in is maintained on day-to-day basis by this cell. Hardware and software maintenance support is being provided to all computer systems, UPS, printers, scanners and accessories without AMC by the cell. This cell also extends full-fledged support to organize and conduct of various types of meetings, seminars, symposium, workshops, video conferencing etc.

Online maintenance of ICAR online databases like Personnel Management Information System Network (PERMISNET), Project Implementation Management System of ICAR (PIMS-ICAR), Half Yearly Progress Monitoring System (HYPM) is done by this cell. Uploading tenders in Central Public Procurement Portal (CPPP) and e-procurement process are also centrally monitored in this cell.


Video conferencing of IJSC of different ICAR institutes with Council

The complete IT infrastructure of the institute comprises underground fibre optic backbone for Local Area Networking with equipment and peripherals. Hardware includes Personal Computers (100+), Server (1), UPS, different types of printers, scanners, Firewall etc. Windows based software includes Operating System (Windows 2012 Server, XP, Vista, Win7, Win8, Win 10); application software (MS Office 2003, 2007, 2010 and 2013, SPSS, SAS, End Point Security (Kaspersky Antivirus etc.). *(Source: AKMU, Contributor: C.S. Kar and Nilanjan Paul)*

## 18.3 Institute Technology Management Unit (ITMU)

**Follow up action on patent applications:** Hearing regarding Patent Application No. 1036/Kol/2008 (An Improved Process of Large Scale Degumming of Ramie Fibre) was completed on 04.01.2017 and action thereafter is in progress.

**Design Registration:** Application for registration of the design for Single Wheel Jute Weeder (Application No. 289424 in Class 15-03 dated 19.12.2016) and 'New Nail Assembly of CRIJAF Nail Weeder (Application No. 289754 in Class 15-03 dated 02.01.2017) were processed.

**Commercialization of the technologies**: Following technologies of the Institute have been commercialized during 2016-17.

- Non-exclusive license has been awarded to M/s. Joy Maa Tara Enterprise, Sodepur and M/s. Krishi Udyog, Howrah for manufacture and sale of Multirow Seed Drill for a period of 10 years w.e.f. 24th May, 2016.
- For manufacture and sale of Flax Fibre Extractor non-exclusive license has been awarded to M/s Santra & Company, Brindabon Mullick Lane, Howrah for a period of 10 years w.e.f. 15th December, 2016.
- Non-exclusive license has been awarded to M/s Creative Displayer, Barrackpore for manufacture and sale of Single Wheel Jute Weeder for a period of 10 years w.e.f. 22nd February , 2017
- Firm M/s Next 2 Nature, Assam has been awarded the non-exclusive license for large scale production and sale of CRIJAF-SONA for a period of 10 years w.e.f. 25th February, 2017.

Execution of MoU between ICAR-CRIJAF and M/s Next 2 Nature

- **Protection of Jute Varieties and DUS Testing in Jute:** Two varieties of jute JRCM-2 (PARTHO) and JROM-1 (PRADIP) were registered on 19th August, 2016 and their respective registration numbers are JRCM-2: 248 of 2016 and JROM-1: 246 of 2016.
- **Germplasm registration:** The applications of following jute germplasms with specific characteristics have been processed for registration at ICAR-NBPGR.

| Germplasm | Special Character |
|---|---|
| OMU 005 | Fibre wedge length and diameter |
| OMU 007 | Bark thickness |
| OMU 18 | High number of fibre cells per fibre bundle |
| Sdf | Extremely dwarf mutant |
| Nonabs | Non-abscission of leaves |
| Llpf | Low-lignin content of fibre |
| Pfr | Pre-mature flowering resistant |
| WCIN 009 | High iron content in leaves |
| Zigzag | Zigzag longitudinal growth |

**Royalty :** During 2016-17, Total Rs. 3, 00,185 was received as royalty payment of various commercialized technologies (CRIJAF-Nail Weeder, CRIJAF Multi-row Seed Drill and CRIJAF-SONA) *(Source: ITMU; Contributor: S.K. Sarkar)*

## 18.4 Prioritization, Monitoring and Evaluation (PME) Cell

The PME cell of ICAR-CRIJAF was established as per guidelines of the Council. It comprises of a group of four scientists headed by a Principal Scientist and one Assistant Chief Technical Officer. The PME of the Institute is working as "Single window" system for priority setting, research monitoring and evaluation, maintenance of data bases related to projects, achievements, technologies developed, publication etc. Important activities performed by the cell are conducting Institute Research Council (IRC) meeting, maintaining Research Project Files (RPP), coordinating online submission of Half Yearly Progress Monitoring (HYPM) report of all the Scientists of the Institute, updating online programme–PERMISNET and PIMS-ICAR. Coordinating reply of Parliamentary question, Annul Plan, DARE report, ATR of Directors' meet and Regional Committee Meetings and coordination of research audit of the institute. The PME cell also facilitates in providing the research information of the institute to other departments and stakeholders *(Source: PME cell, Contributor: S.K. Sarkar).*

# 19. राजभाषा कार्यान्वयन (Official Language Implementation)

## भाकृअनुप–केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान की राजभाषा गतिविधियाँ

केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान में भारत सरकार की राजभाषा नीति का अनुपालन सुनिश्चित करने के लिए संस्थान में एक राजभाषा प्रकोष्ठ है, इसमें एक वरिष्ठ वैज्ञानिक हिन्दी प्रभारी के रूप में तथा एक सहायक कार्यरत हैं।

इस संस्थान के वैज्ञानिकों द्वारा कृषकों के जीवन यापन में गुणात्मक सुधार हेतु पटसन एवं समवर्गीय रेशा फसलों के महत्वपूर्ण कृषि तथ्यों से उन्हें अवगत कराया जाता है। पटसन कृषि के क्षेत्र में इस संस्थान की साकारात्मक भूमिका रही है। विकासात्मक गतिविधियों एवं जानकारियों को अन्य भाषाओं के साथ–साथ हिन्दी में भी किसानों तक पहुँचाने में यह संस्थान प्रयासरत है। के.प.स.रे.अ.सं. एक वैज्ञानिक संस्थान होते हुए भी यहाँ राजभाषा हिन्दी को काफी बढावा दिया जाता है। संस्थान के राजभाषा अनुभाग ने हिन्दी पदों के अभाव के बावजूद भी संस्थान में कार्यरत वैज्ञानिकों/अधिकारियों के बलबूते राजभाषा के प्रचार–प्रसार हेतु अनेकों उल्लेखनीय कार्य किए हैं। भाकृअनुप–के.प.स.रे.अ.सं. में हुई इन उपलब्धियों का संक्षिप्त विवरण प्रस्तुत हैः–

### प्रशासनिक उपलब्धियाँः–

संस्थान ने प्रशासन के क्षेत्र में भी काफी महत्पूर्ण उपलब्धियाँ प्राप्त की हैं:–

- 21 विहित फार्मों एवं 10 मानक मसौदे द्विभाषी हैं तथा बाकी फार्मों एवं मानक मसौदों का द्विभाषी रूप तैयार किया जा रहा है।
- अधिकांश रजिस्टरों के शीर्षक द्विभाषी हैं। बाकी रजिस्टरों के शीर्षक द्विभाषी रूप में किये जा रहें हैं।
- संस्थान में अधिकांश रबर की मोहरें, नाम पट्ट, शीर्षक–पत्र इत्यादि द्विभाषी हैं। समय–समय पर आवश्यकतानुसार मोहरें एवं नाम पट्ट द्विभाषी रूप में बनवाये जाते हैं।
- संस्थान की राजभाषा कार्यान्वयन समिति की बैठकों में होने वाली चर्चायें सिर्फ और सिर्फ हिन्दी में होती हैं।
- अन्य भाषा–भाषी लोगों के हिन्दी शब्द ज्ञान हेतु प्रतिदिन हिन्दी का एक शब्द लिखा जाता है।
- हिन्दी अनुभाग में प्रविष्टियाँ, टिप्पणी एवं मसौदा लेखन व अन्य कार्य हिन्दी में होते हैं।
- संस्थान के अन्य भाषा–भाषी अधिकारियों/कर्मचारियों को हिन्दी में प्रशिक्षण देने के लिए हिन्दी शिक्षण योजना के अन्तर्गत राजभाषा कक्ष द्वारा संस्थान में ही हिन्दी कक्षायें चलायी जाती हैं।
- हिन्दी में प्राप्त पत्रों के शत–प्रतिशत उत्तर हिन्दी में ही दिए जाते हैं।
- संस्थान में धारा 3(3) के अन्तर्गत आने वाले संस्थान के सभी दर आमंत्रण, निविदा–प्रपत्र, निविदा सूचनाएं एवं बिक्री सूचनायें आदि द्विभाषी रूप में जारी किए जाते हैं।
- संस्थान में राजभाषा विभाग के आदेशों के अनुसार संस्थान के स्वीकृत बजट में पुस्तकालयों के लिए निर्धारित कुल अनुदान राशि का 50 प्रतिशत हिन्दी पुस्तकों की खरीद पर व्यय के लक्ष्य को ध्यान में रखते हुए संस्थान में प्रयोग किए जाने वाले विज्ञान, शब्दकोष, सरकारी टिप्पणियाँ एवं कार्यालय उपयोगी संदर्भ पुस्तकें मँगवाई जाती हैं।
- संस्थान में मूल रूप से हिन्दी में काम करने पर दी जानेवाली प्रोत्साहन योजना को वर्ष 2001 से लागू किया गया है।
- भारतीय कृषि अनुसंधान परिषद के दिनांक 31.03.1991 के परिपत्र के अनुसार संस्थान की राजभाषा कार्यान्वयन समिति की बैठकें नियमित रूप से आयोजित की जाती हैं।
- कार्यालय में प्रयुक्त सभी उपस्थिति पंजी के शीर्षक व शीर्ष नाम तथा उनमें अधिकारियों/कर्मचारियों के नाम हिन्दी और अंग्रेजी दोनों भाषाओं में लिखे जाते हैं।

### संस्थान में एक दिवसीय हिन्दी कार्यशाला का आयोजन

राजभाषा कार्यान्वयन समिति के तत्वावधान में दिनांक 27 अगस्त, 2016 को संस्थान के अधिकारियों/कर्मचारियों की हिन्दी में कार्य करने की झिझक को दूर करने के उद्देश्य से एक दिवसीय हिन्दी कार्याशाला का आयोजन किया गया जिसकी अध्यक्षता संस्थान के निदेशक, डा. पी.जी. कर्मकार जी ने की।


डा. एस.के. पाण्डेय, हिन्दी प्रभारी, हिन्दी कार्यशाला में प्रतिभागियों को संबोधित करते हुए।

इस कार्यशाला में व्याख्यान हेतु सुश्री अर्पिता राय, प्राध्यापिका, हिन्दी शिक्षण योजना, भारत सरकार, गृह मंत्रालय, राजभाषा विभाग, निजाम पैलेस, कोलकाता को आमंत्रित किया गया था। उन्होंने राजभाषा नीति, नियम पर पावर प्वाईंट प्रस्तुतिकरण दिया तथा हिन्दी में


मुख्य वक्ता, सुश्री अर्पिता राय, प्राध्यापिका, हि.शि.यो., गृ.मं., भारत सरकार, निजाम पैलेस, कोलकाता हिन्दी कार्यशाला में प्रतिभागियों को प्रशिक्षण प्रदान करती हुईं।

टिप्पण, पत्र लेखन एवं मसौदा लेखन आदि विषयों पर भी जानकारी प्रदान की साथ ही उन्होंने प्रतिभागियों द्वारा उठाए गए प्रश्नों का समाधान भी किया। कार्यशाला में संस्थान के लगभग 70 अधिकारियों एवं कर्मचारियों ने उत्साह पूर्वक भाग लिया।

हिन्दी कार्यशाला में भाग ले रहे संस्थान के अधिकारी एवं कर्मचारीगण।

हिंदी कार्यशाला का संचालन डा. सुरेन्द्र कुमार पाण्डेय, वरिष्ठ वैज्ञानिक एवं प्रभारी, राजभाषा कक्ष ने श्री मनोज कुमार राय, सहायक के सहयोग से किया तथा समापन के दौरान उन्होंने समस्त प्रतिभागियों का आभार व्यक्त किया तथा धन्यवाद ज्ञापन के साथ एक दिवसीय हिन्दी कार्यशाला का समापन हुआ।

## संस्थान में हिन्दी पखवाड़ा का आयोजन

राजभाषा हिन्दी के प्रति जागरूकता पैदा करने तथा उसके प्रभावों में गति लाने के उद्देश्य से संस्थान में दिनांक 14 से 28 सितम्बर, 2016 के दौरान हिन्दी पखवाड़ा का आयोजन किया गया, जिसका उद्घाटन संस्थान के माननीय निदेशक, डॉ. पी.जी. कर्मकार जी के द्वारा किया गया। मुख्य अतिथि/वक्ता के रूप में डॉ. एन. सिंह, पूर्व प्राचार्य, केन्द्रीय विद्यालय संगठन को आमंत्रित किया गया था। उन्होंने अपने व्याख्यान में कहा कि हिंदी संवैधानिक रूप से भारत की प्रथम राजभाषा है और भारत वर्ष में सबसे अधिक बोली और समगझी जाने वाली भाषा है। यूनेस्को के दस्तावेजों के अनुसार, मातृभाषियों


हिन्दी पखवाड़ा के उद्घाटन सत्र में संस्थान के अधिकारियों एवं कर्मचारियों को स्वागत भाषण प्रस्तुत करते हुए हिन्दी प्रभारी, डा. एस.के. पाण्डेय।

की संख्या की दृष्टि से संसार की भाषाओं में चीनी के बाद हिंदी का दूसरा स्थान प्राप्त है। निदेशक महोदय ने अपने अध्यक्षीय संबोधन में संस्थान के समस्त अधिकारियों/कर्मचारियों को कार्यालयीन कार्यों में हिन्दी के अधिकाधिक प्रयोग का आह्वान करते हुए प्रत्येक शासकीय कार्यों में बोधगम्य व सरल हिन्दी के प्रयोग पर बल दिया। डॉ. जीबन मित्रा, प्रभागाध्यक्ष, फसल सुधार ने अपने संबोधन में कहा


संस्थान के निदेशक, डा. पी.जी. कर्मकार हिन्दी पखवाड़ा के उद्घाटन सत्र में संस्थान के अधिकारियों एवं कर्मचारियों को संबोधित करते हुए।

कि हमें स्वयं को राजभाषा में कार्य करने हेतु गंभीर होना पड़ेगा तभी राजभाषा आदेशों को लागू करने में सहायता मिलेगी। डॉ. एस. सत्पथी, प्रभागाध्यक्ष, फसल संरक्षण ने राजभाषा हिंदी में अधिक से अधिक कार्य तथा पत्राचार पर बल देते हुए कहा कि हम सभी का

दायित्व है कि राजभाषा का यथासंभव अपने दैनिक कार्यों में प्रयोग करें। डॉ. दिलीप कुमार कुण्डु प्रभागाध्यक्ष, फसल उत्पादन ने इस बात पर प्रकाश डाला कि राजभाषा हिंदी को यथा संभव हम अपने प्रशासनिक एवं दैनंदिन कार्यालयीन कार्यों में किस प्रकार प्रयोग कर


मुख्य अतिथि एवं वक्ता, डा. एन. सिंह, पूर्व प्राचार्य, केन्द्रीय विद्यालय संगठन, हिन्दी पखवाड़ा के उद्घाटन सत्र में संस्थान के अधिकारियों एवं कर्मचारियों को संबोधित करते हुए।

सकते हैं। डॉ. रीतेश साहा, प्रधान वैज्ञानिक एवं कार्यालय प्रधान ने अपने संबोधन में कहा कि हिन्दी भाषा साधारण जनता, किसान भाइयों के साथ संपर्क बनाने का बेहतर माध्यम है क्योंकि इस भाषा को लगभग हर भारतीय समझता या बोलता है। डॉ. अरविन्द कुमार सिंह, वरिष्ठ वैज्ञानिक एवं प्रभारी, वित्त एवं लेखा अधिकारी ने कहा कि किसी भी भाषा के सही प्रयोग के लिए उस भाषा के व्याकरण की जानकारी होनी चाहिए अन्यथा हम उस भाषा के संदेश से परिचित नहीं हो पाएंगे।

'हिन्दी पखवाड़ा' समापन समारोह दिनांक 28 सितम्बर, 2016 को माननीय निदेशक, डॉ. पी.जी. कर्माकर जी की अध्यक्षता में आयोजित की गयी। इस अवसर पर श्रीमती रीता भट्टाचार्य, पूर्व मुख्य प्रबंधक, राजभाषा विभाग, यू.बी.आई. प्रधान कार्यालय, कोलकाता

श्रीमती रीता भट्टाचार्य, पूर्व मुख्य प्रबंधक, राजभाषा विभाग, यू.बी.आई., प्रधान कार्यालय, कोलकाता हिन्दी पखवाड़ा के समापन सत्र में संस्थान के अधिकारियों एवं कर्मचारियों को पुरस्कार प्रदान करती हुई।

मुख्य अतिथि/वक्ता के रूप में सादर आमंत्रित थीं। उन्होंने अपने विस्तृत व्याख्यान में राजभाषा का कार्यान्वयन व कार्यालय में इसके प्रयोग पर सविस्तार जानकारी प्रदान की। इस कार्यक्रम की अध्यक्षता कर रहे संस्थान के निदेशक, डॉ. पी.जी. कर्मकार के अतिरिक्त डॉ. एस. सत्पथी, प्रभागाध्यक्ष, फसल संरक्षण, डॉ. दिलीप कुमार कुण्डु, प्रभागाध्यक्ष, फसल उत्पादन एवं डॉ. शितांशु सरकार, प्रभारी, कृषि प्रसार मंचासीन थे। डॉ. सुरेन्द्र कुमार पाण्डेय, वरिष्ठ वैज्ञानिक एवं प्रभारी, हिन्दी कक्ष ने अपने समापन भाषण में संस्थान में किये जा रहे हिन्दी कार्य की प्रगति के बारे में जानकारी दी। निदेशक महोदय, मुख्य वक्ता तथा मंचासीन प्रभागाध्यक्षों के द्वारा विभिन्न प्रतियोगिताओं में सफल प्रतिभागियों को क्रमशः प्रथम, द्वितीय व तृतीय पुरस्कार प्रदान किये गये।

हिंदी पखवाड़ा उद्घाटन तथा समापन कार्यक्रम का संचालन डा. सुरेन्द्र कुमार पाण्डेय, वरिष्ठ वैज्ञानिक एवं प्रभारी, राजभाषा कक्ष ने श्री मनोज कुमार राय, सहायक के सहयोग से किया। कार्यक्रम का समापन डा. सुनीति कुमार झा, प्रधान वैज्ञानिक के धन्यवाद ज्ञापन के साथ सम्पन्न हुआ।

## सनई अनुसंधान केन्द्र, प्रतापगढ़, में हिन्दी दिवस का आयोजन

दिनांक 14 सितम्बर, 2016 को सनई अनुसंधान केन्द्र, प्रतापगढ़ में हिंदी दिवस का अयोजन किया गया। इस अवार पर केन्द्र के प्रधान वैज्ञानिक एवं केन्द्र प्रमुख डा़ मनोज त्रिपाठी ने अपने संबोधन में


सनई अनुसंधान केन्द्र, प्रतापगढ़, उ.प्र. में हिन्दी दिवस के अवसर पर केन्द्र के अधिकारियों/कर्मचारियों को संबोधित करते हुए प्रभारी वैज्ञानिक, डा. मनोज कुमार त्रिपाठी।

हिंदी भाषा के इतिहास, महत्व एवं उपयोगिता पर विचार रखते हुए हिंदी भाषा को अधिकतम सम्मान देने की बात कही। डा. त्रिपाठी ने कहा कि आज हिंदी का स्वरूप काफी व्यापक हो चला है। साहित्य, फिल्म, कला, ज्ञान–विज्ञान व संचार सभी क्षेत्रों में हिंदी ने अपनी महत्ता कायम की है। हिंदी के बिना राष्ट्र व समाज का सर्वांगीण विकास संभव नहीं है क्योंकि यह सम्पूर्ण राष्ट्र को एक सूत्र में बांधती है। इसका प्रयोग करने में हमें गौरान्वित होना चाहिए। उन्होंने अपने

उद्बोधन में स्पष्ट किया कि भारतीय समाज में बहुसंख्य लोग अपनी दैनिक भाषा में हिंदी का प्रयोग करते हैं जिससे यह लोकप्रिय भाषा के रूप में उभर रही है। देश के डिजिटल वर्ल्ड में भी हिंदी सामग्री की मांग तेजी से बढ़ रही है।

इस अवसर पर केन्द्र के वरिष्ठ तकनीकी सहायक श्री देशराज मीणा ने हिंदी के योगदान पर परिचर्चा की, श्री संदीप प्रकाश, सहायक, श्री सुरेन्द्र प्रताप प्रजापति, वरिष्ठ तकनीकी सहायक एवं श्री पारसनाथ पाल ने हिंदी के विकास एवं महत्व पर प्रकाश डाला और अपने विचार व्यक्त किये। हिंदी दिवस कार्यक्रम को सफल बनाने में श्री राम आसरे पाल, जवाहर, राम आसरे यादव, राम नाथ यादव, राम बरन यादव, जोखू एवं रामराज इत्यादि का भी सराहनीय योगदान रहा।

## केन्द्रीय पटसन एवं समवर्गीय रेशा बीज अनुसंधान केन्द्र, बुद बुद, में हिन्दी दिवस का आयोजन

केन्द्र प्रभारी एवं प्रधान वैज्ञानिक, डा. सुब्रत बिश्वास ने केन्द्र के समस्त अधिकारियों एवं कर्मचारियों को संबोधित करते हुए हिन्दी की महता एवं इसकी सहज, सरल एवं बोधगम्य प्रवृति के बारे में सविस्तार


केन्द्रीय पटसन एवं समवर्गीय रेशा बीज अनुसंधान केन्द्र, बुद बुद, में हिन्दी दिवस का आयोजन

चर्चा की तथा कार्यालयीन कार्यों में इसकी अधिकाधिक प्रयोग पर बल दिया। सहायक प्रशासनिक अधिकारी, श्री बी.एन. मुखोपाध्याय ने हिन्दी की प्रासंगिकता पर प्रकाश डालते हुए इसके राजभाषा होने की गौरवशाली इतिहास एवं महत्व को विस्तार पुर्वक साझा किया। उन्होंने हिन्दी को मात्र एक भाषा ही नहीं बल्कि विविधतापूर्ण भारतीय संस्कृति, परम्परा एवं पहचान को बनाये रखने में अहम कड़ी के रूप में स्थापित करते हुए इसके व्यापक प्रयोग एवं प्रसार पर जोर दिया।

## सीसल अनुसंधान केन्द्र, बामरा में हिंदी दिवस का आयोजन

सीसल अनुसंधान केन्द्र, बामरा में दिनांक 14 सितम्बर, 2016 को हिंदी दिवस का आयोजन किया गया। केन्द्र प्रभारी एवं वरिष्ठ वैज्ञानिक


सीसल अनुसंधान केन्द्र, बामरा, ओडिशा में हिन्दी दिवस के अवसर पर केन्द्र के अधिकारियों/कर्मचारियों को संबोधित करते हुए प्रभारी वैज्ञानिक, डा. अजीत कुमार झा

डा. अजीत कुमार झा, ने कार्यक्रम का उद्घाटन किया और राष्ट्रीय भाषा के रूप में हिंदी की भूमिका को रेखांकित किया। उन्होंने केन्द्र के समस्त कर्मचारियों से हिंदी में कार्य करने के लिए आग्रह किया तथा साथ ही यह भी बताया कि हिन्दी में कार्य करने से ही इसके प्रयोग में आने वाली झिझक स्वतः दूर होगी। इस कार्यक्रम में केन्द्र के सभी कर्मचारी एवं टी.एस.सी.एल. ने उत्साहपूर्वक भाग लिया। इस उपलक्ष्य पर केन्द्र में भाषण प्रतियोगिता का आयोजन किया गया जिसका विषय राजभाषा का कार्यालयीन कार्यों में प्रयोग निर्धारित किया गया था।

## रेमी अनुसंधन केन्द्र, सरभोग में हन्दी सप्ताह का आयोजन

रेमी अनुसंधन केन्द्र, सरभोग में दिनांक 14–20 सितम्बर, 2016 के दौरान हिन्दी सप्ताह का आयोजन किया गया। इस कार्यक्रम का उद्घाटन केन्द्र के प्रभारी वैज्ञानिक, डा. अमरप्रीत सिंह ने किया। उन्होंने हिंदी में व्याख्यान दिया तथा केन्द्र के सभी अधिकारियों/कर्मचारियों से हिन्दी में कार्य करने का आह्वान किया।


रेमी अनुसंधान केन्द्र, सरभोग में हिन्दी सप्ताह का आयोजन

# 20. Distinguished Visitors

| Name of the Visitor | Affiliation | Date |
|---|---|---|
| Dr. Trilochan Mohapatra | Secretary, DARE & DG, ICAR, New Delhi | 15 June, 2016 |
| Dr. J. K. Jena | Deputy Director General (Fishery Sciences), ICAR, New Delhi | 15 June, 2016 |
| Dr. G. Trivedi | Former Vice Chancellor, RAU, Bihar | 02 September, 2016 |
| Dr. A.K. Patra | Director, ICAR-IISR, Bhopal | 06 September, 2016 |
| Sh. S.K. Singh | Additional Secretary, ICAR & Financial Advisor, DARE | 09 September, 2016 |
| Dr. Arunava Pattanaik | Director, ICAR-VPKAS, Almora | 26 December, 2016 |
| Dr. C.D. Mayee | Former Chairman, ASRB, New Delhi | 27 December, 2016 |
| Dr. S.K. Biswas | Former Director, DJD, Kolkata | 17 January, 2017 |
| Sh. Radha Mohan Singh | Union Minister of Agriculture and Farmers' Welfare, New Delhi | 13 February, 2017 |
| Dr. A.K. Singh | Deputy Director General (Extension), ICAR, New Delhi | 13 February, 2017 |
| Dr. B. Das | Director, ICAR- CIFRI, Barrackpore | 13 February, 2017 |
| Dr. Gautam Roy | Director, ICAR- NIRJAFT, Kolkata | 13 February, 2017 |
| Prof. R.R. Hanchinal | Chairman, PPV & FR, New Delhi | 14 February, 2017 |
| Dr. A.S. Panwar | Director, ICAR-IIFSR, Modipuram | 22 February, 2017 |
| Dr. R.K. Singh | Assistant Director General (Commercial Crops), ICAR, New Delhi | 10 March, 2017 |


Sh. Radha Mohan SinghJi addressing the CRIJAF Staff members and farmers on the occasion of KVK inauguration

Dr. Trilochan Mohapatra, Secretary, DARE and DG, ICAR visiting the CRIJAF fields

Dr. A.K. Singh, DDG (Extension), ICAR, planting sapling on the occasion of KVK inauguration

Sh. S.K. Singh, Additional Secretary, ICAR & FA, DARE meeting with CRIJAF Scientists

# 21. Staff Position

**Table 21.1 Staff position of ICAR-CRIJAF along with the sub-stations as on 31.03.2017**

| Category | Sanctioned strength | Staff in position | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | CRIJAF (HQ) | CSRSJAF | RRS | SRS | ShRS | |
| Scientist | 74+1 (RMP) | 46 | 01 | 02 | 01 | 01 | 51 |
| Technical | 108 | 34 | 06 | 03 | 03 | 02 | 48 |
| Administrative | 62 | 24 | 01 | 03 | 01 | 02 | 31 |
| SSS | 92 | 11 | 02 | 00 | 01 | 00 | 14 |

**Table 21.2 Staff position at Krishi Vigyan Kendra, Budbud, Burdwan as on 31.03.2017**

| Designation | Sanctioned strength | Persons in position |
|---|---|---|
| Programme Coordinator | 01 | 00 |
| Subject Matter Specialist | 06 | 04 |
| Farm Manager | 01 | 01 |
| Programme Asstt. (Computer) | 01 | 01 |
| Programme Asstt. | 01 | 01 |
| Office Supdt. cum Accountant | 01 | 00 |
| Stenographer | 01 | 00 |
| Driver | 02 | 02 |
| Supporting Staff | 02 | 02 |
| **Total** | **16** | **11** |

# 22. Personnel

## 22.1 Staff in Position

| Name | Designation | E-mail id |
|---|---|---|
| Dr. P.G. Karmakar | Director (upto 31.01.2017) | Pran.Karmakar@icar.gov.in |
| Dr. Jiban Mitra | Director (w.e.f. 01.02.2017) | Jiban.Mitra@icar.gov.in |
| **Division of Crop Improvement** | | |
| Dr. J. Mitra | Pr. Scientist and HoD (Plant Breeding) | Jiban.Mitra@icar.gov.in |
| Dr. A.B. Mandal | Pr. Scientist (Plant Breeding) | Asit.Mandal@icar.gov.in |
| Dr. D. Sarkar | Pr. Scientist (Biotechnology) | Debabrata.Sarkar@icar.gov.in |
| Dr. C.S. Kar | Pr. Scientist (Plant Breeding) | Chandan.Kar@icar.gov.in |
| Dr. S. Datta | Pr. Scientist (Biotechnology) | Subhojit.Datta@icar.gov.in |
| Dr. D. Saha | Pr. Scientist (Biotechnology) | Dipnarayan.Saha@icar.gov.in |
| Dr. P. Satya | Sr. Scientist (Plant Breeding) | Pratik.Satya@icar.gov.in |
| Dr. A.K. Chakraborty | Scientist (Agril. Statistics) | Asim.Chakraborty@icar.gov.in |
| Dr. S.B. Choudhary | Scientist (Plant Breeding) | Shashi.Choudhary@icar.gov.in |
| Dr. Amit Bera | Scientist (Seed Technology) | Amit.Bera@icar.gov.in |
| Dr. H.K. Sharma | Scientist (Plant Breeding) | Hariom.Sharma@icar.gov.in |
| Mr. L.L. Kharbikar | Scientist (Biotechnology) | Lalit.Kharbikar@icar.gov.in |
| Mrs. Kanti Meena | Scientist (Biotechnology) | Kanti.Meena@icar.gov.in |
| Dr. Anil Kumar | Scientist (Plant Breeding) | Anil.Kumar@icar.gov.in |
| Dr. Maruthi R.T. | Scientist (Genetics) | Maruthi.RT@icar.gov.in |
| Mr. B. Ghosh | Technical Officer | Basudeb.Ghosh@icar.gov.in |
| Mr. A. Mukhopadhyay | Technical Officer | Ashim.Mukhopadhyay@icar.gov.in |
| **Division of Crop Production** | | |
| Dr. D.K. Kundu | Pr. Scientist (Soil Science) & I/c, HoD | Dilip.Kundu@icar.gov.in |
| Dr. A.K. Ghorai | Pr. Scientist (Agronomy) | Asesh.Ghorai@icar.gov.in |
| Dr. A.R. Saha | Pr. Scientist (Soil Science) | Amit.Saha@icar.gov.in |
| Dr. B. Majumdar | Pr. Scientist (Soil Science) | Bijan.Majumdar@icar.gov.in |
| Dr. S. Sarkar | Pr. Scientist (Agronomy) | Sitangshu.Sarkar@icar.gov.in |
| Dr. H. Chowdhury | Pr. Scientist (Agril. Chemistry) | Hemanta.Chowdhury@icar.gov.in |
| Dr. P. Bhattacharyya | Pr. Scientist (Soil Science) (upto 05.03.2017) | - |
| Dr. R. Saha | Pr. Scientist (Soil Physics) | Ritesh.Saha@icar.gov.in |
| Dr. M.S. Behera | Sr. Scientist (Agronomy) | Madhusudan.Behera@icar.gov.in |
| Dr. A.K. Singh | Sr. Scientist (Soil Science) | Arvind.Singh3@icar.gov.in |
| Dr. S.P. Mazumdar | Scientist (Soil Science) | Sonali.Majumdar@icar.gov.in |
| Dr. D. Barman | Scientist (Soil Physics) | Dhananjay.Barman@icar.gov.in |
| Dr. Mukesh Kumar | Scientist (Agronomy) | Mukesh.Kumar2@icar.gov.in |
| Dr. R.K. Naik | Sr. Scientist (FMP) | Ranjan.Naik@icar.gov.in |
| Mr. M. Ramesh Naik | Scientist (Agronomy) (on study leave from 08.08.2016) | M.Naik@icar.gov.in |
| Mr. Suman Roy | Scientist (Plant Physiology) w.e.f. 14.03.2017 | Suman.Roy@icar.gov.in |
| Mrs. Laxmi Sharma | Scientist (Plant Physiology) w.e.f. 21.11.2016 | Laxmi.Sharma@icar.gov.in |
| Mr. G.G. Basu | Technical Officer | Gobinda.Basu@icar.gov.in |
| Mr. Sk. Phirose | Technical Officer | Sk.Phirose@icar.gov.in |
| Smt. Gita Das | Technical Officer (upto 30.11.2016) | Gita.Das@icar.gov.in |
| Mr. D.K. Patra | Technical Officer | Dilip.Patra@icar.gov.in |

| | | |
|---|---|---|
| **Division of Crop Protection** | | |
| Dr. S. Satpathy | Pr. Scientist (Entomology) & HoD | Subrata.Satpathy@icar.gov.in |
| Dr. R.K. De | Pr. Scientist (Plant Pathology) | Rajib.De@icar.gov.in |
| Dr. S. Biswas | Pr. Scientist (Plant Pathology) (w.e.f. 01.03.2017) | Subrata.Biswas@icar.gov.in |
| Dr. K. Mandal | Pr. Scientist (Plant Pathology) | Kunal.Mandal@icar.gov.in |
| Dr. S.K. Sarkar | Pr. Scientist (Plant Pathology) | Surja.Sarkar@icar.gov.in |
| Dr. C. Biswas | Pr. Scientist (Plant Pathology) | Chinmay.Biswas@icar.gov.in |
| Dr. B.S. Gotyal | Scientist (Entomology) | Bheemanna.Gotyal@icar.gov.in |
| Dr. K. Selvaraj | Scientist (Entomology) (upto 10.06.2016) | K.Selvaraj@icar.gov.in |
| Dr. V. Ramesh Babu | Scientist (Entomology) | Veegala.Babu@icar.gov.in |
| Mr. P.N. Meena | Scientist (Plant Pathology) (on study leave from 01.01.2017) | Prabhu.Meena@icar.gov.in |
| Mr. K.P. Debnath | Technical Officer | Kalipada.Debnath@icar.gov.in |
| Mr. P.K. Biswas | Technical Officer | Pabitra.Biswas@icar.gov.in |
| **Agricultural Extension Section** | | |
| Dr. S. Sarkar | Pr. Scientist (Agronomy) & I/c | Sitangshu.Sarkar@icar.gov.in |
| Dr. S.K. Jha | Pr. Scientist (Agril. Extension) | Suniti.Jha@icar.gov.in |
| Dr. S. Kumar | Sr. Scientist (Agril. Extension) | Shailesh.Kumar@icar.gov.in |
| Dr. Shamna A. | Scientist (Agril. Extension) | Shamna.A@icar.gov.in |
| Dr. Manik Lal Roy | Scientist (Agril. Extension) (w.e.f. 12.09.2016) | Manik.roy@icar.gov.in |
| **Agricultural Meteorology Unit** | | |
| Dr. D. Barman | Scientist (Soil Physics) & I/c | Dhananjay.Barman@icar.gov.in |
| Mr. S. Sarkar | Technical Officer | Sudhir.Sarkar@icar.gov.in |
| **All India Network Project on Jute and Allied Fibres** | | |
| Dr. S. Mitra | Pr. Scientist (Agronomy) & I/c | Sabyasachi.Mitra@icar.gov.in |
| Dr. S.K. Pandey | Sr. Scientist (Plant Breeding) | Surendra.Pandey@icar.gov.in |
| **Agricultural Knowledge Management Unit** | | |
| Dr. C.S. Kar | Pr. Scientist (Plant Breeding) & I/c | Chandan.Kar@icar.gov.in |
| Mr. N. Paul | Asst. Chief Technical Officer | Nilanjan.Paul@icar.gov.in |
| **Prioritization, Monitoring and Evaluation Cell** | | |
| Dr. S.K. Sarkar | Pr. Scientist (Plant Pathology) & I/c | Surja.Sarkar@icar.gov.in |
| Dr. B. Majumdar | Pr. Scientist (Soil Science) | Bijan.Majumdar@icar.gov.in |
| Dr. P. Bhattacharyya | Pr. Scientist (Soil Science) (upto 05.03.2107) | |
| Dr. S. Datta | Pr. Scientist (Biotechnology) | Subhojit.Datta@icar.gov.in |
| Dr. H.K. Sharma | Scientist (Plant Breeding) | Hariom.Sharma@icar.gov.in |
| Mr. N. Paul | Asst. Chief Technical Officer | Nilanjan.Paul@icar.gov.in |
| **IPR & Institute Technology Management Unit** | | |
| Dr. S.K. Sarkar | Pr. Scientist (Plant Pathology) & I/c | Surja.Sarkar@icar.gov.in |
| **Ramie Research Station, Sorbhog, Assam** | | |
| Dr. Amarpreet Singh | Scientist (Agronomy) & I/c | Amarpreet.Singh@icar.gov.in |
| Mr. Monu Kumar | Scientist (Plant Breeding) (on study leave from 14.11.2016) | Monu.Kumar@icar.gov.in |
| Mr. B. Ramchiary | Technical Officer | Birbal.Ramchiary@icar.gov.in |
| Mr. M.K. Das | Technical Officer | Munindra.Das@icar.gov.in |
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| Dr. A.R. Panda | Pr. Scientist (Plant Breeding) (upto 31.05.2016) | |

| | | |
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| **Results Framework Document Cell** | | |
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| Dr. S.K. Sarkar | Pr. Scientist (Plant Pathology) | Surja.Sarkar@icar.gov.in |
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| Mr. S. Sarkar | Technical officer | Sudhir.Sarkar@icar.gov.in |
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| Dr. P. Satya | Sr. Scientist (Plant Breeding) | Pratik.Satya@icar.gov.in |

## 22.2 Promotion

| Name | Designation | Promoted to | w. e. f. |
|---|---|---|---|
| Sh. Susanta Dey | Steno Gr. III | PA | 09.08.2016 |
| Smt. Neena Mandal | Steno Gr. III | PA | 09.08.2016 |
| Sh. Subrata Kumar Pal | Assistant | AAO | 26.10.2016 |
| Sh. Tridib Ghosh | UDC | Assistant | 31.01.2017 (A/N) |
| Sh. Soumya Roy | UDC | Assistant | 31.01.2017 (A/N) |

## 22.3 Superannuation

| Name | Designation | Date of Retirement | Place of Posting |
|---|---|---|---|
| Sh. Manik Lal Sur | SSS | 30.04.2016 | Barrackpore |
| Dr. A. R. Panda | Pr. Scientist (Plant Breeding) | 31.05.2016 | Bamra |
| Sh. Avadh Narayan Dwivedi | Technician (T-1) | 30.06.2016 | Pratapgrah |
| Sh. Sukumar Jana | SSS | 30.06.2016 | Barrackpore |
| Sh. Chandra Kishan | SSS | 30.09.2016 | Bamra |
| Sh. Manik Sikdar | SSS | 31.10.2016 | Barrackpore |
| Smt. Gita Das | TO | 30.11.2016 | Barrackpore |
| Sh. Sunil Kumar Bhadra | TO | 30.11.2016 | Barrackpore |
| Sh. Naba Kumar Das | SSS | 31.12.2016 | Barrackpore |
| Dr. P. G. Karmakar | Director | 31.01.2017 | Barrackpore |
| Sh. Haru Khara | SSS | 31.01.2017 | Barrackpore |
| Sh. Sentu Sarkar | SSS | 28.02.2017 | Barrackpore |

# 23. Financial Statement and Revenue Generation

The budget and expenditure during 2016-17 including the regional stations under plan and non-plan was Rs 313.95 lakh and 2397.98 lakh respectively (Table 23.1.). The budget and expenditure with respect to AINPJAF, TMJ and KVK is given in Table 23.2. Revenue generation at the HQ and the sub-stations was Rs 36.12 lakh. The statement of revenue generation at ICAR-CRIJAF Barrackpore; CSRSJAF, Budbud; Ramie Research Station Sorbhog; Sisal Research Station, Bamra and Sunnhemp Research Station, Pratapgarh are presented in the Table 23.3.

**Table 23.1 Financial statement of ICAR-CRIJAF for the year 2016-17**

(Rs in Lakhs)

| Sub-Head | Non Plan R.E. 2016-17 | Non Plan Expenditure upto 31-03-2017 | Plan R.E. 2016-17 | Plan Expenditure upto 31-03-2017 |
|---|---|---|---|---|
| Establishment Charges | 1465.00 | 1462.74 | 0.00 | 0.00 |
| Wages | 344.00 | 341.86 | 0.00 | 0.00 |
| Retirement Benefit | 290.00 | 288.43 | 0.00 | 0.00 |
| O.T.A. | 0.20 | 0.11 | 0.00 | 0.00 |
| T.A. | 8.00 | 8.00 | 16.10 | 16.05 |
| Loans & Advances | 20.00 | 5.39 | 0.00 | 0.00 |
| Other Charges | 196.80 | 183.26 | 266.35 | 265.27 |
| **Works-Maintenance** | | | | |
| a) Residential | 30.00 | 29.13 | 0.00 | 0.00 |
| b) Non Residential | 45.00 | 44.89 | 0.00 | 0.00 |
| c) Equipment & others | 14.00 | 13.98 | 0.00 | 0.00 |
| d) Minor Works | 15.00 | 14.98 | 0.00 | 0.00 |
| Major Works | 0.00 | 0.00 | 13.00 | 8.20 |
| H.R.D | 0.00 | 0.00 | 2.55 | 2.44 |
| Equipment | 4.00 | 3.94 | 17.39 | 17.38 |
| Vehicle | 0.00 | 0.00 | 0.00 | 0.00 |
| Information Technology | 0.00 | 0.00 | 4.61 | 4.61 |
| Furniture | 3.00 | 1.27 | 0.00 | 0.00 |
| Library Books & Journals | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | **2435.00** | **2397.98** | **320.00** | **313.95** |

**Table 23.2 Financial statement for AINP on Jute & Allied Fibres, Technology Mission on Jute and KVKs for the year 2016-17**

(Rs in Lakhs)

| Head | Target | Achievement (Upto 31-03-2017) |
|---|---|---|
| A.I.C.R.P on J & AF | 232.00 | 229.11 |
| T.M.J. | 70.00 | 67.04 |
| K.V.K - Burdwan | 120.00 | 111.96 |
| K.V.K- North 24 Parganas | 20.46 | 9.65 |

**Table 23.3 Revenue generated at ICAR-CRIJAF and its sub-stations**

(Rs in Lakhs)

| Institute/ Sub-stations | Total Revenue |
|---|---|
| CRIJAF (H.Q.) | 17.91 |
| CSRSJAF, Bud Bud | 7.94 |
| Ramie Research Station, Sorbhog | 0.43 |
| Sisal Research Station, Bamra | 8.75 |
| Sunnhemp Research Station, Pratapgargh | 1.09 |
| **Total** | **36.12** |

# 24. Agricultural Meteorology

**Table 24.1 Meteorological data of ICAR-CRIJAF, Barrackpore, West Bengal**

| Month | Air temperature (˚C) | | RH (%) | | Rainfall (mm) | Rainy days | Bright sunshine (hrs) | Pan evaporation (mm/day) | Wind Speed (km/hr) | Soil temperature (°C) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 0636 IST | | | 1336 IST | | |
| | Max | Min | Max | Min | | | | | | 5 cm | 15 cm | 30 cm | 5 cm | 15 cm | 30 cm |
| Apr-16 | 38.4 | 26.5 | 87.2 | 50.9 | 0.0 | - | 7.3 | 6.0 | 3.7 | 30.8 | 33.0 | 34.5 | 44.6 | 39.4 | 34.7 |
| May-16 | 35.5 | 24.6 | 87.2 | 62.7 | 203.4 | 8 | 6.3 | 4.6 | 3.3 | 27.8 | 30.5 | 32.4 | 40.7 | 36.4 | 32.8 |
| Jun-16 | 34.4 | 26.1 | 90.1 | 73.5 | 192.8 | 9 | 5.0 | 3.7 | 1.9 | 29.2 | 30.2 | 31.8 | 37.2 | 34.7 | 31.7 |
| Jul-16 | 31.9 | 25.7 | 94.0 | 82.9 | 392.8 | 17 | 2.1 | 2.2 | 2.0 | 28.3 | 28.7 | 29.6 | 32.2 | 30.9 | 29.7 |
| Aug-16 | 31.7 | 25.6 | 95.1 | 81.6 | 356.4 | 18 | 3.4 | 2.4 | 2.0 | 27.9 | 28.5 | 29.1 | 33.8 | 31.3 | 29.2 |
| Sep-16 | 32.5 | 25.3 | 93.8 | 81.7 | 351.4 | 18 | 3.9 | 2.4 | 1.3 | 28.2 | 28.6 | 29.3 | 34.5 | 32.1 | 29.5 |
| Oct-16 | 32.0 | 22.9 | 94.6 | 73.9 | 103.6 | 5 | 6.2 | 2.8 | 1.2 | 25.4 | 26.6 | 28.2 | 33.9 | 30.6 | 28.5 |
| Nov-16 | 29.2 | 17.0 | 96.5 | 68.9 | 20.2 | 2 | 5.9 | 1.9 | 0.8 | 19.5 | 21.5 | 23.8 | 30.1 | 25.7 | 24.1 |
| Dec-16 | 26.1 | 13.4 | 97.3 | 66.0 | 0.0 | - | 5.8 | 1.6 | 1.3 | 15.2 | 17.8 | 20.2 | 27.0 | 21.8 | 20.3 |
| Jan-17 | 25.4 | 11.3 | 97.0 | 55.3 | 0.0 | - | 6.8 | 2.1 | 1.8 | 14.2 | 17.3 | 19.8 | 27.6 | 21.4 | 19.9 |
| Feb-17 | 29.3 | 15.3 | 95.5 | 58.6 | 0.0 | - | 6.6 | 2.7 | 1.8 | 16.4 | 21.4 | 23.3 | 32.7 | 25.8 | 23.5 |
| Mar-17 | 32.0 | 20.4 | 95.0 | 62.3 | 27.4 | 2 | 6.5 | 3.8 | 2.9 | 23.4 | 25.3 | 26.7 | 35.7 | 29.7 | 27.7 |

*(Source: Agricultural Meteorology Unit, CRIJAF, Barrackpore. Contributor: D. Barman and Sudhir Sarkar)*

**Table 24.2 Meteorological data of Sisal Research Station, Bamra, Odisha**

| Month | Air temperature (˚C) | | | Relative Humidity (%) | | | Rainfall (mm) | No. of rainy days |
|---|---|---|---|---|---|---|---|---|
| | Max | Min | Mean | 0653 IST | 1353 IST | Mean | | |
| April-16 | 43.7 | 22.2 | 32.9 | 50 | 19 | 34.5 | 00 | 0 |
| May-16 | 41.3 | 22.6 | 31.9 | 60 | 31 | 45.5 | 39.6 | 8 |
| June-16 | 39.3 | 24.3 | 31.8 | 76 | 37.5 | 56.8 | 66.4 | 9 |
| July-16 | 30.3 | 22.6 | 26.5 | 88 | 72.2 | 80.1 | 393.2 | 16 |
| Aug-16 | 30.2 | 23.4 | 26.8 | 88.5 | 76 | 82.3 | 267.8 | 24 |
| Sept-16 | 31.8 | 22.8 | 27.3 | 85.5 | 66.5 | 76 | 171.4 | 18 |
| Oct-16 | 32.8 | 17.9 | 25.4 | 80 | 48 | 64 | 18.6 | 3 |
| Nov-16 | 29.7 | 10.2 | 19.9 | 81 | 38 | 59.5 | 00 | 0 |
| Dec-16 | 27.6 | 9.7 | 18.7 | 81 | 45 | 63 | 00 | 0 |
| Jan-17 | 28.2 | 11.3 | 19.8 | 85 | 44 | 64.5 | 00 | 0 |
| Feb-17 | 32.7 | 16.9 | 24.8 | 86 | 30 | 58 | 00 | 0 |
| Mar-17 | 35.3 | 16.6 | 25.9 | 84 | 25 | - | 4.0 | 1 |

*(Source: SRS, Bamra. Contributor: A.K. Jha)*

**Table 24.3 Meteorological data of Sunnhemp Research Station, Pratapgarh, Uttar Pradesh**

| Month | Air temperature (˚C) | | Relative Humidity (%) | | Rainfall (mm) | No. of rainy days |
|---|---|---|---|---|---|---|
| | Max | Min | Morning | Afternoon | | |
| April-16 | 41.33 | 23.60 | 61.10 | 32.56 | 0.0 | 0.0 |
| May-16 | 38.92 | 25.80 | 70.06 | 39.71 | 67.8 | 5 |
| June-16 | 38.13 | 28.64 | 74.27 | 51.90 | 62.2 | 2 |
| July-16 | 32.15 | 26.33 | 90.16 | 77.55 | 458.6 | 14 |
| Aug-16 | 32.52 | 25.93 | 90.81 | 73.52 | 330.9 | 19 |
| Sep-16 | 32.51 | 25.02 | 91.56 | 73.17 | 112.0 | 11 |
| Oct-16 | 33.41 | 20.20 | 89.91 | 54.84 | 4.0 | 1 |
| Nov-16 | 29.15 | 11.89 | 84.40 | 46.36 | NIL | NIL |
| Dec-16 | 21.14 | 10.14 | 94.32 | 69.25 | NIL | NIL |
| Jan-17 | 21.78 | 8.95 | 90.32 | 55.88 | 3.0 | 2 |
| Feb-17 | 27.00 | 11.10 | 82.75 | 42.61 | NIL | NIL |
| Mar-17 | 32.54 | 16.03 | 69.78 | 42.71 | 1.0 | 1 |

*(Source: ShRS, Pratapgarh. Contributor: M.K. Tripathi)*

# Notes