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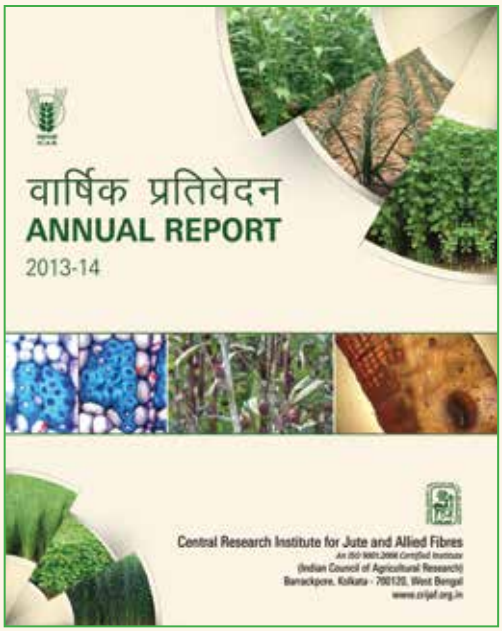

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Back cover: From left to right: CRIJAF retting consortium, Jute stem rot disease development, Demonstration of improved jute retting

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Contents

Preface

The Central Research Institute for Jute and Allied Fibres (CRIJAF), a premier crop research institute of the Indian Council of Agricultural Research (ICAR), is the only institute in the country engaged in developing and promoting technologies to improve production and quality of jute and allied fibre crops. Although the jute and allied fibre sector has been immensely benefitted from the research outcome of this institute, changing climate and increasing cost of cultivation have posed new challenges before CRIJAF. To meet these challenges this institute has reoriented the research activities on this group of bast fibre crops. In the backdrop of recent climate change scenario, the germplasm evaluation programme has put emphasis on imparting resistance against specific stresses. In the field screening, the accession, OIJ 257 (KEN/DS/054C) has shown resistance to pre-mature flowering and 20 olitorius accessions were found to be moderately tolerant to drought. In order to construct high-density genetic maps of *Corchorus olitorius*, phenotyping of mapping population was carried out for a large number of morphological traits including flowering time. Mitochondrial and chloroplast loci polymorphism were studied at nine mitochondrial loci and one chloroplast locus (ALC_1-3) in 60 mutant lines of *C. olitorius*. Three distinct mitochondrial mutants of *C. olitorius* have been identified.

The institute has developed the first fibre flax variety (JRF 2). Besides that, 5 new varieties of jute and allied fibre crops *viz.*, one variety each in *tossa* jute (JROG 1), kenaf (JBMG 4), sunnhemp (JR 610) and two varieties of roselle (CRIJAFR 2 and CRIJAFR 8) have been identified for release during the 11th Annual Group Meeting of AINP on J&AF.

Extraction and retting are two vital processes for production of quality fibres. CRIJAF has developed an improved portable ramie and sisal fibre extractor with 55-60% more fibre extraction efficiency than existing 'raspador' decorticator. The improved microbial consortium mediated retting technology of the Institute with use of talc based formulation "CRIJAF SONA" was extensively demonstrated in 7 districts of West Bengal, Nagaon district of Assam, Katihar and Purnea districts of Bihar, Srikakulam district of Andhra Pradesh and Bahraich district of Uttar Pradesh. Six efficient pectinolytic isolates were screened out for microbial de-gunmming of ramie and a combination of S16 and S11 strains (1:1 v/v) was found most promising.

Towards promoting improved varieties of jute, 98.91 q certified seed of newly released varieties *viz.*, JRO 204, JRO 128, S 19, Ira and JRO 8432 was produced by the institute through specially developed package of practices in drier tracts of West Bengal and distributed through State Govt. to cover 1975 ha area. About 700 farmers were trained during the year on quality seed production in jute.

The targeted yields of jute fibre (4 t/ha) and rice (5 t/ha) were achieved with deviation of (-) 7.5% and (-) 2.8%, respectively when fertilizers were applied on the basis of soil test in farmers fields.

In pest and disease management research, emphasis were given on insect ecological studies, disease diagnostics, host plant resistance and biocontrol. The basis of resistance to Bihar hairy caterpillar through ovipositional and feeding preference studies was established. The economic injury levels (EILs) in jute were developed using single as well as multi-species damage functions at different stages. The parasitoids associated with mealybug in jute and mesta ecosystem were identified as *Aenasius bambawalei* and *Promuscidea unfasciativentris.* A multiple PCR-based method was standardized and developed for tracing *B. bassiana* from soil as well as plant foliage. Very precise, simple and repetitive stem rot disease inoculation technology was standardised to enhance the precision in disease screening.

ICT based extension services were prioritised for the jute farmers and Jute Expert System and Mobile Advisory Service have been initiated. Expansion of area under ramie and sisal cultivation, demonstration of jute seed production, improved fibre production technology, capacity building on improved cultivation of jute, ramie and sisal were implemented through Tribal Sub Plan programme as livelihood support to the tribal farmers of West Bengal, Odisha and NE states.

I acknowledge the efforts of the scientists of CRIJAF who have done a commendable job to accomplish the volume of research and documentation work successfully. I am grateful to Dr. S. Ayyappan, Hon'ble Director General, ICAR for his leadership and direction. I express my sincere gratitude and thanks to Prof. S. K. Datta, Deputy Director General (Crop Science), Dr. N. Gopalakrishnan, Assistant Director General (Commercial Crops), Indian Council of Agricultural Research, New Delhi for their constant encouragement and support.

P. G. Karmakar
27/06/14

Place: Barrackpore
Date: 27. 06. 2014

(P. G. Karmakar)
Director

Executive Summary

Crop Improvement

- A total of 12 accessions of jute and allied fibre (JAF) crops and wild species i.e., *C. aestuans* (02) *Crotalaria* spp. (02), *Hibiscus sabdariffa* (02), *Urena* spp. (02), *Boehmeria* spp. (04) have been collected; 600 accessions of *H. sabdariffa* and 228 new collections of JAF crops have been regenerated; 543 accessions of JAF crops *i.e. Corchorus* spp. (137), *Hibiscus* spp. (22), *Linum* spp. (127), *Crotalaria juncea* (145), *Boehmeria* spp. (102), *Urena* spp. (10) have been evaluated using different morpho-metirc traits and 1706 germplasm accessions of JAF crops have been distributed to indenters of different institutes.
- In *tossa* jute, 21 F_1s along with seven parents were evaluated for fibre yield and attributing characters. Significant positive *sca* effects for fibre weight was recorded by cross OMU 19 × OMU 27 and OIN 255 × OEX 32. Maximum standard heterosis (41.01 %) was observed in cross OMU 19 × OMU 27.
- Mitochondrial and chloroplast loci polymorphism were studied at nine mitochondrial loci and one chloroplast locus (ALC_1-3) in 60 mutant lines of *C. olitorius*. Three distinct mitochondrial mutants of *C. olitorius* have been identified.
- For genetic analysis of resistance to stem rot disease in jute, 202 RILs were screened for *Macrophomina phaseolina* disease reaction. Analysis of variance revealed significant difference among RILs for disease incidence. At seedling stage, 29.7% of the population expressed resistance reaction.
- Large scale phenomics of fibre anatomy has been completed in 58 mutant genotypes of *C. olitorius* to identify suitable parental combination for development of mapping population.
- Parental polymorphism has been studied in *C. capsularis* using 50 SSR markers, of which 18 were found to be polymorphic.
- In white jute, a total of 20 selected families (F_7 generation) derived from 30 crosses were evaluated and 10 superior lines were selected.
- A total of 180 *C. olitorius* germplasm comprising mostly of African accession along with cultivated check varieties JRO 632 (premature flowering susceptible) and JRO 524, JRO 204, JRO 128, JRO 8432 and JBO I (premature flowering resistance) were evaluated during *kharif* 2013. Only one accession OIJ 257 (KEN/DS/054C) did not flower upto 63 DAS.
- Based on screening of 600 *C. olitorius* germplasm accession under field condition and through poly ethylene glycol treatment, 20 accessions were found to be moderately tolerant to drought.
- One new *tossa* jute (*C. olitorius*) variety CO 58 (Sourav) was tested for second growing cycle along with reference varieties under DUS testing at CRIJAF, Barrackpore and CSRSJAF, Budbud. Candidate variety CO 58 was found to be distinct for leaf shape.
- Under field screening for YVMV resistance in kenaf, single plant progenies derived from crosses KIJ 275 x AMC 108, KIJ 281 x AMC 108 and KIJ 31 x MT 150 showed complete resistance to YVMV.
- In roselle, 63 promising individual plant progenies from F_3 generations were selected based on plant height and basal diameter. A total of 36 new F_1s were evaluated along with their parents for fibre yield and attributing traits and observed that F_1 means for different traits were higher than parental means.
- Unlike other lines, the ramie accession (R 1416), observed to develop only female flowers at 60 days crop stage during 1st week of February while the same accessions showed normal behaviour of male and female flowering during August-September.
- The primary constituents of decorticated ramie fibre were determined in R 1411, and noticed that fibre contained 96.1% holocellulose, (of which 88.15% alpha-cellulose), 23.15% gum, 7.9% hemicellulose and 2.3% pectin.
- Floral studies of sunnhemp revealed that it bears terminal raceme inflorescence with indeterminate growth habit. Androecium exhibits anther dimorphism or hetero-anthery condition.

Seed Science and Technology

- In jute, the application of 50 kg K_2O/ha and 45 kg S/ha enhanced the number of the branches per pod, plant height, pod length, number of pods per plant and seed yield to maximum extent.
- For enhancing the seed replacement in jute, 98.91 q certified seed of newly released varieties (JRO 204, JRO 128, S 19, Ira and JRO 8432) was produced in drier tracts of West Bengal.
- During *kharif*, 2013-14, 18.54 q breeder seed of jute has been produced as per DAC indent under National Seed Project. About 511.84 q seeds of jute, sunnhemp, mesta, dhaincha, paddy, wheat and mustard have been produced during *kharif*, 2013 under ICAR Seed Project. Planting materials of ramie (50 q rhizome) and sisal (76,170 bulbils) have also been produced through this project. To create awareness regarding quality seed and jute seed production, about 700 farmers were involved in various training programmes (Seed Days, Review Meetings and Farmers' Training).

Biotechnology

- RNA sequence based bast fibre transcriptome was developed in *C. capsularis* by using cultivar JRC 212 and a lignified secondary phloem fibre-deficient (*dlpf*) mutant. A total of 1,747 genes were differentially expressed between JRC 212 and *dlpf*, out of which 348 were up-regulated and 1,399 were down-regulated in *dlpf* as compared to JRC 212. Real-time PCR was carried out for relative quantification of 19 target genes in shikimate, aromatic amino acids and phenylpropanoid biosynthetic pathways; regulating lignin biosynthesis in bast fibre tissues of jute.
- In order to construct high-density genetic maps of *Corchorus olitorius*, phenotyping of mapping population has been carried out for a large number of morphological traits including flowering time.
- Multiple shoot regeneration was achieved by using cotyledonary leaf explant from white jute (*C. capsularis)* varieties JRC 321 and JRC 517 on MS media containing 5.4 μM NAA, 0.5 μM IBA with 8.9 μM 6-BAP. An efficient and long-term somatic embryogenesis protocol with moderate plantlet regeneration was developed in jute from *in vitro* derived leaf explants.
- Histological analysis indicates that somatic embryos were initiated directly from the pericycle layers of explants as early as on 10th day in liquid culture. Genotype did not affect the frequency and number of somatic embryo formation.

Soil Health and Nutrient Management

- In long term fertilizer experiment, yield of jute, rice and wheat ranged from 1.6 t/ha to 3.4 t/ha, 2.5 t/ha to 4.7 t/ha and 1.2 t/ha to 5.2 t/ha respectively under different treatments with maximum yield and uptake in 150% NPK. The highest SYI (sustainable yield index) values of 0.45, 0.41 and 0.40 respectively for jute, rice and wheat were obtained with 150% NPK treatment. There was reduction in DTPA-extractable Zn, Fe and Mn in soil over initial value in all the treatments and maximum DTPA-extractable micronutrients were recorded in NPK+FYM treatment.
- The multi-locational follow up trials on jute (JRO 204), rice (NDR-97) and garden pea (Azad P-3) recorded the highest yield, net profit and B: C ratio under ST-TY + FYM @ 5 t/ha over RDF and farmers practice for various yield targets.
- The targeted yield of jute fibre (4 t/ha) and rice (5 t/ha) were achieved with yield deviation of (-) 7.5% and (-) 2.8% respectively in ST-TY treatment. Integrated application of FYM, *Azotobacter* and PSB with inorganic fertilizer (ST-TY) increased the agronomic efficiency of P & K fertilizers over RDF for jute and rice. Integrated application of fertilizers as per ST-TY with FYM significantly increased the enzymatic activity.
- Phosphorous distribution in the soils of jute-rice-wheat cropping sequence in long term basis indicates maximum build-up of Ca-P, Al-P and saloid-P fractions under the NPK+FYM treatment, while that of the Fe-P was maximum with 150% NPK treatment. All the P fractions in surface soil together contributed 76% towards grain yield of wheat.
- The jute varieties/cultivars JRO 204, JRO 524, Tanganyika 1, S 19 and JRO 8432 showed higher nitrogen use efficiency on the basis of total dry matter (TDM) and chlorophyll content.

Crop Husbandry

- The jute fibre productivity was maximum in jute-rice-baby corn-jute (leafy vegetable) sequence and least in jute-rice-wheat sequence. Wheat crop residue incorporation significantly reduced the fibre yield with both 75% and 100% recommended dose of fertilizer compared to corn and garden pea residue incorporation in jute-rice-baby corn-jute (leafy vegetable) and jute-rice-garden pea, respectively.

- Open furrow sowing of jute followed by one irrigation reduced the irrigation requirement by 40 % and produced 33.8 q fibre /ha which was 2.6 q/ha higher over traditional flat bed method of sowing. One flood irrigation followed by soil mulching (at field capacity) by CRIJAF nail weeder produced 34.8 q jute fibre /ha and is 3.6 q/ha higher over traditional flood irrigation system.

- Rainfed open furrow sowing of roselle produced 27.8 q fibre /ha which is 1.5 q higher over traditional flat bed sowing. Soil mulching using CRIJAF nail weeder with one flood irrigation could able to produce 30.4 q fibre /ha and it was 4.0 q/ha higher over traditional rainfed system.

- Legume intercrops like pigeon pea, cow pea and green gram between the double row sisal plantation recorded sisal equivalent yield of 492 kg/ha, 391 kg/ha and 384 kg/ha respectively, compared to 311 kg/ha in sole sisal plantation.

- Drip irrigation @ 4 l/hr per plant for 4 hrs at 2 weeks interval and soil application of zinc sulphate @ 20 kg/ha together with borax @ 15 kg/ha produced the longest (85.0 cm) and maximum number of leaves (1, 50,266 leaves/ha) with highest fibre yield (1.10 t/ha).

- The residual effect of sunnhemp as green manure applied before rice crop was assessed to the tune of 30 kg N/ha on succeeding wheat crop.

- The application both phosphorus and potassium @ 40 kg/ha recorded 16.7 q/ha and 15.6 q/ha, flax fibre yield, respectively, which was significantly higher than control and 20 kg/ha.

Biotic and Abiotic Stresses

- The capsularis germplasms i.e. CIN 464, CIN 562 and CIN 13 were least susceptible to semilooper (2.94%), stem weevil (3.31%) and Bihar hairy caterpillar (BHC) (4.45%) respectively. In case of *olitorius* germplasm, OIJ 052, OIN 405 and OIN 470 suffered least from yellow mite.

- Comparative feeding preference by Bihar hairy caterpillar (BHC) among cultivated and wild species was very contrasting which varied from 7.00-28.33% in wild species including *C. aestuans*, *C. tridens*, *C. pseudo-olitorius*, and *C. fascicularis* compared to 81.66% for *C. olitorius*.

- High degree of ovipositional preference by BHC was observed from *C. olitorius* with 3.66±o.33 mean egg mass which was significantly less in *C. tridens* and *C. aestuans* indicating non-preference for egg laying. Later on larval survival in these two species was also very low.

- Protein content had significant positive correlation on larval survival (%), larval weight, pupation and adult emergence (%) of *S. obliqua*. Polyphenol oxidase and total phenol recorded negative effect on survival, growth, pupation and adult emergence.

- Early instars (up to third instars) of *S. obliqua* are more vulnerable to the density dependent mortality factors. Two braconid larval parasitoids, *Meteorus spilosomae* Narendran & Rama and *Protapanteles obliquae* (Wilkinson) were the key mortality factors with the K-value of 0.18 whereas in late instars, mortality due to virus was more with 0.21 K-value. The generation survival was 0.39. The population of *S. obliqua* has been predicted to be much higher in the ensuing generation as trend index was positive.

- Leaf dip bioassay of new insecticides, flubendiamide 480 EC, emamectin benzoate 5 SG, chlorantraniliprole 18.5 SC, lamda cyhalothrin 5 EC and profenophos 50 EC singly and in combinations against third instar larvae of *S. obliqua* recorded least LC_{50} value of flubendiamide LC_{50} + lamda cyhalothrin LC_{50}. This combination also proved promising under field condition with

85.22% reduction in *S. obliqua* infestation and yielded maximum fibre (36.17q/ha).

- Single as well as multiple species economic injury levels (EILs) were developed using multi-species damage functions at different stages. The EILs were determined during the crop stage at which both the pests significantly affected the yield. Individual EIL for yellow mite and lepidopteran pests were 45 mites/cm^2 area on second unfolded leaf and 5% plant damage respectively.
- Developmental thresholds of *S. obliqua* were determined to be 10.57, 11.27, 11.55, 15.28 and 10.92°C for egg, small larva (1-3rd instar), large larva (4-5th instar), pupa, and adult respectively with corresponding thermal constant being 52.91, 344.82, 243.90, 142.85 and 70.42 degree days (DD).
- Preliminary bioassay with a commercial formulation of *Bt var. kurstaki* against 5-day old larvae of Bihar hairy caterpillar, *S. obliqua*, indicated the lethal concentration to be 0.74 and 0.36gm/l at 24hrs and 48hrs, respectively.
- The effect of different endophytic strain of *Beauveria bassiana* was prominent in suppressing the stem weevil infestation in jute. The lowest infestation of 18.13% and 19.18% were recorded in ITCC 6551 and ITCC 4668 treated plots respectively compared to 70.14% in the untreated check.
- Seed treatment of mesta with thiamethoxam 70 WS and chlorpyriphos 20 EC suppressed plant infestation caused by spiral borer, *Agrilus acutus* significantly by 50%.
- On the basis of settlement and survival of mealybug crawler in the host plant, *Hibiscus* sp. (unidentified wild species) was least susceptible while *H. acetocella* was most susceptible.
- The parasitoids associated with mealybug in jute and mesta ecosystem were identified as *Aenasius bambawalei* Hayat (Chalcidodea: Encyrtidae) and *Promuscidea unfasciativentris* Girault (Chalcidodea: Aphelinidae). The later was found to be hyperparasitoid on the encyrtid. This was the first record of the parasitoids in jute and mesta ecosystem in West Bengal.
- The effect of different dosages of nitrogen, phosphate and potashic fertilizers on the incidence of stem rot caused by *Macrophomina phaseolina* in jute indicated that application of high doses of nitrogenous fertilizer enhanced stem rot of jute while P and K moderated the disease incidence.
- Tebuconazole 25.9 EC, carbendazim 50 WP, hexaconazole 5 EC, tricyclazole 75 WP, copper oxychloride 50 WP, propiconazole 25 EC and mancozeb 75 WP were equally effective against stem rot incidence. However, carbendazim 50 WP and tebuconazole 25.9 EC not only managed the stem rot of jute effectively but also decreased the build-up of disease over the crop growth period drastically.
- The elite *olitorius* jute lines OIN 853, JRC 80 and OIN 651 had least stem rot incidence under challenged inoculation in the developing sick plot.
- Stem rot incidence in the two cultivated species of jute was 20.41-48.55% which was 100% in case of *C. pseudo-capsularis*. While *C. pseudo-olitorius* and *C. aestuans* were free from stem rot disease.
- The fungal entomopathogen, *B. bassiana* was found compatible with cypermethrin, lambda cyhalothrin, profenophos, quinalphos and dicofol upto the concentration of 300 ppm. Moreover, cypermethrin and lambda cyhalothrin stimulated the hyphal growth at lower concentrations (50 and 100 ppm).
- Jute plants of varying ages (30, 40, 50 and 60 days after sowing) inoculated with stem rot pathogen in the stem showed significant influence of plant age on the lesion size. Host susceptibility towards the pathogen increased as plants aged.
- A multiple PCR-based method was standardized and developed for detecting *B. bassiana* from soil as well as plant foliage.
- *C. capsularis* cultivars were comparatively more susceptible to the stem rot disease compared to those of *C. olitorius*. Among the *C. capsularis* cultivars, JRC 212 showed resistance reaction while JRC 4444, JRC 532 and JRCM 2 were most susceptible. JRO 204 was highly resistant among the *C. olitorius.*
- *T. harzianum* and *T. viride* strains were screened for tolerance towards newer fungicides viz. pencuron 25% EC, fenamidone 10% + mancozeb

50% WG, tebuconazole 25% EC, fosetyl Al 80% WP, azoxystrobin 25% EC, trifloxystrobin 75% WG and plant essential oils i.e. turmeric oil, mentha oil and citronella oil. On the basis of mycelial growth, all tested strains showed tolerance towards tested molecules in all concentration except tebuconazole 25% EC and citronella oil.

- Two strains of *Trichoderma harzianum* (NBAII Th 8 and NBAII Th 10) were found most effective in evaluation against *M. phaseolina* by using dual culture technique.
- Chemo-sensitivity of *M. phaseolina* were tested towards newer fungicides viz. pencuron 25% EC, fenamidone 10% + mancozeb 50% WG, tebuconazole 25% EC, tebuconazole 50% EC + trifloxystrobin 75% WG, fosetyl Al 80% WP, azoxystrobin 25% EC. On the basis of mycelial growth inhibition (%), tebuconazole 50% EC + trifloxystrobin 75% WG was most effective.
- The incidence of *Sclerotinia* stem rot of roselle and flax wilt caused by *F. oxysporum* f. sp. *lini* (Schlecht) were noticed first time in these crops.
- In broadcast jute, CRIJAF-Nail Weeder operation at 4-5 days after emergence (DAE) followed by one hand weeding controlled composite weeds in early stage and developed line arrangement. CRIJAF-Nail Weeder operation after pretilachlor 50% EC @ 0.5 litre/ha and one hand weeding also provided excellent control of weeds in jute. These weed management practices can save 50 to 70% of total weeding cost incurred in jute.
- Pedotransfer functions (PTFs) were developed to predict soil moisture content up to the 20 cm soil depth during the pre-jute sowing period. There is a decreasing trend in rainfall amount during the early growth period of jute.

Farm Mechanization and Post-Harvest Technology

- An improved portable ramie and sisal fibre extractor was designed, developed and tested with 55-60% more fibre extraction efficiency than existing 'raspador' decorticator. The machine has been commercialized through a MoU between the Institute and the manufacturer.
- The improved CRIJAF microbial consortium mediated retting technology with use of the formulation "CRIJAF SONA" was widely promoted through 650 demonstrations in West Bengal, Assam, Bihar, Andhra Pradesh and Uttar Pradesh with extremely positive feedback from the jute growers.
- Microbial diversity analysis of retting water samples using BIOLOG Eco plate indicated that the active microbial community first attack the carbon source like D-xylose and D-galacturonic acid, up to 8 hours and after 24 hours of incubation, surfactant like tween 40 and tween 80 along with amino acids like L-serine and L-asparagine was degraded. The most promising lignin degrading strain recorded 92% and 100% degradation respectively after 72 hours and 6 days of incubation using azure B (AzB).
- Six efficient pectinolytic isolates were screened out for microbial ramie degumming technology and a combination of S16 and S11 strains (1:1 v/v) recorded highest polygalacturonase activity followed by S33+SS11 and S33+S16 combinations.

Technology Assesment and Transfer

- Among the five high yielding jute varieties demonstrated JRO 204 (30.81 q/ha) produced the highest fibre yield. In weed management, maximum saving on cost of human labour was from nail weeder (Rs. 4,088-10,948/ha) followed by quizalofop ethyl (Rs. 3,201-9,331/ha), butachlor (Rs. 3,402/ha) and pretilachlor (Rs. 1,658/ha). Line sowing through multi-row seed drill saved the cost of human labour in jute cultivation by Rs. 5,234-5,590/ha. In the case of drought management practices, application of sulphur along with recommended dose of fertilizer (60:30:30) resulted in highest net return (Rs. 3,738-12,900/ha). It was followed by augmented nutrition *i.e.* 80:40:40 (Rs. 3,508/ha) and RDF with single irrigation (Rs. 3,285/ha).
- An analysis on the farmers' extent of accessibility of ICT tools revealed that ICT based extension can make use of television and mobile phones as the quicker medium for message transmission to maximum number of farmers keeping the message intact.
- Sixty demonstrations on the performance of jute-paddy-mustard and jute-paddy-wheat sequences

indicated, jute-paddy-wheat to be best with higher benefit cost ratio, higher net return and lower cost of cultivation.

Tribal Sub Plan (TSP)

- Activities under TSP (institute) were carried out on jute (in North 24 Parganas, Dakshin Dinajpur and Nadia districts of West Bengal), sisal (Sambalpur and Jharsuguda districts of Odisha) and ramie (Assam, Meghalaya, Nagaland and Arunachal Pradesh states).
- Technological interventions such as improved varieties, line sowing by seed drill, mechanical weed management by nail weeder, improved microbial retting for jute were involved in the programme. Area expansion, production and distribution of quality planting materials of sisal and ramie were undertaken in Odisha and NE states respectively.
- Under TSP (AINP-JAF) several demonstrations of improved microbial jute retting were organized in North Bengal and Assam; seed production of tossa jute was undertaken in North Bengal districts. Under HRD programme, 13 trainings were organized for 452 tribal farm and farm women beneficiary.

AINP on JAF

- Release proposals of three varieties namely, JRC-9057 (Ishani) of *Capsularis* jute, JRKM 9-1 (Satyen) of kenaf and R-1411 (Hazarika) of ramie, identified during the 27th Annual Workshop held at CRIJAF, Barrackpore, have been submitted to the Central Sub-Committee on Crop Standards, Notification and Release of Varieties (CSCSNRV). One variety each in *tossa* jute (JROG-1), kenaf (JBMG-4), sunnhemp (JRJ-610), flax (JRF-2) and two varieties of roselle (CRIJAFR-2 and CRIJAFR-8) have been identified for release during the 11th Annual Group Meeting of AINP on J&AF held at UBKV, Pundibari, Coochbehar during February, 28th to 1st March, 2014.
- The highest benefit-cost ratio was recorded with post-emergence application of quizalofop ethyl @ 60 g/ha at 15 DAE with one hand weeding at 15-20 days after herbicide application at Bahraich and Katihar centres. In mesta, the highest fibre yield was observed with application of pretilachlor 50 EC @ 900 ml/ha followed by one hand weeding at Amadalavalasa and Aduthurai centres. Under the drought condition the highest fibre yield was recorded when jute was sown on 30th March to 3rd week of April with one irrigation and application of 80 kg N + 18 kg P + 33 kg K/ha along with bunding all around the field. At Amadalavalasa, the highest fibre yield of mesta was recorded when crop was sown with onset of monsoon with application of 60 kg N + 13 kg P + 25 kg K/ha +30 kg S/ha.
- Incidence of stem rot and root-rot was most severe at Barrackpore, Coochbehar, Katihar and Kendrapara. Mosaic and anthracnose were prominent at Katihar, Bahraich, Kendrapara and Nagaon. Seedling blight was specific to Nagaon. Stem-rot appeared at later stage (85–105 DAS) of crop growth. Anthracnose disease was recorded at Nagaon (34.05%), Baharich (18.70%) and Katihar (3.56%) during 60-105 DAS. Mosaic incidence was highest at Bahraich (68.80%) followed by Kendrapara (33.33%) and Katihar (11.48%). Seedling blight incidence was high at Nagaon (1.80%) centre at 35 DAS.

KVK, Burdwan

- Krishi Vigyan Kendra (KVK), Burdwan conducted 7 On-Farm Trials (OFT) and 220 FLDs to popularize various recommended technologies in the fields of agriculture (food, fibre, fodder and oilseed crops), horticulture (vegetables, fruits and flower), animal husbandry (cattle, pigs and poultry) and fishery.
- Total 144 training programmes were conducted for 3445 farmers, farm women, rural youths and extension workers. Considerable amount of quality seeds of paddy, pulses and planting materials of vegetables and orchards were produced and distributed. Several extension programmes namely field days, animal health camps, exposure visits, farm workshop, krishi mela etc were organised.

कार्यकारी सारांश

फसल सुधार

- पटसन एवं समवर्गीय रेशा फसलों के कुल 12 जननद्रव्यों का संकलन किया गया जिनमें अकृषित पटसन, अकृषित सनई, रोज़ेल तथा *यूरेना स्पेसीज* के दो–दो तथा रेमी के चार जननद्रव्य शामिल थे। इसके अतिरिक्त रोज़ेल के 600 तथा अन्य समवर्गीय रेशा फसलों के 228 नवीनतम संकलनों का पुनर्उद्भवन भी किया गया है। पटसन एवं समवर्गीय रेशा फसलों के कुल 543 प्रभेदों, जिनमें पटसन के 137, मेस्ता के 22, फ्लैक्स के 127, सनई के 145, रेमी के 102 तथा *यूरेना* के 10 प्रभेद शामिल थे, का मूल्यांकन उनके वाह्य मात्रात्मक गुणों के लिए किया गया। विभिन्न संस्थानों से प्राप्त मांग–पत्रों के अनुरूप पटसन तथा समवर्गीय रेशा फसलों के कुल 1706 जननद्रव्यों का वितरण भी किया गया है।
- *तोषा* पटसन के 21 संकरों तथा उनके 7 पित्रों का परीक्षण उनकी रेशा उपज क्षमता तथा सबंधित गुणों के लिए किया गया जिनमें संकर संयोग ओ.एम.यू.–19 × ओ.एम.यू.–27 तथा ओ.आई.एन.–255 × ओ.आई.एक्स.–32 का एस.सी.ए. प्रभाव सार्थकपूर्वक धनात्मक दर्ज किया गया। संकर संयोग ओ.एम.यू.–19 × ओ.एम.यू.–27 का मानक संकर ओज़ (41.01:) अधिकतम पाया गया।
- *तोषा* पटसन के 60 उत्परिवर्ती प्रभेदों के माइटोकॉड्रियल तथा क्लोरोप्लास्ट लोसाई की बहुरूपता अध्ययन के दौरान माइटोकॉड्रिया के 9 तथा क्लोरोप्लास्ट के एक (ए.एल.सी._1–3) लोकस बहुरूपी पाये गये।
- पटसन के तना सड़न रोग के आनुवांशिक विश्लेषण हेतु पटसन के 202 आर.आई.एल. समुदाय का *मैक्रोफोमिना फैसियोलिना* जनित रोग प्रतिक्रिया के लिए परीक्षण के अन्तर्गत इनमें रोग संक्रमण के प्रति सार्थक विभिन्नता पायी गयी। आर.आई.एल. समुदाय के 29.7 प्रतिशत पौधों ने अंकुरण अवस्था में इस रोग के लिए प्रतिरोधक क्षमता दर्ज कराये।
- मैपिंग पॉपुलेशन के विकास के लिए उपयुक्त पित्रों की पहचान हेतु *तोषा* पटसन के 58 उत्परिवर्ती प्रभेदों में रेशा संरचना का व्यापक अध्ययन किया गया है।
- 55 एस.एस.आर. मार्कर के माध्यम से सादा पटसन में पैत्रिक बहुरूपता के अध्ययन के दौरान कुल 18 प्रभेद बहुरूपी पाये गये।
- सादा पटसन के 30 संकरों से प्राप्त कुल 20 एफ$_7$ संततियों के परीक्षण के उपरान्त 10 उत्कृष्ट संततियों का चयन किया गया है।
- *तोषा* पटसन के कुल 180 अफ्रिकी प्रभेदों के साथ–साथ कृषित प्रजातियों नामतः जे.आर.ओ.–632 (पूर्व पक्वन पुष्पन संवेदनशील) तथा जे.आर.ओ.–524, जे.आर.ओ.–204, जे.आर.ओ.–128 एवं जे.बी.ओ.–1 (पूर्वपक्वन पुष्पन प्रतिरोधी) का खरीफ–2013 में परीक्षण किया गया जिनमें एक मात्र प्रभेद ओ.आई.जे.–257 (के.ई.एन./डी.एस./054 सी.) में बुआई के 63 दिनों तक भी पुष्पन नहीं पाया गया।
- *तोषा* पटसन के कुल 600 जननद्रव्यों के प्रक्षेत्र परीक्षण के साथ–साथ पॉलीईथाइलीन ग्लाईकॉल उपचार के आधार पर कुल 20 प्रभेद मध्यम रूप से शुष्क सहिष्णु पाये गये।
- *तोषा* पटसन की सी.ओ.–58 (सौरभ) प्रजाति को अन्य संदर्भ प्रजातियों के साथ डी.यू.एस. के अन्तर्गत बैरकपुर तथा बुद बुद केन्द्रों पर लगातार दो वर्षों तक परीक्षण से ज्ञात हुआ कि कैन्डिडेट प्रजाति सी.ओ.–58 पर्ण आकृति (लीफ सेप) के लिए अन्य प्रजातियों से भिन्न है।
- केनॉफ में पीत सिरा मौज़ेक रोग के प्रक्षेत्र मूल्यांकन के अन्तर्गत संकर संयोग के.आई.जे.–275 × ए.एम.सी.–108, के.आई.जे.–281 × ए.एम.सी.–108 तथा के.आई.जे.–31 × एम.टी.–150 से प्राप्त सभी एफ$_5$ संततियां इस रोग के प्रति पूर्णतः प्रतिरोधी पायी गयी।
- रोज़ेल के एफ$_3$ संततियों से कुल 63 उत्कृष्ठ एकल पौधों का चयन उनके ऊँचाई तथा मोटाई के आधार पर किया गया। कुल 36 एफ$_1$ तथा उनके पित्रों का मूल्यांकन रेशा उपज तथा इससे सम्बद्ध गुणों के लिए किया गया तथा यह पाया कि संकरों का औसत निष्पादन उनके पित्रों के सापेक्ष बेहतर था।
- रेमी के जननद्रव्यों का उनके पुष्पन व्यवहार के मूल्यांकन में पाया गया कि फरवरी के प्रथम सप्ताह में बोई गयी फसल में एक जननद्रव्य आर.–1416 में अन्य 60 जननद्रव्यों के विपरीत केवल मादा पुष्प ही देखे गये जबकि अगस्त–सितम्बर के दौरान बोई गई फसल में अन्य जननद्रव्यों के ही तरह सामान्य नर तथा मादा पुष्पन पाया गया।
- रेमी के प्रभेद आर.–1411 से निष्कर्षित रेशे के मुख्य तत्वों के निर्धारण के दौरान पाया कि इसमें 96.1 प्रतिशत तक

होलो–सेल्यूलोज की मात्रा थी जिसका 88.15% हिस्सा अल्फा सेल्यूलोज था। निष्कर्षित रेशे में गोंद की मात्रा 23.15%, हेमी–सेल्यूलोज की मात्रा 7.9% तथा पेक्टीन 2.3% दर्ज की गयी।

- सनई के पुष्पन व्यवहार से ज्ञात हुआ कि इसमें टर्मिनल रेसीम प्रकार का पुष्प विन्यास होता है जिसका बढ़वार निरन्तर होता रहता है। इसका पराग–कोष द्विरूपी अथवा असमान परागकोषीय होता है। विभिन्न परागण उपचारों के द्वारा प्रजनन व्यवहार के अध्ययन से ज्ञात हुआ कि सनई एक पर–परागीत रेशा फसल है।

बीज विज्ञान एवं प्रौद्योगिकी

- पटसन बीज फसलों में 50 कि.ग्रा./है. पोटाश का प्रयोग उनमें शाखाओं की संख्या, फलों की लम्बाई तथा उनकी संख्या एवं पटसन बीज की उपज को सार्थक पूर्वक बढ़ाता है जो कि 25 तथा 75 कि.ग्रा./है. पोटाश के प्रयोग की तुलना में बेहतर था। इसी प्रकार 45 कि.ग्रा./है. सल्फर के प्रयोग से 15 तथा 30 कि.ग्रा./है. की तुलना में पौधे की ऊँचाई, शाखाओं तथा फलों की संख्या, फलों की लम्बाई तथा बीज उपज में सार्थक वृद्धि दर्ज की गयी।
- पश्चिम बंगाल के सूखा ग्रस्त क्षेत्रों में पटसन के नवीनतम विमोचित प्रजातियों (जे.आर.ओ.–204, जे.आर.ओ.–128, एस.–19, ईरा तथा जे.आर.ओ.–8432) का 98.91 कु. प्रमाणित बीज उत्पादन करके पश्चिम बंगाल सरकार को हस्तान्तरित किया गया जो राज्य की लगभग 1975 है. बुआई के लिए पर्याप्त है।
- राष्ट्रीय बीज परियोजना के अन्तर्गत भारत सरकार के कृषि एवं सहकारिता विभाग के मांग–पत्र के सापेक्ष खरीफ 2013 के दौरान कुल 18.54 कु. जनक बीज का उत्पादन किया गया। वर्ष 2013–14 के दौरान भारतीय कृषि अनुसंधान परिषद के बीज परियोजना के अन्तर्गत पटसन, सनई, मेस्ता, ढ़ैंचा, धान, गेहूं तथा सरसों के कुल 511.84 कु. बीज का उत्पादन किया गया। इस परियोजना के अन्तर्गत रेमी (50 कु. राईजोम) तथा सीसल (76,170 बलबिल्स) का रोपण सामग्री भी उत्पादित किया गया।
- कृषकों में बीज उत्पादन के प्रति जागरूकता उत्पन्न करने के उद्देश्य से विभिन्न प्रकार के प्रशिक्षण कार्यक्रमों (बीज दिवस, कृषक प्रशिक्षण) के द्वारा लगभग 700 कृषकों को प्रशिक्षण प्रदान किया गया।

जैव प्रौद्योगिकी

- सादा पटसन की प्रजाति जे.आर.सी.–212 तथा *डी.एल.पी.एफ.* उत्परिवर्ती प्रभेद के माध्यम से आर.एन.ए. आधारित बास्ट फाइबर ट्रान्सक्रिप्टोम विकसित किया गया है। जे.आर.सी.–212 तथा *डी.एल.पी.एफ.* के मध्य कुल 1747 जीन्स का विभिन्नतापूर्ण प्रकटीकर देखा गया जिनमें जे.आर.सी.–212 की तुलना में कुल 348 जीन्स अप–रेगुलेशन तथा 1399 जीन्स डाउन–रेग्यूलेशन प्रकृति के थे। पटसन में सिकिमेट, संगध एमीनों एसीड तथा फेनाईलप्रोपेनायड जैव संश्लेषण प्रक्रिया, जो कि पटसन में लिग्नीन जैव संश्लेषण प्रक्रिया को निर्धारित करता है, से सम्बंधित 19 जीन्स के सापेक्षिक मात्रात्मक विश्लेषण हेतु रीयल–टाईम पी.सी.आर. निष्पादित किया गया।
- *तोषा* पटसन में उच्च–सघन अनुवांशिक नक्सा तैयार करने के उद्देश्य से एक मैपिंग समुदाय का फिनोटाइपिंग पुष्पन समय सहित तमाम वाह्य गुणों के लिए किया गया है।
- सादा पटसन के जे.आर.सी.–321 तथा जे.आर.सी.–517 प्रजातियों के कॉटिलिडनरी पत्तियों को एक्सप्लान्ट के रूप में एम.एस. मीडिया, जो कि 5.4 माईक्रमोल एन.ए.ए., 0.5 माइक्रोमोल आई.बी.ए. तथा 8.9 माइक्रोमोल 6–बी.ए.पी से युक्त था, पर उत्तक संवर्धन के अन्तर्गत बहुतायत पौध उद्भवन पाया गया। नियंत्रित दशा में उगाये गये पौधों से प्राप्त एक्सप्लांट से एक सक्षम एवं दीर्घ–कालीन शाकीय भ्रूण उद्भवन की तकनीकी (प्रोटोकाल) विकसित किया गया है।
- उत्तकीय विश्लेषण से ज्ञात हुआ है कि 10 दिनों तक तरल मिडिया में उत्तक संवर्धन के दौरान एक्स्प्लांट के बाहरी सतह से ही शाकीय भ्रूणों का प्रत्यक्ष उद्भवन होता है। पटसन की प्रजातीय विभिन्नता उत्तक संवर्धन के दौरान उद्भवित होने वाले शाकीय भ्रूणों बारंम्बारता तथा उनकी संख्या को प्रभावित नहीं करता है।

मृदा स्वास्थ्य एवं पोषक तत्व प्रबन्धन

- दीर्घकालीक उर्वरक परीक्षण के दौरान विभिन्न उपचारों में 150 प्रतिशत एन.पी.के के प्रयोग से पटसन, धान एवं गेहूँ की अधिकतम उपज क्रमशः 1.6–3.4 टन/है., 2.5–4.7 टन/है. तथा 1.2–5.2 टन/है. प्राप्त हुई। पटसन, धान एवं गेहूं में एन.पी.के. के 150 प्रतिशत प्रयोग से अधिकतम स्थायी उपज सूचकांक (एस.वाई.आई.) क्रमशः 0.45, 0.41 तथा 0.40 दर्ज

की गयी। लगभग सभी उपचारों से प्राप्त मृदा के प्रारंभिक नमूनों में डी.टी.पी.ए. के माध्यम से निष्कर्षित जस्ता, लौह तथा मैंग्नीज जैसे सूक्ष्म तत्वों की मात्रा कम पायी गयी तथा एन.पी.के.+एफ.वाई.एम. के उपचार में डी.टी.पी.ए. के द्वारा निष्कर्षित सूक्ष्म तत्वों की मात्रा अधिकतम दर्ज की गयी।

- बहुस्थानीय परीक्षण में विभिन्न उपज लक्ष्य एस.टी.–टी.वाई.+एफ.वाई.एम 5 टन प्रति है. के प्रयोग से संस्तुत उर्वरकों के साथ–साथ कृषक विधि द्वारा निर्देशित उपज लक्ष्य की तुलना में पटसन (जे.आर.ओ.–204), धान (एन.डी.आर. 97), तथा मटर (आजाद पी.–3) द्वारा सर्वाधिक शुद्ध लाभ व लाभ खर्च अनुपात के साथ अधिकतम उपज की प्राप्ति हुई।
- मृदा परीक्षण आधारित उपज लक्ष्य के अन्तर्गत पटसन (4 टन/है.) एवं धान (5 टन/है.) में क्रमशः(–)7.5 तथा (–)2.8 विचलन के साथ उपज लक्ष्य की प्राप्ति हुई। धान एवं पटसन में संस्तुत उर्वरकों की तुलना में एफ.वाई.एम., एजेटोबैक्टर तथा पी.एस.बी. के साथ अकार्बनिक उर्वरकों (एस.टी.–टी.वाई.) के समन्वित प्रयोग से फॉस्फोरस एवं पोटाश उर्वरकों के सस्य दक्षता में वृद्धि पायी गयी। एस.टी.टी.वाई के अनुसार धान की फसल में एफ.वाई.एम. के समन्वित प्रयोग से कृषक विधि तथा संस्तुत उर्वरकों के प्रयोग की तुलना में किण्वक क्रियासिलता की गति में भी वृद्धि हुई।
- पटसन–धान–गेहूँ फसल चक्र में फॉस्फोरस का दीर्घ–कालीक वितरण अध्ययन से ज्ञात हुआ कि अधिकतम कैल्शियम–फास्फोरस, अल्युमीनियम–फास्फोरस, सेल्यूआइड फास्फोरस का अंश एन.पी.के.+एफ.वाई.एम. उपचार के बाद एन.पी.के. के 150% में था। अधिकतम लौह–फॉस्फोरस की मात्रा एन.पी.के. की 150% मात्रा में पाई गई। सभी जगहों पर भू सतह में फॉस्फोरस अवशेष ने गेहूँ उत्पादन में 76% का योगदान तथा फॉस्फोरस अवशोषण में 80% के साथ ही सेल्वाइड फॉस्फोरस अंश का भी सार्थक योगदान था।
- कुल शुष्क भार (टी.डी.एम.) एवं क्लोरिफिल की मात्रा के आधार पर पटसन प्रजाति जे.आर.ओ.–204, जे.आर.ओ.–524, तंजानिका–1, एस.–19 तथा जे.आर.ओ.–8432 में उच्च नत्रजन उपयोग दक्षता पाई गई।

फसल रख–रखाव

- पटसन आधारित फसल चक्र में सबसे ज्यादा उत्पादन व सबसे कम उत्पादन क्रमशः पटसन–धान–बेबी कॉर्न–पटसन साग तथा पटसन–धान–गेहूँ से प्राप्त हुआ। फसल अवशेषों का उस फसल चक्र के उत्पादकता के संदर्भ में यह देखा गया कि संस्तुत खाद की 75% तथा 100% दोनों ही स्तर पर, मक्का एवं मटर फसल अवशेष की तुलना में गेहूँ फसल के अवशेष से पटसन–धान–गेहूँ में रेशे की उपज काफी कम हो जाती है।
- समतल खेत में पारंपरिक ढ़ंग से पटसन बुआई करने की अपेक्षा खुले कुंड़ में पटसन बुआई कर कुंड़ में केवल एक सिंचाई देने से इसमें परवर्ती सिंचाई की आवश्यकता को 40% तक कम करके 33.80 कु. रेशा/है. प्राप्त कर सकते हैं जो कि पारंपरिक विधि की तुलना में 2.6 कु./है. ज्यादा है। एक सिंचाई पश्चात् अगर उसमें नेल वीडर से मिट्टी का पल्वीकरण करते हैं तो 34.8 कु./है. रेशे की प्राप्ति होती है जो कि पारंपरिक विधि (केवल एक सिंचाई) की तुलना में 3.6 कु./है. ज्यादा है।
- समतल खेत में पारंपरिक ढ़ंग से रोज़ेल की बुआई की अपेक्षा उसे वर्षा आश्रित खुले कुंड़ में बुआई करने से हमें 1.5 कु./है. ज्यादा रेशे की प्राप्ति होती है। एक सिंचाई पश्चात् अगर उसमें नेल वीडर द्वारा मिट्टी का पल्वीकरण करते हैं तो 30.4 कु./है. रेशा की प्राप्ति होती है जो कि पारंपरिक विधि (केवल एक सिंचाई) की तुलना में 4 कु./है. ज्यादा है।
- द्वि–पंक्तीय सीसल प्लांटेशन में अरहर, बोदी और मूंग लगाने से सीसल तुल्य उपज क्रमशः–492 कि.ग्रा./है., 391 कि.ग्रा./है. तथा 384 कि.ग्रा./है. प्राप्त हुआ जो कि केवल सीसल प्लांटेशन की तुलना (311 कि.ग्रा./है.) में काफी ज्यादा है।
- प्रत्येक पौधा (सीसल) प्रति 4 लीटर पानी प्रति 4 घंटा सिंचाई (ड्रीप विधि) दो सप्ताह के अंतराल पर करने तथा जिंक सल्फेट (20 कि.ग्रा./है.) तथा बोरैक्स (15 कि.ग्रा./है.) को मिट्टी में व्यवहार करने से सीसल में सबसे लम्बी पत्ती (85 सें.मी.), सबसे ज्यादा पत्तियाँ (1,50,266 पत्तियाँ/है.) तथा अधिकतम रेशा उपज (1.10 टन/है.) की प्राप्ति हुई।
- धान की रोपाई से पूर्व सनई को हरी खाद के रुप में उगाने से धान के पश्चात बोई गयी गेहूँ के फसल को भी लगभग 40 कि.ग्रा./है. नत्रजन अवशेष के रुप में प्राप्त होता है।
- फास्फोरस तथा पोटाश की मात्रा 40 कि.ग्रा./है. अलग–अलग प्रयोग करने से फ्लैक्स में क्रमशः 16.7 कु./है. तथा 15.6 कु./है. रेशा उपज प्राप्त हुआ जोकि 20 कि.ग्रा./है. की तुलना में सार्थकतापूर्वक अधिक किन्तु 60 कि.ग्रा./है. फॉस्फोरस तथा पोटाश के प्रयोग के समतुल्य था।

जैविक एवं अजैविक तनाव

- *कैपसुलरिस* जननद्रव्यों के प्रभेद सी.आई.एन.–464, सी.आई.एन.–562 तथा सी.आई.एन.–13 अर्धकुण्डलक (2.94%), तना घुन (3.31%) तथा बिहार रोमिल सूड़ी (4.45%) के प्रति अत्यन्त कम संवेदनशील थे। *तोषा* पटसन के ओ.आई.जे.–052, ओ.आई.एन.–405 तथा ओ.आई.एन.–470 जननद्रव्यों में पीली मकड़ी का न्यूनतम प्रकोप देखा गया।
- बिहार रोमिल सूड़ी की आहार वरीयता पटसन के कृषित एवं अकृषित प्रजातिओं में भिन्न पायी गयी। अकृषित प्रजातियों *सी. स्टुएन्स, सी. ट्राइडेन्स, सी. स्यूडो–ऑलीटोरियस* एवं *सी. फैसिकुलरिस* में 7.00–28.33% तक किन्तु इसके विपरीत *तोषा* पटसन में 81.66 प्रतिशत तक भक्षण वरीयता पाई गई।
- बिहार रोमिल सूड़ी की औसत अण्डोत्सर्जन (3.66±0.33) वरीयता *सी. ऑलीटोरियस* में अकृषित पटसन *सी. ट्राईडेन्स* तथा *सी. स्टुएन्स* की तुलना में सार्थकता पूर्वक अधिक पायी गयी जो इसकी उच्च वरीयता को दर्शाता है। इन अकृषित प्रजातियों में लार्वा की संख्या भी अत्यन्त कम पायी गयी।
- *एस. आब्लिकुआ* में प्रोटीन का लार्वा अस्तित्व (%), लार्वा भार, प्यूपेशन (कोशावस्था), प्रौढ़ कीट उत्पत्ति के साथ धनात्मक सहसम्बंध पाया गया। पॉलीफिनॉल आक्सीडेज एवं कुल फिनॉल का कीट के अस्तित्व, वृद्धि, कोशावस्था एवं वयस्क उत्पति पर ऋणात्मक प्रभाव पाया गया।
- *एस. आब्लिक्यूआ* के प्रारंभिक इन्सटार (पहले तीन इन्सटार) सघनता आधारित मृत्यु कारकों के प्रति अत्यन्त संवेदनशील होते हैं। मृत्यु दर के मूल कारण दो ब्रैकोनिडी लार्वी पारासीटायड *मेटियोरस स्पाइलोसोमी* नरेन्द्रन एवं राम तथा *प्रोटापेन्टेलिस आब्लिकुआ* (विल्कीनसन) थे जिनका के. मान 0.18 था जबकि बाद वाले इन्सटार में विषाणु जनित मृत्यु दर का के. मान 0.21 के साथ अधिक था। इनका संतति अस्तित्व 0.39 था। धनात्मक प्रवृत्ति सूचकांक के कारण अगली पीढ़ी में इसके अधिक जनसंख्या का पुर्वानुमान लगाया गया।
- नए कीटनाशियों फ्लुबेन्डियामाइड 380 ई.सी., इमामेक्टिन बेन्जोएट 5 एस.जी., क्लोरेन्ट्रानिलिप्रोल 18.5 एस.सी., लैम्डा सायहैलोथ्रिन 5 ई.सी. तथा प्रोफेनोफॉस 50 ई.सी. का एकल तथा मिश्रित प्रयोग *एस. आब्लिकुआ* के तीसरे इन्सटार के विरूद्ध किया गया जिनमें सबसे कम एल.सी.–50 का मान फ्लुबेन्डियामाइड + लैम्डा सायहैलोथ्रीन वाले मिश्रण में दर्ज किया गया। उक्त मिश्रण ने प्रक्षेत्र दशा में *एस. आब्लिकुआ* की संख्या में 85.22% तक की कमी के साथ अधिकतम रेशा उपज (36.17 कु./है.) दर्ज कराया।
- विभिन्न अवस्थाओं के लिए बहु प्रजाति क्षति फलन द्वारा एकल तथा बहु प्रजाति आर्थिक क्षति स्तर (इ.आई.एल.) विकसित की गई है। फसलावस्था में दोनों प्रकार के कीटों के व्यापक संक्रमण के समय होने वाली आर्थिक क्षति स्तर का निर्धारण किया गया। पटसन की फसल में आर्थिक क्षति के स्तर पर पीली मकड़ी की संख्या शीर्ष से दूसरी पत्ती में 45/वर्ग से.मी. जबकि लेपिडोप्टेरन पीड़कों के द्वारा 5% तक पौधों में क्षति दर्ज की गई।
- *एस. आब्लिकुआ* में डिम्ब, छोटा लार्वा, बड़ा लार्वा, प्यूपा तथा वयस्क कीट के लिए विकासात्मक सीमारेखा का निर्धारण क्रमशः 10.57, 11.27, 11.55, 15.28 तथा 10.92^0 सेल्सियस एवं तदानुसार तापीय स्थिरांक 52.91, 344.82, 243.90, 142.85 तथा 70.42 डिग्री दिन निर्धारित किया गया है।
- *बी.टी.* प्रभेद *कुरस्टाकी* के व्यवसायिक फार्मुलेशन की प्रारंभिक जाँच बिहार रोमिल सूडी एवं *एस. आब्लिकुआ* के 5 दिन पुराने लार्वा के विरूद्ध किया गया जिनकी 24 एवं 48 घंटों के उपरान्त मृत्युदायी सान्द्रता क्रमशः 0.74 तथा 0.36 ग्रा./ली. आंकी गई।
- पटसन में तना घुन के संक्रमण को रोकने के लिए *ब्यूवेरिया बैसियाना* के विभिन्न अन्तः पादपी प्रभेदों का प्रतिजैवी प्रभाव देखा गया। उपचारित पौधों (70.14^0 %) की तुलना में आई.टी.सी.सी.–6551 तथा आई.टी.सी.सी.–4668 से उपचारित पौधों में न्यूनतम संक्रमण क्रमशः 18.13 तथा 19.18% दर्ज किया गया।
- थाईमेथोक्जाम 70 डब्ल्यू.एस. एवं क्लोरपाइरिफॉस 20 ई.सी. के द्वारा मेस्ता बीजोपचार करने से स्पाइरल बोरर एवं *एग्रीलस एक्यूटस* जैसे कीटों के संक्रमण में 50 प्रतिशत तक की सार्थक कमी देखी गयी है।
- स्थापना एवं उत्तरजीवन के आधार पर मिलीबग कीट के *हिबिसकस प्रजाति* (बगैर चिन्हित मेस्ता की अकृषित प्रजाति) में न्यूनतम तथा *हिबिसकस एसीटोसिल्ला* में अधिकतम संक्रमण पाया गया।
- पटसन एवं मेस्ता पारिस्थतिकी में मिलीबग से संबंधित पारासिटायड *ऐनासियस बाम्बावेलेइ* हयात (कैल्सिडोडी : *इन्सायरटिडी*) तथा *प्रोम्यूसीडी अनफैसिएटीवेन्ट्रीस* जीराल्ट (कैल्सिडोडी : एफिलिनिडी) को चिन्हित किया गया है। बाद

वाली (दूसरी) प्रजाति को *इन्सायरटिडी* में हाइपरपारासिटायड के रूप में पहचान की गयी है। ऐसा पश्चिम बंगाल के पटसन–मेस्ता पारिस्थिकी में पहली बार देखा गया है।

- पटसन में *माइक्रोफोमिना फैसियोलिना* जनित तना सड़न रोग पर नाइट्रोजन, फास्फोरस एवं पोटाश उर्वरकों के विभिन्न दरों के प्रभाव को देखा गया और यह पाया गया कि नाइट्रोजन के अधिक प्रयोग करने से रोग में वृद्धि होती है जबकि फॉस्फोरस व पोटाश की अधिक मात्रा रोग के प्रकोप को कम करने में कारगर साबित हुई।
- तना सड़न रोग के प्रबंधन में टेबुकोनाजोल 25.9 ई.सी., कार्बेन्डाजिम 50 डब्ल्यू.पी., हैक्साकोनाजोल 5 ई.सी., ट्राइसाइक्लाजोल 75 डब्ल्यू.पी., कॉपर ऑक्सीक्लोराइड 50 डब्ल्यू.पी., प्रोपिकोनाजोल 25 ई.सी. एवं मैंकोजेब 75 डब्ल्यू. पी. समान रूप से प्रभावी पाये गये। कार्बेन्डाजिम 50 डब्ल्यू. पी. तथा टेबुकोनाजोल 25.9 ई.सी. ने न केवल प्रभावी ढ़ंग से तना सड़न रोग का प्रबन्धन किया बल्कि पटसन के वृद्धि अवस्था के द्वौरान इस रोग को बढ़ने से भी रोका।
- *तोषा* पटसन के उत्कृष्ठ प्रभेदों, ओ.आई.एन.–853, जे.आर. सी.–80 तथा ओ.आई.एन.–651 को रोग संक्रमित प्लॉट में उगाने पर इनमें तना सड़न रोग का न्यूनतम प्रभाव देखा गया।
- पटसन के दो कृषित प्रजातिओं में तना सड़न रोग का प्रकोप 20.41–48.55 प्रतिशत तक पाया गया। अकृषित प्रजाति *सी. स्यूडो–कैपसुलरिस* में इस रोग का प्रकोप शत–प्रतिशत था जबकि *सी. स्यूडो ऑलीटोरियस तथा सी. एसटूएन्स* तना सड़न रोग से पूर्णतः मुक्त पाये गये।
- कीट रोग जनक *बी. बैसियाना* की 300 पी.पी.एम. सान्द्रता साइपरमेथ्रीन, लैम्डा सायहैलोथ्रीन, प्रोफेनोफॉस, क्वीनालफॉस एवं डाइकोफॉल के साथ अनुकूल पायी गयी। जबकि साइपरमेथ्रीन तथा लैम्डा सायहैलोथ्रीन की अल्प सान्द्रता (50 एवं 100 पी.पी.एम.) कवक वृद्धि को उत्प्रेरित करने में सहायक साबित हुए।
- पटसन के विभिन्न उम्र वाले पौधों (बुआाई के 30, 40, 50 एवं 60 दिन वाले) में तना सड़न रोगजनक के इनॉकुलेशन से उनके उम्र का सार्थक प्रभाव धब्बे के आकार पर देखा गया। उम्र बढ़ने के साथ रोग के प्रति पौधों की संवेदनशीलता बढ़ती है।
- मिट्टी तथा पौधों में मौजूद *ब्यूवेरिया बैसियाना* के पहचान के लिए एक पी.सी.आर. आधारित विधि का मानकीकरण एवं विकास किया गया है।
- *तोषा* पटसन की तुलना में सादा पटसन की प्रजातियाँ तना सड़न रोग के प्रति अधिक संवेदनशील पायी गयीं। सादा पटसन की प्रजाति जे.आर.सी.–212 ने प्रतिरोधिता का प्रदर्शन किया जबकि जे.आर.सी.–4444, जे.आर.सी.–532 तथा जे. आर.सी.एम.–2 सबसे अधिक संवेदनशील थे। *तोषा* पटसन की प्रजाति जे.आर.ओ.–204 को सबसे अधिक प्रतिरोधी पाया गया।
- *टी. हारजिएनम* तथा *टी. विरिडी* के प्रभेदों की जाँच नये कवकनाशियों जैसे–पेनकुकुरोन 25% ई.सी., फेनमिडोन 10% + मैंकोजेब 50% डब्ल्यू.जी., टेबुकोनाजोल 25% ई.सी., फोसेटाइल ए.एल. 80% डब्ल्यू.पी., एजोक्सीस्ट्रोबीन 25% ई. सी., ट्राइफ्लोक्सीस्ट्रोबीन 75% डब्ल्यू.जी. तथा पौधों से प्राप्त तेल, जैसे–हल्दी तेल, मेन्था तेल तथा सीट्रोनेला तेल के प्रति सहिष्णुता को जानने के लिए किया गया। कवक के वृद्धि के आधार पर, टेबुकोनाजोल 25% ई.सी. तथा सिट्रोनेला तेल को छोड़कर जाँचे गये समस्त अणुओं के सभी सांद्रता में दोनों प्रभेदों ने सहिष्णुता का प्रदर्शन किया।
- द्वि–संवर्द्धन तकनीक से मूल्यांकन के दौरान *ट्राइकोडर्मा हरजीएनम* के दो प्रभेद (एन.बी.ए.आई.आई. टी.एच.–8 तथा एन.बी.ए.आई.आई. टी.एच.–10) *माइक्रोफोमिना फैसियोलिना* के प्रति अत्यन्त प्रभावी पाये गये।
- *एम. फैसियोलिना* का परीक्षण नये कवकनाशियों जैसे–पेनकुरोन 25% ई.सी., फेनमीडोन 10% + मैंकोजेब 50% डब्ल्यू.जी., टेबुकोनाजोल 25% ई.सी., टेबुकोनाजोल 50% ई.सी. + ट्राइफ्लोक्सीस्ट्रोबीन 75% डब्ल्यू.जी., फोसेटाइल ए.एल. 80% डब्ल्यू.पी. तथा एजोक्सीस्ट्रोबीन 25% ई.सी. के प्रति रासायनिक संवेदनशीलता के लिए किया गया। कवक के वृद्धि में प्रतिशत ह्रास के आधार पर टेबुकोनाजोल 50% ई. सी. + ट्राइफ्लोक्सीस्ट्रोबीन 75% डब्ल्यू.जी. को सबसे प्रभावी पाया गया।
- पहली बार रोज़ेल के बीज वाली फसल में *स्केलेरोसिनिया* तना सड़न तथा फ्लैक्स में फ्लैक्स विल्ट *(फ्यूजेरियम आक्सिस्पोरम स्पी. लीनी)* के संक्रमण को इन फसलों में देखा गया।
- छिटकवाँ विधि से बोये गये पटसन के खेत में, बीज अंकुरण के 4–5 दिन पश्चात नेल वीडर का प्रयोग तथा उसके बाद

हाथ से एक निराई करने से प्रारंम्भिक अवस्था में मिश्रित प्रकार के खरपतवार नियंत्रण के साथ–साथ पंक्ति का भी निर्माण होता है। इसके अलावा पटसन के खेत में प्रेटीलाक्लोर 50% ई.सी. 0.5 ली./है. की दर से तथा हाथ की एक निराई के बाद नेल वीडर का प्रयोग करने से खर–पतवार में काफी कमी आती है। इस विधि से पटसन में खर–पतवार प्रबन्धन खर्च में 50 से 70% तक की बचत होती है।

- पटसन बीज बुआई से पहले मिट्टी में 20 सें.मी. की गहराई तक निहित नमी की पूर्वानुमान के लिए पेडोट्रान्सफर फंक्शन (पी.टी.एफ.) का विकास किया गया है। फसल के प्रारंभिक अवस्था में वर्षा जल में कमी की प्रवृत्ति देखी जा रही है।

प्रक्षेत्र यंत्रीकरण एवं कटाई उपरांत प्रौद्योगिकी

- रेमी व सीसल रेशा निष्कर्षक यंत्र, जो कि या तो एकल फेज 3 अश्व शक्ति विद्युत मोटर अथवा 3.5 अश्व शक्ति डीजल ईंजन चालित है, का डिजाईन, विकास एवं परीक्षण किया गया जिसकी कार्यक्षमता मौजूदा 'रास्पाडोर' रेशा निष्कर्षण यंत्र की तुलना में 55–60% अधिक पायी गयी। इस यंत्र का हमारे संस्थान एवं एक यंत्र निर्माता कम्पनी के बीच एम.ओ.यू. के तहत व्यावसायिक उत्पादन किया जा रहा है।

- क्रिजैफ द्वारा विकसित पाउडर आधारित सूक्ष्मजीवी सम्मिश्रण 'क्रिजैफ सोना' के माध्यम से उन्नत सड़न विधि का बड़े पैमाने पर 650 कृषकों के खेतों में प्रक्षेत्र प्रदर्शन किया गया। इस विधि का व्यापक प्रचार इन 650 प्रदर्शनों के द्वारा पश्चिम बंगाल के सात जिलों, असम के नौगांव, बिहार के पूर्णिया तथा कटिहार, आंध्र प्रदेश के श्रीकाकुलम और उत्तर प्रदेश के बहराइच जिलों में किया गया। इन सभी इलाकों से पटसन तथा मेस्ता कृषकों द्वारा हमें सकारात्मक प्रतिक्रिया प्राप्त हुई है।

- बायोलाग इको प्लेट का उपयोग कर, सड़न वाले पानी के नमूनों (28 संख्या) का सूक्ष्मजीवी विविधता के विश्लेषण से ज्ञात हुआ कि सूक्ष्मजीवियों की सक्रिय समूह सर्वप्रथम कार्बन के स्रोत यथा डी–जाइलोज और डी–गेलैक्टुरोनिक अम्ल पर आक्रमण करता है। इनके उष्णन के 8 से 24 घंटों के पश्चात् सर्फेक्टेन्ट ट्वीन 40 तथा ट्वीन 80 के साथ–साथ अमीनो अम्ल एल–सेरीन तथा एल–ऐस्पेरेजीन का ह्रास देखा गया। एजुर बी. (AZB) रंजकों के प्रयोग से सर्वश्रेष्ठ प्रभेद के द्वारा 72 घंटे एवं 6 दिन के उष्णन क्रिया के उपरान्त क्रमशः 92 तथा 100% तक लिग्निन का ह्रास देखा गया।

- छह कार्यदक्ष पेक्टिनोलाईटिक प्रभेदों को रेमी गोंद विरलीकरण के लिए जाँचा गया जिनमें एस.–16 तथा एस.–11 प्रभेदों के संयोग (1:1 v/v) ने सबसे ज्यादा पॉलीगेलैक्टुरोनेज क्रिया को सम्पदित किया। इसके पश्चात एस.–33+एस.–11 तथा एस.–33+एस.–16 संयोगों का स्थान था।

प्रौद्योगिकी हस्तांतरण

- पटसन की पाँच उच्च उत्पादन क्षमता वाले प्रदर्शित प्रजातियों में जे.आर.ओ.–204 (30.81 कु./है.) ने सर्वाधिक रेशा उपज दर्ज कराया। खरपतवार प्रबंधन हेतु मानव श्रम लागत में सर्वाधिक बचत क्रमशः 'नेल वीडर' (4,088–10,948 रू0/है.), क्विजॉलोफॉप ईथाइल (3,201–9,331 रू0 प्रति है.), ब्यूटाक्लोर (3,402 रू0/है.) तथा प्रेटिलाक्लोर (1,658 रू0/है.) के प्रयोग से हुई। बहु पंक्ति सीड ड्रील के प्रयोग से मानव श्रम के मद में 5,234–5,590 रू0/है. तक की बचत हुई। सूखा प्रबन्धन तकनीकों के प्रदर्शन में शुद्ध लाभ के आधार पर सबसे उपयोगी तकनीकें क्रमशः सल्फर+अनुशंसित उर्वरक अर्थात् 60:30:30 (3,738–12,900 रू0/है.), उर्वरकों की बढ़ी हुई मात्रा अर्थात् 80:40:40 (3,508 रू0/है.) तथा अनुशंसित उर्वरकों की मात्रा के साथ एक सिंचाई (3,285 रू0/है.) थी।

- कृषकों द्वारा संचार प्रौद्योगिकी (आई.सी.टी.) पहुँच के अध्ययन से ज्ञात हुआ कि आई.सी.टी. आधारित प्रसार के लिए टी.वी तथा मोबाइल फोन बेहतर साधन है। इनके उपयोग से संदेश को मूलरूप में तीव्र गति से अधिकतम कृषकों तक पहुंचाया जा सकता है। आई.सी.टी. के प्रसार में उपयोग के बारे में अधिकतर कृषकों के रूझान से यह पता चला कि आई.सी.टी. का वर्तमान आधारभूत सुविधा कृषक समुदाय के आवश्यकताओं को पूरा करने के लिए पर्याप्त नहीं है।

- पटसन–धान–सरसों तथा पटसन–धान–गेहूँ फसल चक्र के कुल 60 प्रदर्शन कृषक प्रक्षेत्रों पर आयोजित किए गए। लगभग सभी स्थानों पर पटसन–धान–सरसों की तुलना में पटसन–धान–गेहूँ द्वारा कम लागत खर्च के साथ–साथ अधिकतम शुद्ध लाभ की प्राप्ति हुई।

जनजातीय उप–योजना (टी.एस.पी.)

- संस्थान द्वारा जनजातीय उप–योजना के तहत तीन रेशा फसलों–पटसन (पश्चिम बंगाल के उत्तर–24 परगना, दक्षिण दिनाजपुर तथा नदिया जिलों में), सीसल (उड़ीसा के संबलपरु और झारसुगुडा जिलों में) तथा रेमी (असम, मेघालय,

नागालैण्ड तथा अरूणाचल प्रदेश) में विभिन्न कार्यक्रमों का संपादन किया गया।

- पटसन में उच्च उत्पादकता वाली नयी प्रजातियों, पंक्तिबद्ध बीज बुआई यंत्र, नेल वीडर, माइक्रोबियल सड़न इत्यादि प्रौद्योगिकीयों को जनजातीय कृषि पद्धतियों में समाविष्ट किए गए। सीसल और रेमी में भी गुणवत्ता रोपण सामग्रियों के उत्पादन, वितरण तथा क्षेत्र विस्तार आदि विषयों पर कार्य हुए।
- अखिल भारतीय नेटवर्क परियोजना (पटसन एवं समवर्गीय रेशा फसल) के कार्य क्षेत्रों में भी जनजातीय उप–योजना के अन्तर्गत उन्नत माइक्रोबियल सड़न विधि के कई प्रदर्शनों का आयोजन पश्चिम बंगाल के उत्तरी भागों तथा असम राज्य में किया गया। पश्चिम बंगाल के उत्तरी भागों में टी.एस.पी. के तहत पटसन बीज उत्पादन कार्यक्रम को कार्यान्वित किया गया। मानव संसाधन विकास के लिए 13 प्रशिक्षणों का आयोजन किया गया जिससे करीब 452 आदिवासी किसान बन्धु एवं महिलाएं लाभान्वित हुए।

अखिल भारतीय नेटवर्क परियोजना

- संस्थान मुख्यालय (बैरकपुर) में आयोजित ए.आई.एन.पी की 27वीं वार्षिक कार्यशाला में चिन्हित सादा पटसन की जे.आर.सी.–9057 (ईशानी), केनॉफ की जे.आर.के.एम.–9–1 (सत्येन) तथा रेमी की आर.–1411 (हजारिका) प्रजातियों का विमोचन प्रस्ताव केन्द्रीय उप–समिति–प्रजाति विमोचन को प्रेषित किया गया है, जिसका प्रतिउत्तर प्रतिक्षित है। इसके अतिरिक्त तोषा पटसन (जे.आर.ओ.जे.–1), केनॉफ (जे.बी.एम.जी.–4), सनई (जे.आर.जे.–610) फ्लैक्स (जे.आर.एफ.–2) की एक–एक तथा रोजेल (क्रिजैफ आर.–2 एवं क्रिजैफ आर.–8) की दो प्रजातियों को उत्तर बंग कृषि विश्वविद्यालय, कूचबिहार में आयोजित ए.आई.एन.पी. की 11वीं वार्षिक बैठक में विमोचन हेतु चिन्हित किया गया है।
- बहराईच तथा कटिहार केन्द्रों पर अंकुरण पश्चात क्विजॉलोफॉप ईथाइल 60 ग्रा./है. के प्रयोग तथा 15–20 दिनों के पश्चात एक बार हस्त निराई से अधिकतम लाभ–लागत अनुपात दर्ज किया गया। आमाडालावालासा तथा अदुथूरई केन्द्रों पर मेस्ता में प्रेटिलाक्लोर 50 ई.सी. को 900 मीली/है. की दर से छिड़काव तथा एक बार हस्त निराई करने से प्रभावी खर–पतवार नियंत्रण के कारण अधिकतम रेशा उपज दर्ज किया गया। सूखे की स्थिति में पटसन की बुआई 30 मार्च से अप्रैल के तीसरे सप्ताह तक तथा एक सिंचाई के साथ–साथ 80 कि.ग्रा. नत्रजन + 18 कि.ग्रा. फॉस्फोरस + 33 कि.ग्रा. पोटाश/है. के प्रयोग तथा खेत के चारों ओर मेड़बंदी से अधिकतम रेशा उपज की प्राप्ति हुई। आमाडालावालासा में वर्षा प्रारंभ होने के पश्चात् मेस्ता की बुआई तथा 60 कि.ग्रा. नत्रजन + 13 कि.ग्रा. फास्फारस + 25 कि.ग्रा. पोटाश के साथ 30 कि.ग्रा. सल्फर/है. के प्रयोग से अधिकतम रेशा उपज दर्ज किया गया।
- बैरकपुर, कूचबिहार, कटिहार तथा केन्द्रपाड़ा में तना एवं जड़ सड़न रोग का अत्यधिक प्रकोप देखा गया जबकि, कटिहार, बहराईच, केन्द्रपाड़ा तथा नौगांव केन्द्रों पर मोजैक तथा एन्थ्रेकनोज जैसे रोगों का प्रकोप तीव्र था। पौध सड़न (सीड़लिंग ब्लाईट) रोग का प्रकोप विशेषरूप से नौगांव केन्द्र में देखा गया। तना गलन रोग का लक्षण फसल के अन्तिम अवस्था (85–105 दिनों) में परिलक्षित हुआ जबकि एन्थ्रेक्नोज का लक्षण नौगांव (30.05%), बहराईच (18.70%) तथा कटिहार (3.50%) केन्द्रों पर बुआई के 60–105 दिनों के पश्चात परिलक्षित हुए। मोजैक रोग का अधिकतम प्रकोप बहराईच (69.80%) में दर्ज किया गया जिसके बाद क्रमशः केन्द्रपाड़ा (33.33%) तथा कटिहार (11.48%) केन्द्रों में इसकी तीव्रता दर्ज की गयी। पौध सड़न रोग का प्रभाव नौगांव (1.80%) में बुआई के 35 दिनों के पश्चात अभिलेखित किया गया।

कृषि विज्ञान केन्द्र, बर्दवान

- कृषि विज्ञान केन्द्र, बर्दवान ने कृषि (खाद्य, रेशा, चारा तथा तिलहन फसल), उद्यानिकी (सब्जी, फल व फूल), पशु पालन (गाय, सुअर तथा पॉल्ट्री इत्यादि) तथा मत्स्यकी के क्षेत्र में विभिन्न अनुशंसित प्रौद्योगिकी को किसानों तक पहुँचाने व प्रचारित करने के उद्देश्य से सात प्रक्षेत्र परीक्षण (ऑन–फार्म ट्रायल) तथा 220 अग्रिम पंक्ति प्रदर्शन (एफ.एल.डी.) आयोजित किए। इसके अतिरिक्त कृषकों, ग्रामीण युवकों, महिला किसानों व प्रसार कार्यकर्ताओं के लिए कुल 144 प्रशिक्षण कार्यक्रमों का आयोजन भी हुआ जिनमें कुल 3445 प्रतिभागियों ने भाग लिया।
- धान व दलहन के बीज तथा सब्जियों और उद्यानिकी फसलों के रोपण सामग्रियों को भी काफी मात्रा में पैदा कर किसानों के मध्य वितरण किया गया। इसके साथ ही कई प्रसार कार्यक्रमों जैसे प्रक्षेत्र दिवस, पशु स्वास्थ्य शिविर, एक्सपोजर भ्रमण, कृषि कार्यशाला, कृषि मेला, ग्रामीण विकास अनुष्ठान इत्यादि का भी आयोजन किया गया।

Introduction

Background

Central Research Institute for Jute and Allied Fibres (CRIJAF) is one of the oldest research institutes of NARS which 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, the following four research stations, 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.

Besides, the institute has nine (9) SAU-based and six (6) ICAR institute based collaborating centres for multi-locational testing and revalidation of the technologies under All India Coordinated Research Projects on Jute and Allied Fibres (AICRP J&AF), now functioning as All India Network Project on Jute and Allied Fibres (AINP J&AF).

The institute has played major role in developing and popularizing more than 50 varieties of jute and allied fibre crops which has doubled the productivity with considerable reduction in harvest period which 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 (18 km) and Howrah railway station (35 km).

Mission

To explore traditional and new frontier areas of science for technology development and policy guidance resulting in a resilient jute and allied fibre agriculture which must be effectively productive, eco-friendly, economically and socially equitable.

Vision

To ensure the livelihood security of resource-poor farmers by enhancing the productivity of quality jute and allied fibres through generation, assessment, refinement and adoption of appropriate technologies.

Mandate

- Improvement of jute (*Corchorus olitorius*) and *C. capsularis*), mesta (*Hibiscus cannabinus* and *H. sabdariffa*), sunnhemp (*Crotalaria juncea*), ramie (*Boehmeria nivea*), sisal (*Agave sisalana*) and flax (*Linum usitatissimum*) for higher yield and better quality.
- Improvement of jute and allied fibre crops for biotic and abiotic stresses.
- Development of economically viable and sustainable production technology and jute and allied fibres-based cropping systems.
- Development of post-harvest technology for improving the quality of fibre.
- Transfer of technology and human resource development in relation to jute and allied fibre crops.

Organizational set up

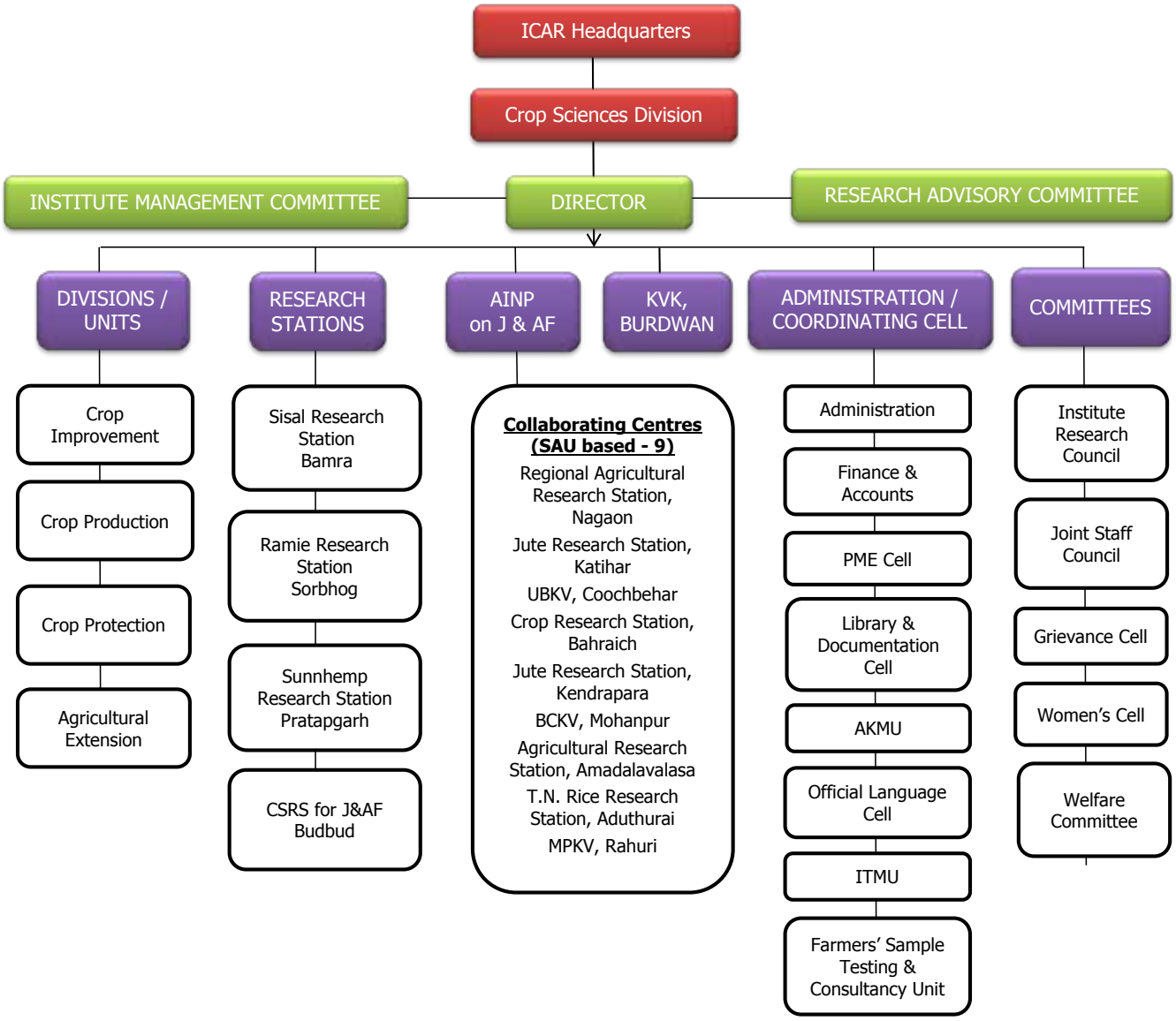
The institute has 3 research divisions *viz.*, Crop Improvement, Crop Production, Crop Protection and

Agricultural Extension section at the headquarters to meet research and extension needs in specific areas. The 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.

Farm

For conducting field experiments and for seed production the institute has 61.04 ha farm at the headquater at Barrackpore, 56.00 ha at Ramie Research Station, Sorbhog, Assam, 103.60 ha at Sisal Research Station, Bamra, Odisha, 9.18 ha at Sunnhemp Research Station, Pratapgarh, U.P. and 65.00 ha at Central Seed Research Station for Jute and Allied Fibres, Budbud, Burdwan, W.B.

Organogram



1. Crop Improvement

1.1 Genetic resource management

Enrichment of genetic resources for wider variability is key for genetic improvement of jute and allied fibres. In this endeavour exploration of germplasm, its characterisation and evaluation, mid-term conservation and utilization are very important activities in improvement of jute and allied fibre crops.

1.1.1. Germplasm exploration and conservation

Through explorations in Odisha and Port Blair during November and December, 2013 eight accessions of jute and allied fibres; *C. aestuans* (02) *Crotalaria* spp. (02), *Hibiscus sabdariffa* (02), *Urena* spp. (02) have been collected (Fig. 1.1). About, 4000 accessions of jute and allied fibres are being conserved in mid-term storage module. These accessions are regenerated at regular intervals to replenish older stock in gene bank. In 2013-14, a total of 600 accessions of *Hibiscus sabdariffa* have been regenerated at CRIJAF, Barrackpore and SRS, Bamra. Besides, new collections of wild *Hibiscus* spp. (19) and *Crotalaria* spp. (42) collected from Tamil Nadu and Kerala in 2013 were grown for seed multiplication (Fig. 1.2) (**Source JB 1.1. Contributors: P.G. Karmakar, S.B. Choudhary, H.K. Sharma and A. Anil Kumar**).

Ramie, *Boehmeria nivea* being the crop of NE India, exploration were conducted in Sikkim (1650 msl, 27^{0}8'N to 88^{0}4'E). Four germplasm accessions were collected from Sikkim during the month of December (Fig. 1.3 &Table 1.1). All the four accessions were planted in the introduction plot of RRS, Sorbhog, Assam for further study and characterization. All four accessions are being identified as wild ramie (*Boehmeria spp*.). Accession SGRC-4 has small thorns on the leaves. Species level identification will be done at the flowering stage of the plants. (**Source: RB 1.0. Contributors: A. K. Sharma and S.P. Gawande**).

Crotalaria sp. *Urena* sp.

Fig. 1.1: *Crotalaria* sp. and *Urena* sp. in their natural habitat

Fig. 1.2: Different species of new collections of *Hibiscus* and *Crotalaria* being multiplied at CRIJAF, Barrackpore

Fig. 1.3: Germplasm collections of *Boehmeria spp*. from Sikkim and planted at RRS, Sorbhog

Table 1.1: Pass port data of germplasm collection form Sikkim

Accession	Place of collection	State	Latitude	Longitude	Altitude (MSL)
SGRC-1	Gangtok	Sikkim	2708'N	8804'E	1650 M
SGRC-2	Arithang	Sikkim	2708'N	8804'E	1650 M
SGRC-3	Tadong	Sikkim	2708'N	8804'E	1650 M
SGRC-4	Tadong	Sikkim	2708'N	8804'E	1650 M

1.1.2 Characterization and evaluation

A total of 169 newly collected germplasm accessions of jute and allied fibres comprising of *Corchorus* spp. (137), *Hibiscus* spp. (24) and *Urena* spp. (08) have been characterized using morphological and quantitative traits (Table 1.2). Trend for fibre yield in these accessions depicted in Fig. 1.4. Further, eighty OIN accessions of tossa jute selected for better fibre quality have been re-evaluated for fibre yield attributing traits (Table 1.3). A total of 127 accessions of flax were characterized for floral morphology and 20 different accessions of flax have been evaluated for total biomass partitioning at 60 DAS (Fig. 5) (**Source: JB 1.1. Contributors: P.G. Karmakar, S.B. Choudhary, H.K. Sharma and A. Anil Kumar**)

Table 1.2: *Per se* performance of new germplasm accessions collected from Tamil Nadu and Kerala

Species	Plant height (cm)	Basal diameter (cm)	Green weight (g)	Stick weight (g)	Dry fibre weight (g)
C. olitorius (18)					
Mean	204.7	11.1	102.8	12.3	4.64
Range	166.4-235.4	9.2-13.7	74.0-164.0	7.6-21.7	2.8-8.4
C. aestuans (54)					
Mean	138.7	9.7	150.1	21.2	4.6
Range	86.6-166.6	6.8-15.1	50.0-328.0	1.0-50.1	0.84-12.24
C. tridens (14)					
Mean	125.1	10.6	129.9	26.5	1.7
Range	97.0-139.4	7.9-14.3	70.2-238.0	16.3-41.8	0.4-3.7
C. trilocularis (7)					
Mean	135.5	8.0	85.1	17.7	2.2
Range	117.2-149.8	6.8-9.9	47.2-142.0	10.3-26.7	1.1-2.9
C. pseudo-olitorius (02)					
Mean	157.6	10.4	82.7	14.5	3.8
Range	157.0-158.2	10.0-10.8	72.4-93.0	13.0-16.1	3.4-4.24
H. sabdariffa (09)					
Mean	193.8	19.1	179.1	15.7	6
Range	170.0-246.0	13.5-40.7	118.7-231.8	4.2-23.0	3.8-8.4
H. cannabinus (15)					
Mean	258.9	17.5	207.7	28.4	10.1
Range	215.6-324.8	14.8-21.6	145.4-332.3	16.0-50.8	6.2-19
Urena lobata (08)					
Mean	226.4	14.5	172.3	27.5	6.7
Range	199.0-246.0	12.7-16.0	101.9-224.9	16.8-36.4	4.4-8.4

Note: Values in parenthesis indicate number of germplasm accessions of the respective species

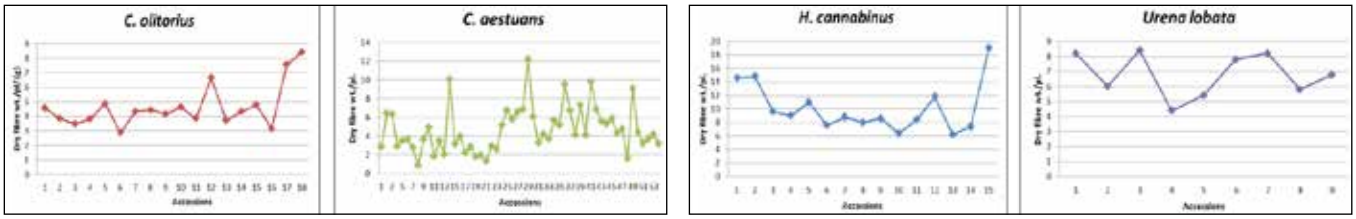


Fig. 1.4: Dry fibre production trend in new collections

Table 1.3: Qualitative and quantitative traits variation in selected *C. olitorius* accessions

Qualitative traits						
Stem colour	**Leaf shape**	**Leaf Lamina colour**	**Leaf vein colour**	**Stipule colour**	**Petiole colour**	**Branching habit**
Green / Red	Lanceolate, Cordate, Ovate, Palmate	Green/ red	Green/ red	Red / green	Red / green	Non branching
Quantitative traits						
Leaf angle (°)	**Petiole length (cm)**	**Leaf lamina length (cm)**	**Leaf lamina width (cm)**	**Dry fibre weight (g)**	**Highest fibre yielding accession**	
25.8 -36	3.5 – 5.3	8.4 – 25.8	4.6- 7.8	4.2-17.4	PG 110, PG 130	

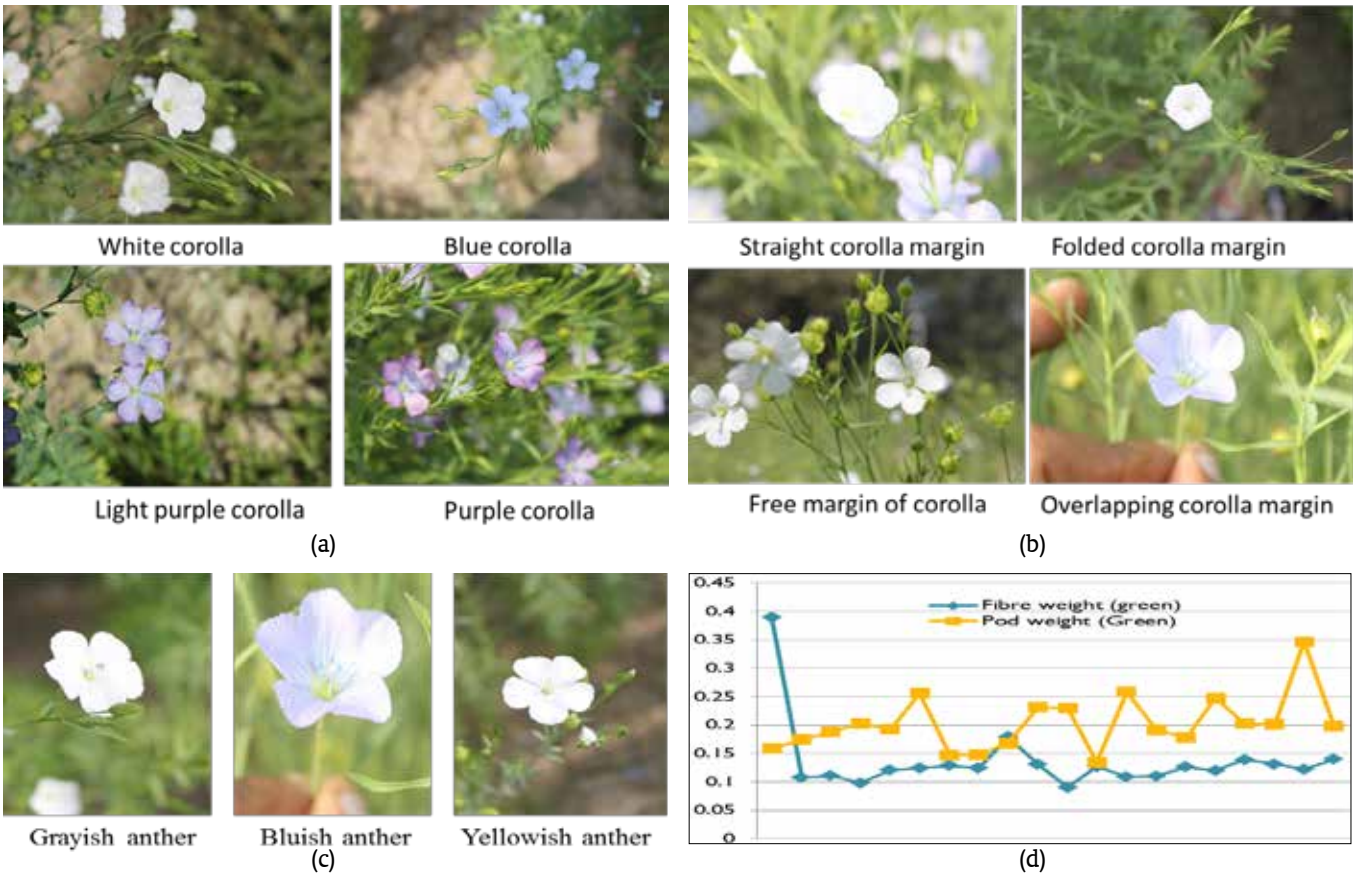


Fig. 1.5: (a-c) Flower morphology variability in flax germplasm accessions (d) Biomass distribution between green fibre and pod weight (g) at 60 DAS in 20 accessions of flax

A total of 127 accessions of flax (*Linum usitatissimum*) were evaluated along with 4 checks namely, JRF-2, JRF-4, FT-895 and FT-897 at sunnhemp research station, Pratapgarh (Table 1.4) **(Source: SNHB 1.8. Contributors: B. Chaudhary, M.K. Tripathi and H. Bhandari).**

Table 1.4: Data of range for flax germplasm evaluation during 2012-13

Characters	Range
Plant height (cm)	76.6-145.2
Basal diameter (mm)	2.8-5.2
Primary branches/plant	2.2-6.0
Days to 1st flowering	50-71
Days to 50% flowering	74-103

Crotalaria juncea L. germplasms (145) were evaluated and maintained. Data were recorded on fibre yield and yield component (Table 1.5) **(Source: SNHB 1.8. Contributors: S.B. Chaudhary, M.K. Tripathi, H. Bhandari and S.K. Pandey**).

Table 1.5: Range for different variables recorded on 145 germplasm accessions of sunnhemp

Characters	Range
Germination (%)	2.0-80.0
Plant height (cm)	76.4-206.8
Basal diameter (mm)	3.7-11.0
No. of Primary branches/plant	2.6-8.8
No. of secondary branches/plant	3.4-19.6
Days to 1st flowering	33-53
Days to 50% flowering	41-57
Seed yield/plot (g)	0.1-145.0
No. of pod/plant	5.6-107.4
No. of damage pod/plant	2.0-37.0
Pod length (cm)	2.4-3.6
Pod diameter (mm)	8.6-13.0
Dry weight /5plant (g)	25.0-390.0
Pod weight/5 plant (g)	5.0-215.0
Seeds/pod	1.8-13.8
Seed yield/5 plant (g)	0.1-145.0
Plant stand	2.0-77.0

Out of 181 total germplasm collections of ramie at RRS, Sorbhog, 102 germplasm were grouped as cultivated and other 79 collections are wild types. Two major groups of wild and cultivated can be identified by visual observation very easily. The major collections of cultivated types were further grouped into three sub-groups *viz.*, exotic green, exotic white and indigenous white accessions. Considerable variation have been found in ramie germplasm regarding leaf colour, petiole colour, colour of female and male flowers, seedling colour etc. (Fig. 1.6-1.8 & Table 1.6). Cultivated germplasm collection can be identified and characterized using these traits. **(Source: RB1.0. Contributors: A.K. Sharma and S.P. Gawande)**

R-1411 R-1445 R-1427

Fig. 1.6: Variation for colour of female flowers in exotic germplasm

R-1411 R 67-34 R-1411 R 67-34

Fig. 1.7: Petiole colour and seedling colour variation in ramie germplasm

R 1410 (Exotic Green) R 1411 (Exotic white) R 1424 (Indigenous white)

Fig. 1.8: Phenotype of cultivated tall ramie germplasm

Table 1.6: Characterization of cultivated gene pool of ramie at RRS, Sorbhog

Phenotypic trait	Cultivated Accessions (total collections 102)		
	Green exotic ramie (1)	White ramie (101)	
		Exotic (67)	Indigenous (34)
Leaf colour	Both side green	One green and one white surface	One green and one white surface
Petiole colour	Green	Green (R0-1411), pink (R 67-34)	Pink (R 1424)
Colour of male flower	Green	Green	Green
Colour of female flower	Green	Green, light yellow, pink and red	Light green
Seedling colour	Green	Green and pink	Pink
Maximum plant height (m)	1.5	2.5	2.0
Green weight (%) at harvest (55 days in summer)	35-40	30-35	35-40
Name of major accessions	R 1410	R-1411, R-1416, R1418, R 67-34, R- 1445, R 1427, AK-11-01 & RMB-14	R-1424, R-1426, R-1429, R-37, R-38, R-39, R-40, RMB-1 AK-11-49 & 209-06

1.1.3 Distribution

A total of 1706 germplasm accessions of jute and allied fibres have been distributed to different indenters including scientists of CRIJAF, AINP on Jute and Allied Fibres and other institutes (**Source: JB 1.1. Contributors: P.G. Karmakar, S.B. Choudhary, H.K. Sharma and A. Anil Kumar)**

1.1.4 Heterosis and diversity study in *C. olitorius*

Twenty one F_1s along with seven parents and two checks (JRO 524 and JRO 204) were evaluated in 2013-2014 for five major yield attributing characters (Table 1.7, Fig. 1.9). Among F_1s plant height ranged from 326.30 to 376.33 cm, basal diameter ranged from 13.26 to 17.22 mm, fibre yield per plant ranged from 9.20 to 16.73 g. Highest fibre yield was recorded by a cross OMU 19 x OMU 27 (16.73 g) followed by cross OIN 255 x OEX 32 (15.72) and OIN 255 x OMU 27 (14.33 g). Data were analyzed based on Griffing's fixed effect model. Analysis of variance was significant for treatments for all characters except basal diameter, which showed considerable amount of variation present in parents and hybrids and significance of parents *vs* hybrids for fibre yield/ plant indicated presence of heterosis in the hybrids. Among the parents, OIN 255 recorded significantly positive *gca* effects for plant height (10.11*), green weight (134.13**) and fibre yield/ plant (4.49*) and OMU-27 recorded significant positive *gca* effects for plant height and stick weight (Table

1.8). Significant positive *sca* effects (Table 1.9) for green weight, stick weight and fibre weight was recorded by OMU 19 × OMU 27 and OIN 255 × OEX 32. Maximum standard heterosis was recorded by OMU 19 × OMU 27 (41.01%) followed by OIN 255 × OEX 32 (32.47) (Fig. 1.10) **(Source JB 9.1. Contributors: A. Anil Kumar, C.S. Kar and J. Mitra)**

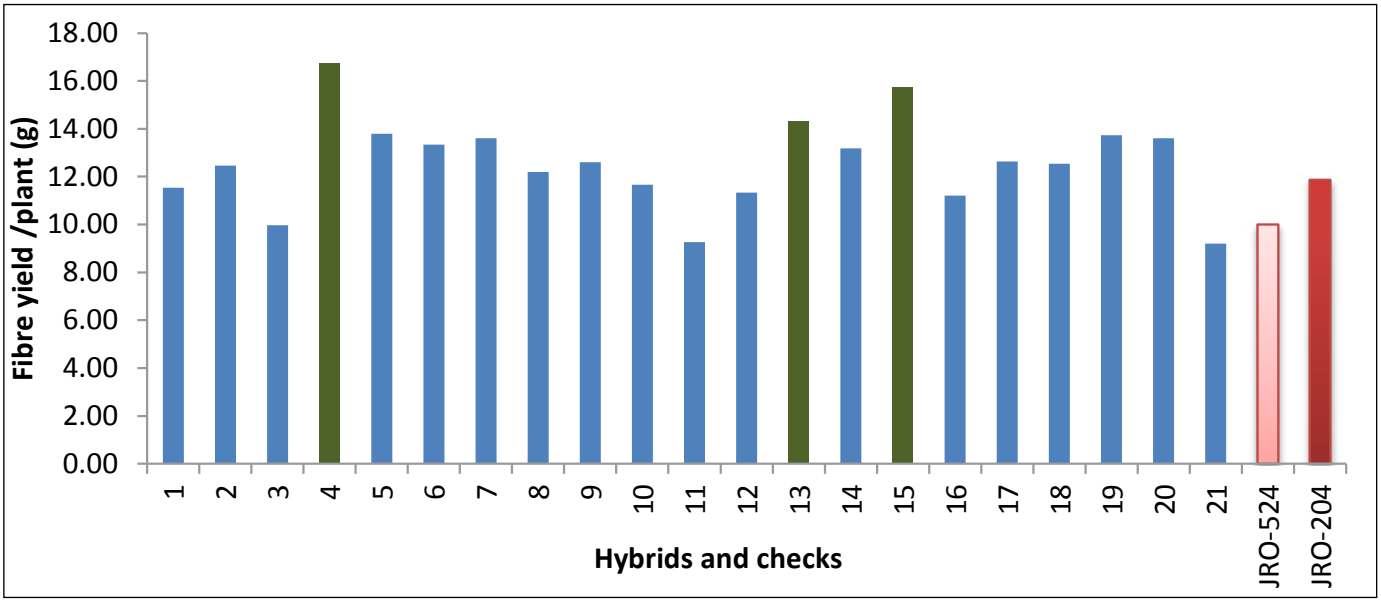


Fig. 1.9: *Per se* performance of 21 F1 hybrids of *C. olitorius* for fibre yield per plant (g)

Table 1.7: Mean, range and best cross combinations among 21 F_1 hybrids of *C. olitorius*

Traits	Mean±SE	Maximum	Minimum	Best cross
Plant height (cm)	351.72±3.07	376.33	326.60	OIN 255 x OMU 27
Basal diameter (mm)	15.25±0.22	17.22	13.26	OMU 19 x OMU 27
Green weight (g)	263.72±27.37	361.30	208.93	OMU 19 x OMU 27
Stick weight (g)	39.67±4.09	54.47	25.33	OMU 19 x OMU 27
Fibre yield/plant (g)	12.60±1.16	16.73	9.20	OMU 19 x OMU 27

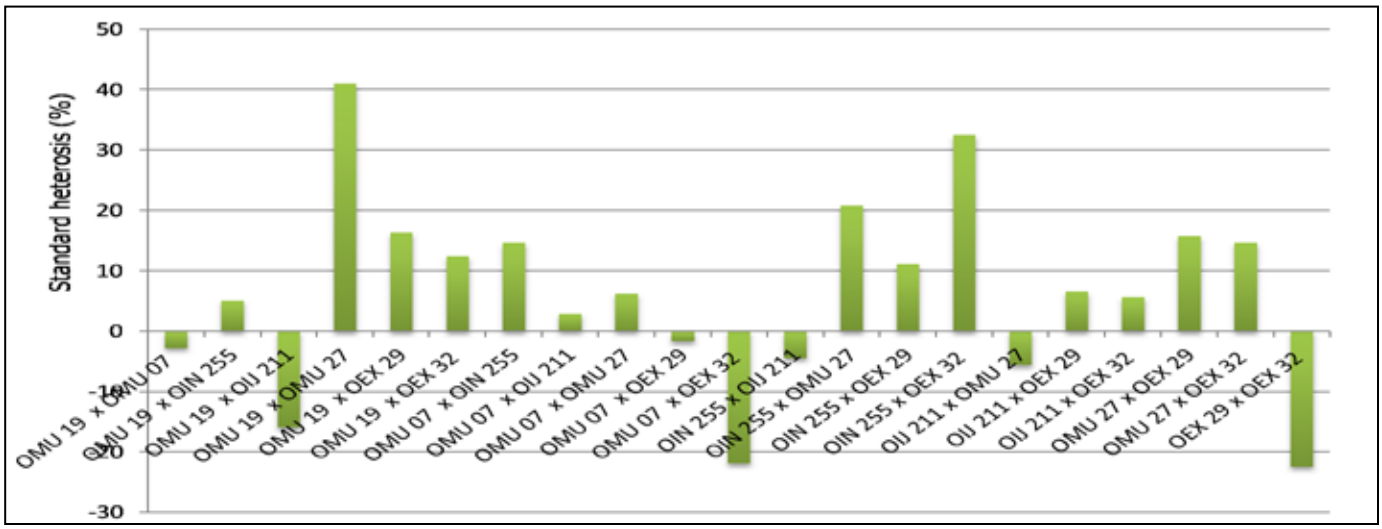


Table 1.8: GCA effects of parents for fibre yield attributing traits in *C. olitorius*

Parents	Plant height	Basal diameter	Green weight	Dry core weight/plant	Fibre weight/plant
OMU-19	0.95	0.03	-4.04	4.09	2.42
OMU-07	-23.55**	-0.12	-102.37*	-25.69**	-5.00*
OIN-255	10.11*	0.23	134.13**	12.79	4.49*
OIJ-211	1.492	0.27	-9.98	-3.79	-2.07
OMU-27	12.87*	0.20	73.73	14.59*	3.28
OEX-29	2.40	-0.27	-64.52	-1.07	-3.29
OEX-32	-4.29	-0.33	-26.93	-0.93	0.16

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

Table 1.9: Mean fibre yield, SCA effects and standard heterosis of 21 F_1s of *C. olitorius*

Cross	Mean fibre yield/plant (g)	*SCA* effects	Standard heterosis over JRO 204 (%)
OMU 19 x OMU 07	11.53	1.82	-2.81
OMU 19 x OIN 255	12.47	-3.00	5.06
OMU 19 x OIJ 211	9.97	-8.90	-15.96
OMU 19 x OMU 27	16.73	19.53**	41.01**
OMU 19 x OEX 29	13.80	11.44	16.29
OMU 19 x OEX 32	13.33	5.65	12.36
OMU 07 x OIN 255	13.60	10.08	14.61
OMU 07 x OIJ 211	12.20	9.65	2.81
OMU 07 x OMU 27	12.60	6.29	6.18
OMU 07 x OEX 29	11.67	8.20	-1.69
OMU 07 x OEX 32	9.27	-7.25	-21.91
OIN 255 x OIJ 211	11.33	-4.18	-4.49
OIN 255 x OMU 27	14.33	5.45	20.79
OIN 255 x OEX 29	13.19	6.30	11.12
OIN 255 x OEX 32	15.72	15.50*	32.47*
OIJ 211 x OMU 27	11.20	-3.63	-5.62
OIJ 211 x OEX 29	12.64	10.13	6.52
OIJ 211 x OEX 32	12.53	6.14	5.62
OMU 27 x OEX 29	13.73	10.24	15.73
OMU 27 x OEX 32	13.60	6.11	14.61
OEX 29 x OEX 32	9.20	-9.30	-22.47

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

To estimate heterosis in tossa jute, 54 F_1 hybrids along with 15 parents (nine lines and six testers) and one check were evaluated in RBD design (Table 1.10). Three important quantitative characters *i.e.*, plant height, basal diameter and fibre yield were evaluated for heterosis. The hybrid performances were significantly different from that of parents. OIJ 268 exhibited highest *gca* effects, while the cross combination OIJ 268 x S 19 exhibited highest *sca* effect and high heterosis for fibre yield (75.4%). Highest heterosis for fibre yield was recorded by the cross combination OIJ 5 x OMU 7.

Table 1.10: Line x Tester ANOVA for assessing heterosis in *C. olitorius*

Source	df	Plant height	Basal diameter	Fibre yield
Blocks	2	18,953.6**	44.488**	481.541**
Parents	14	554.314	6.84**	824.375**
Crosses	53	1,367.78	2.37	502.11**
Parents vs. Crosses	1	8,477.09**	26.143**	25,064.3**
Males	5	109.617	10.851**	568.456**
Female	8	663.535	2.209	859.87**
Male vs Female	40	1,904.03**	23.834**	1,820.00**

** significant at 1% level of probability

Mitochondrial and chloroplast loci polymorphism were studied at nine mitochondrial loci and one chloroplast locus (ALC_1-3) in 60 mutant lines of *C. olitorius*. The study identified three distinct mitochondrial types in the mutant population of *C. olitorius*, indicating mitochondrial variability may play a key role in classification of jute and development of mitochondrial DNA based markers for identification and characterization of plant genetic resources. (**Source: RKVY component I. Contributors: D. Sarkar, A. Anil Kumar, J. Mitra, C. S. Kar, P. Satya, H. K. Sharma and S. B. Choudhary**)

1.1.6 Phenotyping of RIL population of *C. capsularis* for resistance to stem rot

For genetic analysis of resistance to stem rot disease in jute, a RIL population of 202 genotypes was screened using challenge inoculation of *Macrophomina phaseolina* in lower and middle parts of the stem at active vegetative growth stage (80 – 90 days). Disease progress was monitored through lesion length development. Analysis of variance revealed significant difference among RILs for disease progress. The same population was also screened at seedling stage (15 – 20 days) using seed treatment of *M. phaseolina* spore suspension and scored using percent mortality of seedlings. At seedling stage, 29.7% of the population expressed resistance reaction. In *C. olitorius*, a BC_1F_1 population has been developed using OIN 154 as resistant donor parent, which will be phenotyped at BC_1F_2. Parental polymorphism has been studied in *C. capsularis* using 50 SSR markers, of which 18 were found to be polymorphic **(Source: DBT project on stem rot resistance. Contributors: P. Satya, P. G. Karmakar and C. Biswas)**

1.1.7 Phenomics of bast fibre anatomy in *C. olitorius*

For characterization of bast fibre anatomy, nine fibre anatomical characters were selected on the basis of association of these characters with fibre yield. These were - fibre strip thickness, periderm thickness, fibre wedge length, fibre wedge thickness at base, fibre wedge thickness at top, fibre wedge thickness at middle, number of fibre bundles at base of wedge, number of fibre bundles at middle of wedge and number of fibre cells per fibre bundle. Quantitative fibre anatomy was studied at 140 days old plants of JRO 524 and S 19. Based on the data, a model has been developed for prediction of fibre yield using the following equation.

$$\text{Fibre yield/plant} = \tfrac{1}{2}\ \text{SFA} \times h \times N \times 1.34$$

(where SFA is single fibre wedge area, h is plant height and N is number of fibre wedges per cross sectional area)

The SFA is determined from the anatomical observations of fibre. The model predicted fibre yield of cv. JRO 524 to be 24.9 g/plant, while the fibre yield of cv. S 19 was predicted to be 23.4 g/plant. The vaiability in fibre wedge development and fibre cell maturation is depicted in fig. 1.11

Fig. 1.11: Variability in fibre wedge development (A, B) and fibre cell maturation (C, D) in jute

Further, large scale phenomics of fibre anatomy has been completed in 58 mutant genotypes of *C. olitorius* to identify suitable parental combination for mapping population development. Fifty four out of sixty mutants exhibited higher fibre cell number per bundle than the cultivars. Based on results, crosses have been affected between JRO 524 and OMU 7, JRO 524 and OMU 21 and between JRO 204 and OMU 21. The F_1 population is being grown in national facility for off season nursery at Agali, Kerala.

In another programme under the project, four high yielding varieties of *C. olitorius* and three *M. phaseolina* resistant and one semilooper resistant (donor) genetic stocks were used to develop F_1. For optimization of anther culture, a surface sterilization protocol for flower buds has been optimized. Anthers of late uninucleated stage involving anthers from F_1 hybrids were cultured *in vitro*. Callus induction media have been optimized, which resulted in massive callus induction and have been phased through multiplication media (**Source: TMJ-I. Contributors: P. Satya, P. G. Karmakar, A. B. Mandal, K. Meena, H. K. Sharma, S. B. Choudhary)**

1.2 Varietal development

1.2.1 Jute

1.2.1.1 White jute (*Corchorus capsularis*)

A total of 20 segregating population (F_7 generation) of selected 30 crosses from 10 diverse parents (CIM 003, CIM 007, CIM 036, CIM 068, CIM 069, CIM 076, CIM 077, CMU 010, CIN 109, and CIN 309) were evaluated for fibre yield, to select superior lines as marked in Table 1.11.

Table 1.11: Mean performance of selected 20 families of *C. capsularis*

Family	Plant height (cm)	Basal diameter (mm)	Green weight/plant (g)	Fibre yield/plant (g)
1	323.5	18.0	312.2	18.2
2	330.2	17.2	300.2	16.3
3	342.6	17.4	325.0	19.0*
4	343.2	15.6	300.4	16.3
5	322.5	17.4	311.2	18.5
6	345.2	18.2	340.2	20.3*
7	340.2	16.9	345.6	20.4*
8	345.5	18.5	355.6	21.3*
9	335.6	16.1	256.3	15.6
10	332.6	16.3	256.4	16.3
11	334.5	17.9	300.2	18.9*
12	340.2	17.0	304.8	16.5

13	330.3	17.6	332.4	20.1*
14	335.9	17.2	312.3	19.0*
15	342.8	16.5	275.6	14.5
16	329.5	17.2	300.2	15.6
17	336.7	17.5	324.2	20.3*
18	332.2	15.6	274.5	15.3
19	340.5	18.6	332.5	20.3*
20	335.6	17.5	324.6	19.8*
JRC 321	343.5	16.3	300.2	16.5
JRC 698	347.8	17.2	311.2	16.2

*Selected superior families of C. Capsularies

These 10 lines were evaluated as station trial along with three checks at Barrackpore in *kharif* 2013-14. Based on performance with respect to fibre yield and fibre quality (fineness and strength) (Table 1.12), best two lines denominated as JRCJ 6 and JRCJ 7 have been nominated as entry in IET trial , 2013-14 under AINPJAF.

Table 1.12: Performance of 10 lines of *C. capsularis* in station trial

Line	Plant height (cm)	Basal diameter (mm)	Green weight (q/ha)	Fibre yield (q/ha)	Fibre strength (g/tex)	Fibre fineness (tex)
1	349.3	17.6	48.6	28.6	16.9	1.2
2	343.4	17.0	51.0	30.5	16.8	1.4
3 (JRCJ 6)*	345.2	18.2	57.2	33.6	19.6	1.2
4(JRCJ 7)*	344.4	16.9	55.5	32.9	18.6	1.3
5	342.1	18.7	52.3	30.2	16.0	1.6
6	328.4	19.3	50.7	30.5	20.5	1.4
7	338.5	17.0	51.2	29.6	20.3	1.5
8	346.2	16.9	48.0	27.8	16.3	1.9
9	340.0	18.2	52.3	29.6	17.5	1.8
10	345.6	17.5	46.7	26.9	12.7	1.6
JRC 517	343.4	17.5	48.3	28.5	16.3	1.5
JRC 532	340.2	16.9	48.6	28.7	16.5	1.6
JRC698	346.2	18.0	45.6	26.9	17.8	1.6
SE(m)	-	-		1.3	-	-
LSD (P=0.05)	-	-	-	2.2	-	-

*Nominated in IET trial of AINPJAF

Selection in F_7: Based on evaluation of 50 single plant progenies of 5 F_7 populations of 5 different crosses (JRC 698 X Bidhan Pat 3,CEX 006 X JRC 4444, KTC 1 X CEX 007, JRC 4444 X CEX 007, CEX 007 X CIJ 001), 10 lines (as bulk seed of single plant progeny) were selected. Mean performance of F_7 progeny of five crosses are depicted in Table 1.13

Table 1.13: Mean performance of F_7 progeny of 5 crosses

Cross	Plant height (cm)	Basal diameter (mm)	Green weight/ plant (g)	Fibre yield/ plant (g)
1 CEX 006 X JRC 698	330.5	16.5	312.3	18.6
2 JRC 4444 X JRC 321	348.6	14.9	278.5	14.2
3 CMU 010 X CIN 010	341.9	16.9	311.6	18.9
4 CEX 006 X KTC 1	355.4	15.6	350.2	19.6
5 CEX 007 X CIN 010	329.1	17.8	289.6	16.3

Selection in F_6: From another set of 45 single plant F_6 progeny of three different crosses (CIJ 126 X JRC 80, CIJ 126 X CIJ 121, JRC 321 X CIJ 121), 5 lines were selected. Mean performances of F_6 progeny of three crosses are depicted in Table 1.14 (**Source: JB 8.4. Contributors: J. Mitra and C. S. Kar).**

Table 1.14: Mean performance of F_6 progeny of three crosses

Cross	Plant height (cm)	Basal diameter (mm)	Green weight/ plant (g)	Fibre yield/ plant (g)
1 CIJ 126 X JRC 80	344.5	17.4	315.2	19.2
2 CIJ 126 X CIJ 121	355.6	16.8	300.2	17.4
3 JRC 321 X CIJ 121	352.5	18.6	302.2	16.9

1.2.1.2. Tossa jute (*Corchorus olitorius*)

1.2.1.2.1. Screening of germplasm for new source of premature flowering resistance in *C. olitorius*

A total of 180 germplasm including mostly of African accession (OIJ 1 to OIJ 152, OIJ 201, 202, OIJ 232-235, OIJ 256- 260 from Keniya, OIJ 263-264, OIJ 276, OEX 002-004 from Tanzania) along with cultivated check varieties JRO 632 (premature flowering susceptible) and JRO 524, JRO 204, JRO 128, JRO 8432 and JBO 1 (premature flowering resistant) were evaluated during *kharif* 2013. Only one accession OIJ 257 (i.e. KEN/DS/054C) did not flowered up to 63 DAS along with popular varieties JRO 524, JRO 204, JRO 128, JRO 8432 and JBO 1. But neither Sudan green (OEX031) nor Tanganyika-1 (OEX 002) or Tanganyika-2(OEX 003) or Tanganyika 3 (OEX 004) were able to show premature flowering resistance even after 50 DAS. This indicates that genetic purity of these lines had been altered over time. Only Tanganyika-2 (OEX 003) has shown 5% flowering upto 63 DAS.

1.2.1.2.2 Development of new Crosses

Inter varietal diallel (7×7) crosses were made involving parents JRO 524, JRO 204, S-19, KOM 62, JRO 2407, JRO 8432, JRO 878 during *kharif*, 2013 with an objective to estimate varietal heterosis. These 21 crosses along with reciprocals and parents will be grown for evaluation during *kharif*, 2014.

Confirmation of Hybrid

Two hundred attempted crosses of 9 interspecific combinations were grown in *kharif*, 2013. All F_1 plants reverted to female types only. No successful interspecific hybrid was obtained.

Table 1.15: Detail of cross seeds grown *kharif*, 2013

Crosses	Progeny
JRO-204 X WCIJ-018	10
JRO-204 X WCIJ-92	30
JRO-204 X WCIJ-133	10
JRO-204 X WCIN-182	20
JRO-204 X WCIJ-52	5
JRO-204 X WCIJ-123	30
JRO-204 X Monalisha	20
JRO-204 X JRO-2407	25
JOC-9057 X JRO-2407	50
Total	200

1.2.1.2.3 Segregating generation

F_2 generation: 257 progenies of 26 F_2 populations were

evaluated in *kharif*, 2013. Selection was done for stem rot resistance or tolerance as all progenies were derived from either of the two donor lines *i.e.*, OIN-125 and OIN-154. Selected 42 progenies will be advanced to F_3 in *kharif*, 2014.

Table 1.16: F_2 progenies of *C. olitorius* evaluated for stem rot resistant

Crosses	Progeny	Crosses	Progeny
OIN-004 X OIN-125	4	OIN-054 X OIN-154	12
OIN-007 X OIN-125	5	OIN-058 X OIN-154	10
OIN-008 X OIN-125	10	OIN-082 X OIN-154	10
OIN-054 X OIN-125	2	OIN-102 X OIN-154	8
OIN-058 X OIN-125	9	OIN-106 X OIN-154	9
OIN-082 X OIN-125	5	OIN-125 X OIN-154	10
OIN-102 X OIN-125	10	OIN-198 X OIN-154	10
OIN-106 X OIN-125	8	JRO-128 X OIN-154	9
OIN-125 X OIN-125	10	JRO-204 X OIN-125	7
OIN-198 X OIN-125	9	JBO-1 X OIN-125	12
OIN-004 X OIN-154	14	JRO-128 X OIN-154	12
OIN-007 X OIN-154	13	JRO-204 X OIN-154	14
OIN-008 X OIN-154	13	JBO-1 X OIN-154	22
Total	257		

F_3 Generation: One set of ten crosses were advanced to F_2 generation in offseason nursery at Agali, Coimbatore in 2012 and these 10 F_3 Populations were evaluated for plant height (cm), basal diameter (mm), resistance to stem rot, green fibre weight, dry fibre weight and stick weight. 10 progeny rows of all F_3 population *i.e.* OIN 004×OIN 125, OIN 007×OIN 125, OIN 008×OIN 125, OIN 054×OIN 125, OIN 058×OIN 125, OIN 004×OIN 154, OIN 007×OIN 154, OIN 008×OIN 154, OIN 054×OIN 154, OIN 058×OIN 154 except 40 rows for 004×OIN 154 were grown. **(Source: JB 8.3. Contributors: C.S. Kar, S.K. Sarkar and A.K. Ghorai)**

Table 1.17: Detail of 28 selected progenies from 10 F_3 populations

Crosses	Progeny No.	Plant height (cm)	Basal diameter (mm)	Green wt. (g/plant)	Dry fibre wt. (g/plant)	Stick wt. (g/plant)
OIN-004 X OIN-125	3	287	12.5	215	23.7	69.0
	8	314	15.7	373	23.4	59.4
	9	320	14.1	351	20.8	63.4
OIN-007 X OIN-125	2	311	15.2	323	20.7	48.7
OIN-058 X OIN-125	3	326	14.6	290	19.6	49.8
	4	326	14.9	260	18.8	50.0
	5	320	14.0	278	18.8	58.5
	6	336	14.9	338	18.8	54.0
	7	322	15.3	329	18.7	51.0
	8	329	13.6	290	18.5	52.8

OIN-004 X OIN-154	1	348	14.7	322	18.2	45.3
	2	346	15.4	339	18.0	67.3
	8	367	17.4	511	18.0	58.2
	13	327	16.9	415	16.0	50.5
	19	351	14.9	384	16.0	56.5
OIN-007 X OIN-154	1	400	16.3	481	17.8	64.8
	2	398	14.4	378	17.8	42.5
	3	403	14.9	478	17.6	46.2
	4	390	16.2	424	17.5	64.0
OIN-008 X OIN-154	3	370	14.9	402	17.4	53.8
	6	357	13.8	372	17.3	65.0
	8	394	15.6	527	17.3	42.7
	10	374	16.6	526	17.2	41.8
OIN-054 X OIN-154	2	360	13.0	317	17.0	52.8
	10	322	12.7	266	17.0	44.0
OIN-058 X OIN-154	3	362	15.4	402	17.0	51.3
	6	362	14.8	386	16.8	36.1
	8	364	15.5	441	16.8	54.8

Based on disease reaction, plant height, base diameter and fibre weight per plant, 28 progenies were selected for next generation.

1.2.1.2.3. Screening for drought tolerance

A total of 600 germplasm accessions along with 15 varieities of tossa jute were evaluated under field condition as well as under PEG treatment. Frequency distribution of germination % under PEG given in Table 1.18 reveals that majority of accession was found to be susceptible to drought condition.

Table 1.18. Germination percentage of *C olitorius* germplasm accession under PEG treatment

Germination %	No. of accession
0	466
1-10	84
11-20	12
21-30	6
31-40	10
41-50	2
51-60	11
61-70	3
71-80	5
81-99	1
100	0
Total	600

Based on screening 20 lines of tossa jute were found to be moderately drought resistance which requires further testing. Germination % under PEG and Control are given in Table 1.19

Table 1.19: Germination % under PEG and Control of selected 20 lines

Accession	Germination % under PEG Treatment	Germination % under Control
OIN 566	84	89
OIN 633	80	84
OIN 637	80	92
OIN 571	76	80

OIN 569	76	92
OIN 634	72	88
OIN 564	68	88
OIN 632	64	80
OIN 567	64	80
OIN 636	60	92
OIN 576	60	84
OIN 575	56	80
OIN 214	55	78
OIN 215	55	88
OIN 635	54	77
OIN 565	52	70
OIN 570	52	87
OIN 573	52	72
OIN 22	51	79
OIN 574	51	84

However response of 15 released varieties to PEG treatment depicted in Table 1.20 indicates JRO 524 is comparatively more tolerant to drought as compared to other varieties **(Source: TMJ. Contributors: J. Mitra, P.G. Karmakar, S.K. Pandey, A.K. Jha, S.B. Choudhary, H.K. Sharma, A. Anil Kumar)**.

Table 1.20. Germination % of varieties of tossa jute under control and PEG treated condition

Variety	Germination %	
	Control	PEG treatment
JRO 128	98	14
JRO 204	100	22
CO 58	99	7
S 19	92	10
JRO 524	96	46
JRO 8432	95	6
JRO 66	90	13
JRO 7835	91	4
KOM 62	94	19
TJ 40	92	3
Bidhan Rupali	89	8
JRO 2345	90	11
JRO 632	92	2
JRO 878	96	9
JRO 2407	100	32

1.2.1.2.4. Mutation Breeding:

A total of 502 newly developed mutants of tossa jute were characterized (Table 1.21) for agro-morphological traits (S**ource: JB 8.9. Contributors: S.B. Choudhary, C.S. Kar and H.K. Sharma).**

Table 1.21: Characterisation of mutants for agro-morphological traits

Morphological traits	Range	Mean	CV%
Petiole length (cm)	4.7-8.1	6.1	3.2
Leaf length (cm)	12.1-17.8	14.8	1.7
Leaf width (cm)	4.1-7.2	6.0	1.4
Leaf angle (°)	38.3-59.4	52.1	1.2
Plant height (cm)	27.1-342.1	235.6	4.1
Basal diameter (cm)	11.3-17.3	15.1	3.8
Days to 50% flowering (DAS)	54.1-172.5	82.1	1.4
Fibre yield (g/ plant)	5.6-24.3	11.6	2.9

1.2.1.4 Interspecific hybridization

In jute, interspecific hybridization was attempted between *C. capsularis* and *C. fascicularis*. F_1 seeds have been harvested. Hybridity of F_1 seeds will be tested in next season (**Source: JB 1.1. Contributors: P.G. Karmakar, S.B. Choudhary, H.K. Sharma and A. Anil Kumar**).

1.2.1.5 Protection of jute varieties and DUS testing

One new *tossa* jute variety *(C. olitorius*), CO 58 (Sourav) was tested for second growing cycle along with reference varieties (JRO 524, JRO 8432, JRO 128, JRO 632 and JRO 7835) during 2013-14 to observe distinctiveness, uniformity and stability at CRIJAF, Barrackpore and CSRSJAF, Budbud. All the characters as specified by the PPV & FR authority in their guideline were observed critically for distinctiveness, uniformity and stability. Candidate variety CO 58 was found to be distinct for leaf shape.

Similarly, another new tossa jute variety, JRO 2407 (Samapti) was tested for first growing cycle along with reference varieties (S-19 and JRO 878). This candidate variety, JRO 2407 (Samapti) showed more stem pigmentation under comparable incident of light with compare to reference varieties (S-19 and JRO 878) and green seed colour as distinct characters. Distinctiveness, uniformity and stability of these two candidate varieties

were critically verified by monitoring team visited on 23.08.2013 and 24.08.2013 at CRIJAF, Barrackpore and CSRSJAF, Budbud respectively.

All the reference varieties of both tossa (JRO 632, JRO 3690, JRO 66, JRO 524, JRO 7835, JRO 878, JRO 8432, S-19, JRO 128, JRO 620, Chinsurah Green, Sudan Green, Tanganyika-1, JRO 36E, JRO 2345, KOM 62, TJ 40 and Bidhan Rupali) and white jute (JRC 212, JRC 80, JRC 698, JRC 7447, JRC 4444, Padma, JRC 321, Monalisa, UPC 94, Bidhan Pat 1, Bidhan Pat 2, Bidhan Pat 3, KC 1, KTC 1 and D 154) were maintained **(Source: PPVFRA project on DUS testing. Contirbutor: J. Mitra)**

1.2.2. Kenaf (*Hibiscus cannabinus*)

For development of YVMV lines in kenaf a total of 577 single plant progenies rows of F_5 generations of kenaf were evaluated in augmented design along with 4 check varieties namely, HC 583, AMC 108, MT 150 and JBM 2004D in 11 Blocks. These single plant progenies were derived from selected promising crosses including 3 completely resistant progeny derived from crosses KIJ-275 x AMC 108, KIJ-281 x AMC 108 and KIJ-31 x MT 150. Observations were recorded on plant growth parameters including fibre yield. On the basis of growth parameters, fibre yield and fibre % to green stick weight, 25 promising plant progeny rows were identified (Table 1.22). These progenies were found to be superior in terms of fibre % (Fig. 1.12), plant height and base diameter, mid-diameter and top-diameter over all the check varieties (Fig. 1.13). All single plant progenies derived from three crosses combination *viz.* KIJ-275 x AMC 108, KIJ-281 x AMC 108 and KIJ-31 x MT 150 were found to be highly resistant to yellow vein mosaic disease whereas 100% disease symptoms were observed in all check varieties across replications (Fig. 1.14). It indicated stable expression of disease resistance in these selected lines. Seeds of these selected progeny rows expressing stable resistance to yellow vein mosaic disease have been collected and station yield evaluation trial will be done in the next crop season. Few single crosses using selected lines of kenaf were also attempted and seeds were collected for further evaluation (**Source: JB 8.5. Contributors: S.K. Pandey, Pratik Satya, H.K. Sharma, S. Satpathy and R.K. De**).

Table 1.22: F_5 progenies of kenaf selected on the basis of fibre yield and reaction to YVMV disease

Pedigree	Plant height (cm)	Basal diameter (mm)	Green weight (g/plant)	Fibre weight (g/plant)	Stick weight (g/plant)	Fibre % (green weight basis)
KIJ-281×AMC-108-5-19-434	332	19.1	251.6	24.0	54.4	9.5
KIJ-31×AMC-108-5-13-95	307	20.3	236.0	22.2	51.8	9.4
KEX-11×AMC-108-1-21-546	344	20.9	257.4	24.0	59.8	9.3
KIJ-281×MT-150-6-4-462	407	22.7	360.8	32.0	63.8	8.8
KEX-11×MT-150-3-13-574	289	20.0	274.6	24.2	68.2	8.8
KIJ-31×HC-583-1-17-39	290	21.3	250.4	22.0	51.4	8.7
KIJ-275×AMC-108-5-33-345	355	21.0	322.4	28.0	61.2	8.6
KIJ-31×MT-150-2-9 -114	312	20.4	237.6	20.4	51.4	8.5
KIJ-275×AMC-108-1-5-251	299	18.7	249.2	21.0	45.0	8.4
KIJ-31×HC-583-1-31-57	313	20.4	277.8	23.2	55.6	8.3
KIJ-281×MT-150-6-7-465	399	21.8	369.4	30.0	63.6	8.1
KIJ-31×AMC-108-5-9-91	285	20.6	271.6	22.0	47.2	8.1
KIJ-275×AMC-108-5-14-326	354	23.1	333.6	27.0	76.4	8.0
KIJ-31×AMC-108-7-3-100	297	21.1	265.6	21.0	46.0	7.9

KEX-11×MT-150-3-30-595	285	19.6	284.8	22.4	47.4	7.8
KIJ-275×AMC-108-5-32-344	348	23.7	356.6	28.0	65.6	7.8
KIJ-281×MT-150-3-1-440	365	24.9	310.8	24.4	46.8	7.8
KIJ-275×AMC-108-5-23-335	346	21.8	369.4	28.8	70.6	7.7
KIJ-275×AMC-108-4-6-298	328	20.8	339.4	26.4	60.6	7.7
KIJ-275×AMC-108-7-9-363	306	20.5	288.6	22.4	53.8	7.7
KIJ-31×HC-583-4-1-68	275	20.8	259.6	20.0	39.4	7.7
KIJ-281×MT-150-3-6-445	355	22.0	342.0	26.2	58.0	7.6
KIJ-281×MT-150-6-3-461	380	20.5	313.4	24.0	53.0	7.6
KIJ-309×HC-583-4--2-470	417	23.1	397.4	30.4	72.8	7.6
KEX-11×AMC-108-1-26-551	362	21.9	317.8	24.2	58.6	7.6
HC 583 (Check)	301	20.2	259.4	17.4	37.5	6.6
AMC 108 (Check)	324	19.9	288.5	19.7	45.5	6.7
MT 150 (Check)	326	20.2	306.4	19.7	43.1	6.4
JBM 2004D (Check)	318	20.0	296.8	20.6	46.1	6.8
Mean	312	19.6	289.4	18.9	44.2	6.5
SD	33.8	02.3	74.9	05.4	15.39	0.9
Range	214-467	13.6-29.4	142-660	8.2-50.0	14.0-114.8	3.2-9.7

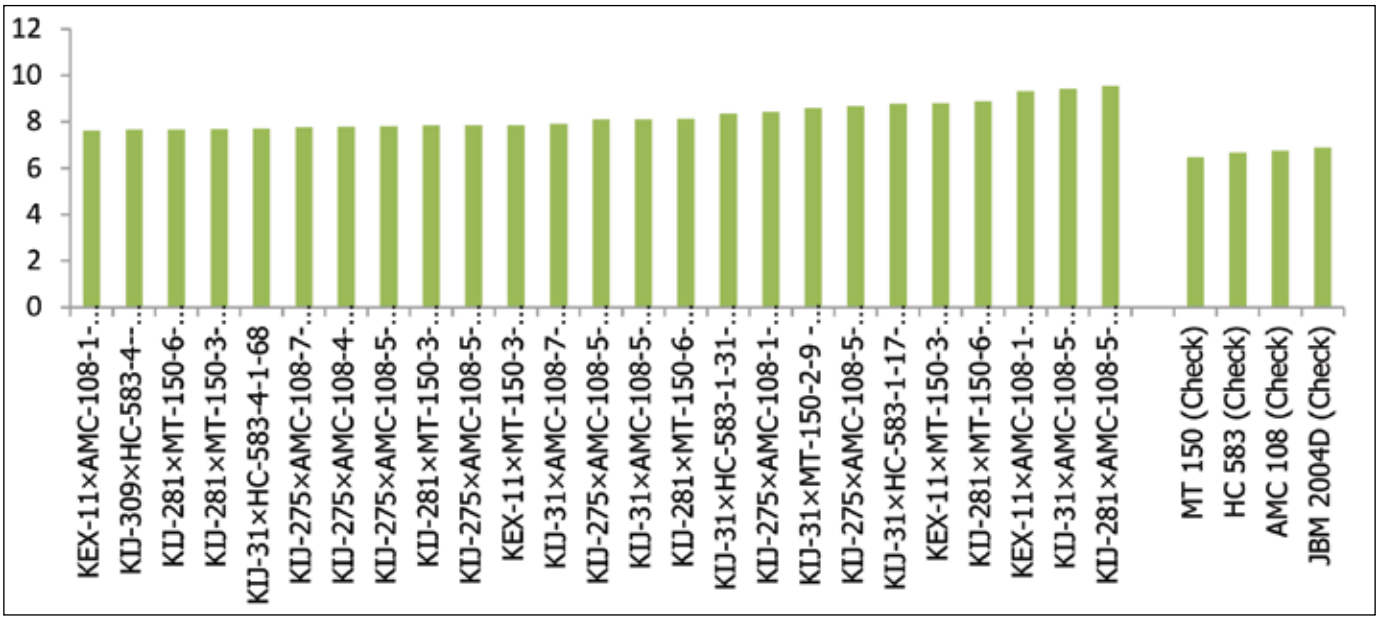


Fig. 1.12: Fibre per cent of selected F_5 plant progenies of kenaf

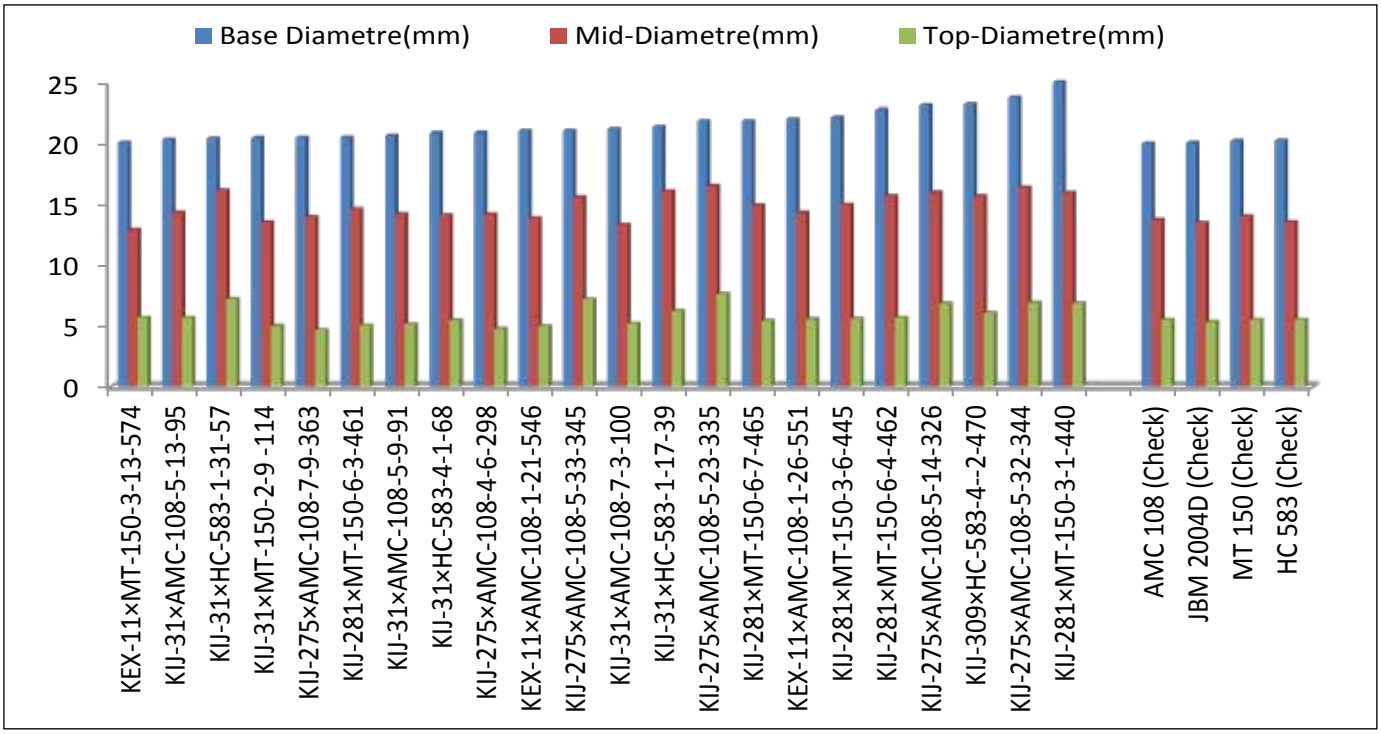


Fig. 1.13: Basal diameter, middle diameter and top diameter (mm) of selected F_5 plant progenies of kenaf

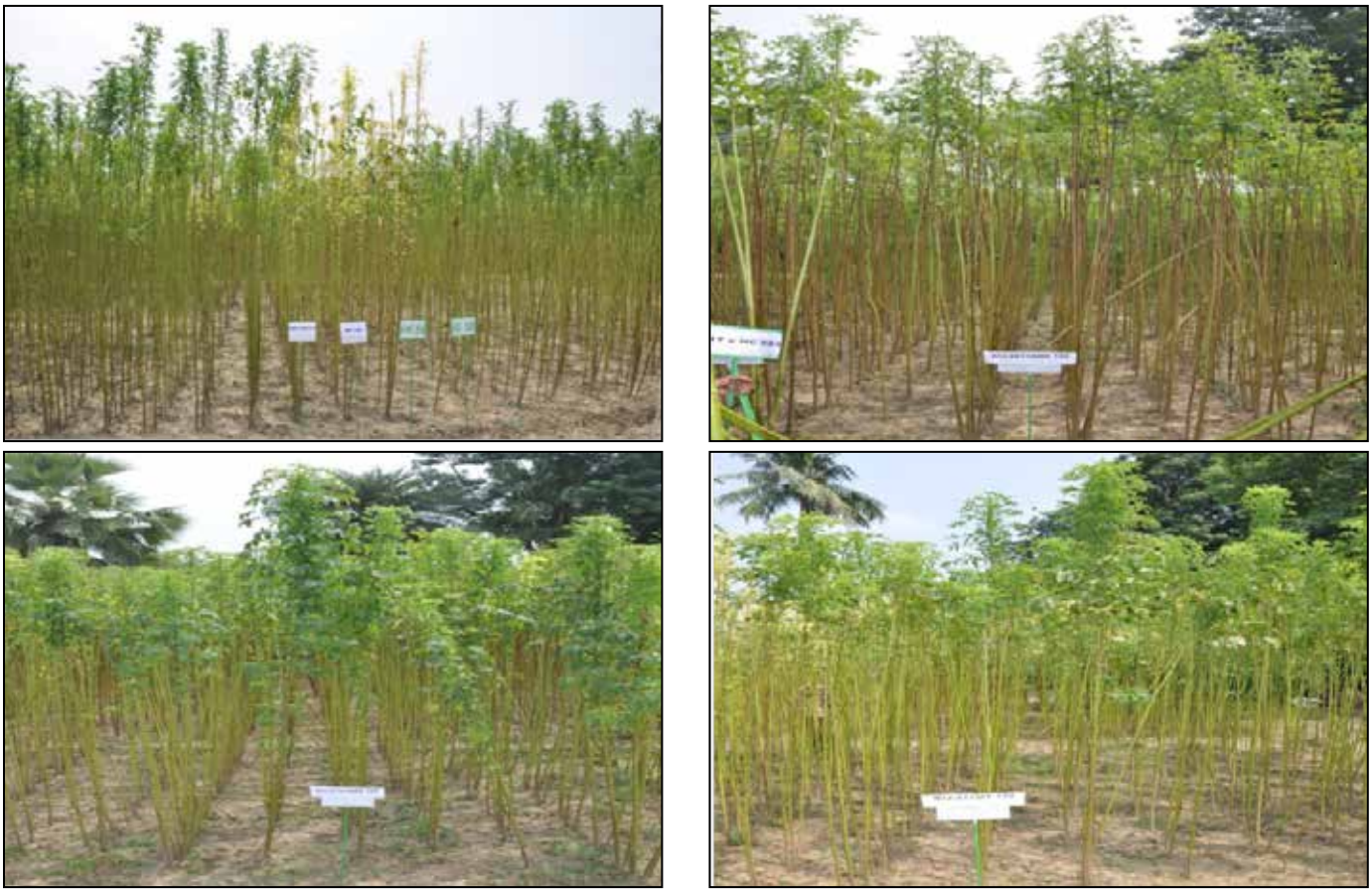


Fig. 1.14 (a) 100% disease incidence in checks (b) Progenies of KIJ-281 x AMC 108 (c) Progenies of cross KIJ-275 x AMC 108 (d) Progenies of cross KIJ-31 x MT 150

1.2.3 Roselle (*H. sabdariffa*)

1.2.3.1 Breeding for improvement

In roselle, a total of 63 promising individual plant progenies from F_3 generations of roselle were selected based on plant height and basal diameter. Plant height (cm) varied from 301.67 to 409.33 with a general mean of 383.83 and basal diameter (mm) ranged from 19.67 to 31.29 with an average of 24.64 cm (Fig. 1.15). A total of 48 new crosses using 22 diverse parents (REX-01, REX-03, REX-6 , REX-21, REX-58, REX-63, REX-64, RIJ-04, RIJ-06, RIJ-21, RIJ-22, RIJ-24, RIJ-27, RIJ-35, RIJ-36, RIN-10, RIN-12, RIN-208, RIN-259, RIN-299, RIN-351, RIN-385) were generated. A total of 36 F_1 were evaluated along with their parents for fibre yield and attributing traits in *H. sabdariffa*. Plant height in F_1 varied from 201.8 to 353.0 cm with a mean of 286 cm and dry fibre weight/ plant ranged from 5.5 to 20.42 g with a mean of 12.60 g (Table 1.23). It was observed that F_1 means for different traits were higher than parental means **(Source JB.9.0. Contributors: H.K. Sharma, P. Satya and S.K. Pandey).**

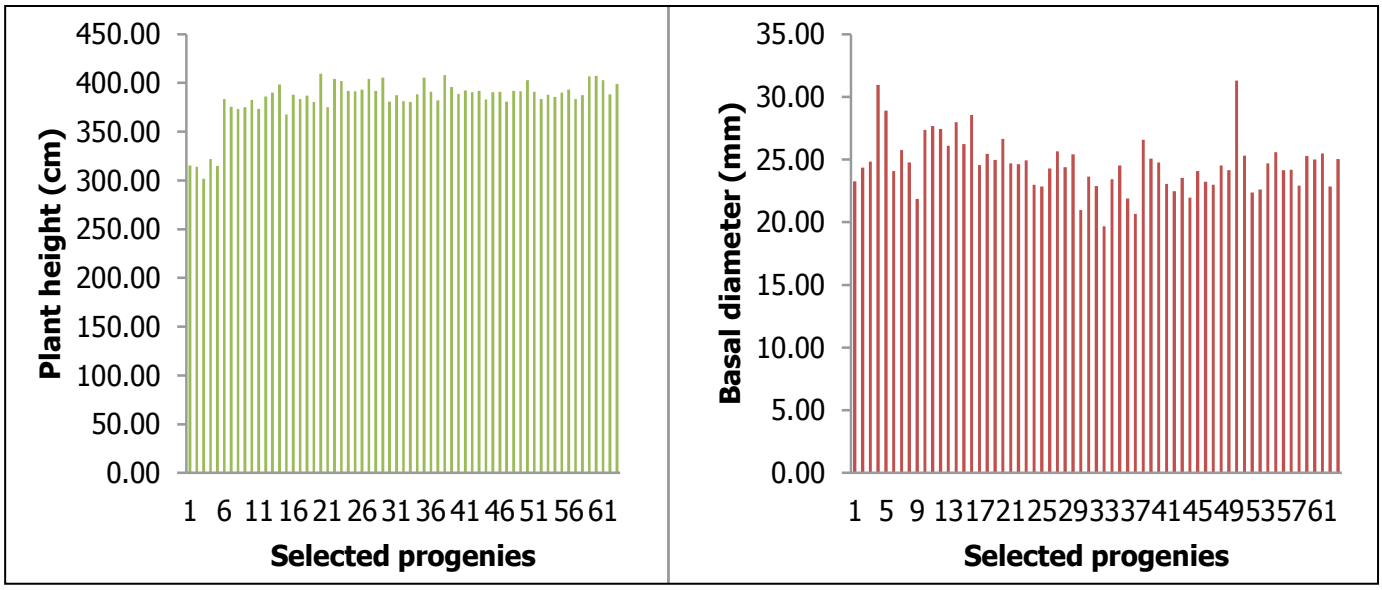


Fig. 1.15: (a) Plant height and (b) Basal diameter of selected progenies of roselle.

Table 1.23: Descriptive statistics of F_1s and their parents for fibre yield and other attributing traits of *H. sabdariffa* L.

Parameters	Plant height (cm)	Basal diameter (mm)	Green weight (g)	Fibre weight (g)	Stick weight (g)
F1 mean	286.04	16.47	267.39	12.60	36.05
F1 range	201.80-353.00	13.22- 21.69	136.0-460.00	5.50-20.42	14.75-62.50
Parental Mean	250.14	13.67	181.83	8.49	23.63
Parental Range	105.6-303.60	8.67-15.83	38.80-248.80	1.0-12.00	2.0-35.00

1.2.3.2 Screening for drought tolerance

In *H. sabdariffa* a total of 502 germplasm accessions were screened for drought tolerance under field conditions at SRS, Bamra. Based on quantitative traits (plant height, basal diameter, green weight, dry fibre weight and stick weight) and root and shoot length 15 lines (Table 1.24) have been identified and which will be further screened under controlled conditions **(Source: TMJ. Contributors: J. Mitra, P.G. Karmakar, S.K. Pandey, A.K. Jha, S.B. Choudhary, H.K. Sharma, A. Anil Kumar).**

Table 1.24: Promising genotypes of roselle identified for drought tolerance under field screening at SRS, Bamra

Entry No	Origin	Plant height (cm)	Basal diameter (mm)	Green weight/plant (g)	Fibre weight/plant (g)	Stick weight (g)	Root Length (cm) (75 DAS)	Shoot Length (cm) (75 DAS)
RIN261	Assam	303.40	10.35	161.00	8.05	25.47	14.3	164.0
RIN280	Gujarat	188.40	9.86	110.60	7.98	13.06	17.2	135.0
RIN283	Gujarat	239.00	11.16	147.80	7.96	19.10	15.1	136.4
RIN332	Odisha	278.00	11.97	197.40	7.20	29.73	15.1	160.8
REX12	USA	232.60	11.19	179.40	6.01	24.62	17.2	113.2
RIN284	Gujarat	290.00	15.90	344.00	15.58	47.04	17.2	128.0
RIN312	Odisha	330.60	11.32	313.80	11.44	47.98	11.4	163.8
RIN314	Odisha	337.00	12.88	200.60	12.54	40.73	12.7	169.6
RIJ39	Thailand	299.00	16.13	305.20	12.12	50.30	11.0	123.0
RIJ48	Nepal	263.60	16.46	594.80	12.27	52.77	9.8	98.0
RIJ61	USA	271.00	15.18	430.60	13.60	46.30	8.1	100.6
RIJ80	Indonesia	324.40	17.63	211.60	15.98	58.13	9.2	82.0
RIJ87	Indonesia	288.20	16.00	357.40	13.91	51.29	13.9	110.2
RIJ88	Indonesia	308.20	16.73	337.40	15.23	57.75	13.6	126.2
REX63	Africa	269.00	11.76	171.40	8.20	26.77	9.9	132.0

1.2.4 Ramie

1.2.4.1 Genetic improvement

Ten diverse genotypes including all the three group of cultivated ramie were evaluated during summer, 2013 using RBD with three replications (Table 1.25). Twenty five representative plants per replication of all the genotypes were observed for 10 quantitative traits at 55 days of crop. Data depicted from the table revealed that all the promising cultivated exotic genotypes except R 1416 and R 1418 performed better than the exotic green (R 1410) and indigenous white (R 1424) genotypes. Indigenous white (R 1424) exhibited less fibre recovery but higher fodder recovery (green leaves and succulent green stem). Due to the poor quality of fibre and higher fodder recovery this genotypes has the potential use as a fodder crop. Similarly exotic green ramie genotypes (R 1410) showed less fibre recovery but better fibre quality. This genotype has been selected as a fibre quality parent for hybridization program. TRS population of R 1411 showed maximum fibre recovery (5.82 %).

Table 1.25: Mean performance of 10 promising diverse genotypes of cultivated ramie

Accession	Plant height (cm)	Strip wt. (kg)	Leaf wt. (kg)	Basal diameter (cm)	Fibre yield (g)	Fibre length (cm)	Fodder % (leaves + succulent stem)	Fibre recovery (%)
R 67-34	180	2.28	0.90	1.27	160	153	28.35	5.05
R 1411	180	2.38	0.98	1.36	161	166	28.95	4.80
R 1415	172	2.10	1.24	1.13	142	160	37.19	4.25
R 52	132	1.82	0.57	1.17	84	122	23.90	3.52
1416	150	2.23	1.08	1.43	132	137	32.41	4.01
1414	123	1.32	0.85	1.10	84	114	39.30	3.87
R 1418	164	2.02	1.37	1.20	132	152	40.39	3.89
TRS	178	2.09	1.08	1.43	184	160	34.03	5.82
R 1410	163	2.33	1.47	1.07	66	148	38.54	1.74
R 1424	143	1.26	0.93	1.10	53	123	42.43	2.42
C.D.	4.67	0.28	0.17	0.26	0.13	6.36	5.22	7.04
SE(m)±	1.56	0.09	0.06	0.09	0.04	2.12	1.74	2.35
SE(d) ±	2.21	0.13	0.08	0.12	0.06	3.00	2.46	3.33

On the basis of previous station trials as well as AINPJAF trials, five high yielding genotypes were selected as parents for the hybridization program (Table 1.26). The flowering behaviour and time have also been observed and recorded for making the synchronization of the flowering time of all the genotypes in the crossing block. All the selected parents were planted in the crossing block developed at RRS, Sarbhog.

Table 1.26: Parents selected for hybridization in Ramie

Parent	Group of germplasm	Important traits
R-1411 (Hazarika)	Promising exotic white ramie	High yielding with better fibre quality
R-67-34 (Kanai)	Promising exotic white ramie	High yielding and wide adaptability
R-1410	Only exotic green ramie collection	Excellent fibre quality and low temperature tolerance
R-1416	Exotic white ramie	Environmental sensitive female line
R-1415	Promising exotic white ramie	High yielding and disease tolerance. (Best genotype of IET)

In order to exploit the hybrid vigour in ramie ten promising clones were selected from open pollinated population of promising genotypes (Table 27). Open pollinated seeds of the two promising genotypes were grown in the seed nursery and single seedlings were transplanted in the main plot during 2012. After 4 cuttings during 2013, dissimilar plants from female parent of distinct traits were selected and multiplied for further study of yield and fibre quality traits **(Source: RB 2.4. A. K. Sharma, P. Satya, K. Selvaraj and S.P. Gawande).**

Table 1.27: Ramie clones selected to study hybrid vigour in ramie

Name of the clone	Name of the female (Seed Parent)	Morphological trait for selection
Ramie clone-1	R 67-34	High basal diameter and tillering
Ramie clone-2	R 67-34	High basal diameter and tillering
Ramie clone-3	R 1411	High basal diameter and tillering
Ramie clone-4	R 67-34	Dark pink stem with high tillering but green female flowers
Ramie clone-5	R 67-34	Pink female flowering with early flowering and high tillering
Ramie clone-6	R 1411	Green female flower with larger leaves
Ramie clone-7	R 1411	Green female flower with larger leaves and faster growth
Ramie clone-8	R 67-34	High basal diameter and tillering
Ramie clone-9	R 67-34	High basal diameter and tillering
Ramie clone-10	R 67-34	High basal diameter and tillering

1.2.4.2 Variation in sexual progenies of R1411cultivar of ramie.

High cost of planting material and transportation in ramie were always major bottle necks for the ramie cultivation in traditional areas of North eastern states. Ramie produces large number of tiny viable seeds twice in a year (upto 100g/plant /year). The open pollinated true ramie seeds could be used for the commercial cultivation of ramie provided the variation in the population must be assessed at fibre level. Due to the partial utilization of hybrid vigour in open pollinated population the yield performance was found better than the asexually propagated population in ramie. In order to study the phenotypic and genetic variation of single plant open pollinated seed population, seeds harvested from single plant of R -1411 genotype were raised in the nursery and transplanted with parents population in the main field for further phenotypic and genotypic study. As per the observation of population at seedling stage, no phenotypic variation for, leaves, stem and petiole colour & shape was observed among the seedlings **(Source: RB 2.4. Project Contributors: A. K. Sharma, P. Satya, K. Selvaraj and S.P. Gawande).**

1.2.4.3 Confirmation of Environmental sensitive female line of ramie

For revalidation of the previous year observation the same ramie germplasm accession R 1416 was observed for flowering behavior during December, 2013 to Feb, 2014 and found that under irrigated winter conditions it exhibits complete female flowers (Fig 1.16). In 50-60 days old crop during 1st week of February (temperature, min. 11^{0}C and max. 25^{0}C, RH 80%) environmental sensitive female line (R 1416), develops female flowers only earlier than the other lines. Generally during the 3rd week of February ramie initiates male flowers in lower portion of the plant and after 15 days female flower comes in upper portion of the plant. Initiation of 100 per cent absent of male flowers (female only) with 15-20 percent seed setting (depending on the availability of pollen of other genotypes) in this genotype can be used for hybrid program in ramie. As ramie flowers twice in a year under agro-climatic conditions of Assam. During August-September the same genotype (R 1416) showed normal behavior of male and female flowering (first male flower in lower stem and after 10 -15 days female flower on upper stem) like other ramie genotypes **(Source: RB 1.0. Contributors: A. K. Sharma and S.P. Gawande).**

Fig 1.16: Environmental sensitive female line in the field at RRS, Sorbhog

1.2.4.4 Flowering, pollination and seed development in ramie

Flowering behaviour was studied in two early and two late flowering genotypes. The genotypes R 1412 and R 1427 flowered early during August – September, while the other two genotypes MB 16 and SL 22 flowered late extending over a period of September to November. The male flowers in 80% of the early flowering genotypes appeared in August, 2013; rest flowered within the second week of September (Fig. 1.17). No fresh male flower appeared after 61 DAH in R 1427 and after 65 DAH in R 1412. The female flowers appeared on the same canes 9 – 11 days later, of which 52.5% appeared in August and rest appeared within 3rd week of September. In the late flowering genotypes, over 80% of the flowering was observed in the month of October. The duration of female flowering in SL 22 and MB 16 was higher (41 days) compared to that of early flowering types (34.5 days).

Male floral developmental period was divided into four sections, early bud stage (S_1), full bud stage one day before anthesis (S_2), full bloom stage (S_3) and dry flower stage (S_4) . The male flowers were pubescent, each with four lobed perianth and short pedicel. Four stamens were present in the flower bearing numerous pollen grains in each anther. Average anther filament length was 1.8 mm, while the diameter of anther was 0.7 mm. Four stages of female flower development were also identified; early bud stage (S_1), fully receptive white style stage (S_2), brown style stage (S_3) and curved style stage (S_4). It was observed that the reproductive period in ramie spans over a period of 55 – 82 days, of which seed development takes about 20 – 32 days.

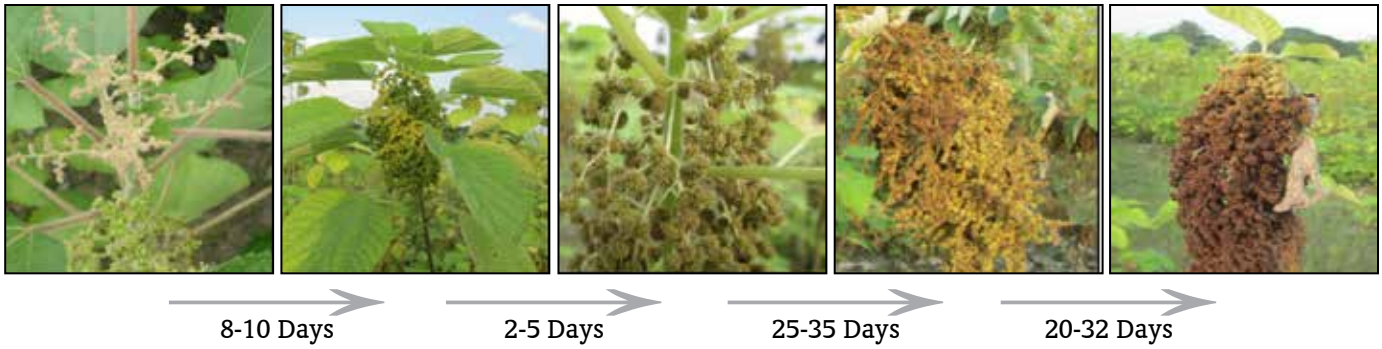


Fig 1.17: Reproductive stages in ramie

During the flowering period, daily temperature variations were also monitored. It was observed that the sterility of pollen in late flowering types and failure of seed set in the late lowering types were correlated with temperature variation, particularly drop in minimum temperature. High pollen sterility was observed in the late flowering genotypes **(Source: NFBSFARA FQ 3030. Contributors: P. Satya, S. Mitra (CRIJAF), D. P. Ray (NIRJAFT)).**

1.2.4.5 Modification and validation of chemical fibre degumming (HTHP with short time treatment of raw fibre) of ramie

The existing chemical ramie fibre degumming technique (developed by NIRJAFT) has been modified and validated at RRS, Sorbhog. In this modified technique, freshly decorticated fibre is re-decorticated after washing thoroughly, and re-washed in fresh water. The double decorticated fibre was soaked in 1.0 per cent washing soda and kept overnight for making the fibre more penetrating. After washing, fibre was boiled with 2% caustic soda (NaOH) and 0.5% wetting agent in pressure cooker (usually 121 ^{0}C and 15 psi pressure) for 15-20 minutes followed by washing with fresh water and immersed in 1.0 % hydrogen peroxide solution in the warm water for one hour for bleaching. After drying, combing and hackling is done for softening of dried fibre. Degummed fibre sample (2 kg) was sent to the spinning mill to test the spinning quality of fibre, which was found suitable for spinning. **(Source Exploratory project. Contributors: A.K. Sharma and S.P. Gawande).**

1.2.4.6 Primary chemical constituents of ramie fibre

The primary constituents of decorticated ramie fibre were determined in R 1411, a cultivar identified for release through Central Variety Release Committee. All the methods used were standard laboratory methods (TAPPI Standard methods). The decorticated fibre contained 23.15% gum. The fibre contained 96.1% holocellulose, of which 88.15% was alpha-cellulose. Hemicellulose and pectin content were estimated as 7.9% and 2.3% of decorticated fibre, respectively. Presence of hemicellulose components were verified through FT-IR spectrometry and HPLC. It was observed that 5% NaOH treatment completely removes gum from fibre **(Source: NFBSFARA FQ 3030. Contributors: P. Satya (CRIJAF) and D. P. Ray (NIRJAFT).**

1.2.5: Flax

1.2.5.1. Genetic improvement

F_1 generations of 4 crosses, F_2 generations of 32 crosses, F_5 generation of 15 crosses and two backcrosses were grown for generation advancement and evaluation of fibre yield. Six new cross combinations JRF-1 x JRF-2, FT-897 x JRF-2, FT-897 x JRF-4, *L. gallicum* x JRF-4, Polf 31 x H-5 and 1 backcross (H-25 x JRF-2) x JRF-2 from different parents were attempted (Fig 16). A total of 100 single plant progenies selected from F_4 and F_5 generations and germplasm of flax have been evaluated for fibre yield **(Source SNHB 1.8. Contributors: Babita Chaudhary, MK Tripathi and Hemraj Bhandari)**

1.2.6: Sunnhemp (*Crotalaria juncea*)

1.2.6.1 Genetic improvement

A total no. of 25 selected germplasm lines were evaluated (Table 1.28). Data were recorded on fibre contributing traits *viz*., plant height, basal diameter, fresh weight, fibre weight and stick weight. Plant height ranged from 224.8 to 267.0 cm and basal diameter ranged from 8.1mm to 10.4 mm and fibre weight ranged from 4.33 to 7.83 q/ha. Disease data of leaf curl and vascular wilt were also recorded in the scale range of 1.0 to 9.0.

Table 1.28: Data of fibre yield & its component trait in selected sunnhemp germplasm lines

Entries	Plant height (cm)	Basal diameter (mm)	Fresh wt (q/ha)	Fibre wt (q/ha)	Sitck wt (q/ha)	Leaf curl (grade)	Vascular wilt (grade)
SUIN 018-4	244.0	9.3	215.00	5.17	27.17	1	1
SUIN 019-2	241.4	9.4	191.67	5.00	27.50	1	1
SUIN 019-3	236.0	8.1	213.33	5.67	29.17	1	1
SUIN 019-4	236.2	10.2	191.67	5.33	25.83	1	1
SUIN 021	254.8	9.6	275.00	5.33	35.83	1	1
SUIN 023	250.4	9.7	246.67	5.67	30.17	1	2
SUIN 024-1	267.0	10.0	223.33	6.17	29.67	1	1
SUIN 024-2	255.6	10.1	225.00	6.67	29.50	1	5
SUIN 036-1	254.4	9.5	203.33	6.17	25.67	1	3
SUIN 036-3	245.0	9.8	225.00	6.00	33.33	1	2
SUIN 037	240.0	9.2	205.00	7.17	27.67	1	8
SUIN 038-1	252.0	10.4	233.33	5.50	30.83	1	2
SUIN 041	240.4	9.0	191.67	5.33	26.00	1	4
SUIN 047-2	228.0	10.2	241.67	6.33	25.67	1	2
SUIN 083-1	246.0	9.4	263.33	6.33	29.67	1	1
SUIN 083-2	224.8	8.6	291.67	6.67	37.83	1	2
SUIN 083-3	253.0	9.4	325.00	7.83	35.50	1	4
SUIN 086-2	232.4	9.4	250.00	4.33	28.00	1	3
SUIN 094-1	248.4	9.7	200.00	6.17	27.83	1	9
SH-4-1	245.6	9.5	258.33	6.17	27.00	1	5
SH-4-2	241.0	10.1	216.67	5.67	29.50	1	5
SH-4-3	251.2	9.3	233.33	6.00	32.83	1	6
SH-4-8	251.6	10.1	270.00	6.83	35.67	1	3
SH-4-12	242.6	8.8	271.67	6.33	32.17	1	1
SUEX 004-1	243.4	9.8	233.33	5.17	28.00	1	1
Mean	245.0	9.5	235.80	5.96	29.92	1.0	3.0
Min	224.8	8.1	191.67	4.33	25.67	1.0	1.0
Max	267.0	10.4	325.00	7.83	37.83	1.0	9.0
SD	9.4	0.05	33.87	0.76	3.51	0.0	2.3

A total of 14 F_1 crosses i.e., SUIN 001 x SH-4-17, SUIN-19-4 x SH-4-3, SUIN 19-4 x SH-4-20, SUIN-21 x SH 4-3, SUIN21 x SH-4-17, SUIN-21 x SH-4-20, SUIN 30-1 x SH-4-3, SUIN-30-1 x SH-4-17, SUIN 30-1 x SH-4-20, SUIN-36-1 x SH-4-3,

SUIN 36-1 x SH-4-17, SUIN-38-1 x SH-4-3, SUIN 38-1 x SH-4-17 and SUIN-38-1 x SH-4-20 were evaluated for fibre yield. Data were recorded on fibre yield contributing traits *viz*., plant height, basal diameter, green weight, fibre weight and stick weight (Table 1.29). Plant height ranged from 208.3 to 264.0 cm and fibre weight ranged from 0.01 kg - 0.06 kg/plot. Disease data range of leaf curl were also recorded on the scale of 1.0 to 9.0. **(Source: SNHB 1.8. Contributors: B. Choudhary, M.K. Tripathi and H. Bhandari)**

Table 1.29: Data of 14 F_1 crosses for fibre yield during 2013 at SHRS, Pratapgarh

Crosses	Plant height (cm)	Basal diameter (mm)	Leaf curl
SUIN 001 x SH-4-17	259.4	10.6	1.0
SUIN-19-4 x SH-4-3	208.3	10.6	1.0
SUIN 19-4 x SH-4-20	262.0	9.5	1.0
SUIN-21 x SH 4-3	254.4	10.2	1.0
SUIN21 x SH-4-17	253.0	10.8	1.0
SUIN-21 x SH-4-20	210.0	8.0	1.0
SUIN 30-1 x SH-4-3	259.4	7.7	1.0
SUIN-30-1 x SH-4-17	256.0	9.8	1.0
SUIN 30-1 x SH-4-20	263.0	10.9	1.0
SUIN-36-1 x SH-4-3	248.8	11.3	1.0
SUIN 36-1 x SH-4-17	264.0	11.4	1.0
SUIN-38-1 x SH-4-3	240.4	10.7	1.0
SUIN 38-1 x SH-4-17	251.0	11.4	1.0
SUIN-38-1 x SH-4-20	228.4	10.7	1.0
Range	208.3-264.0	7.7-10.3	1.0-1.0
Mean	247.0	10.3	1.0
Min	208.3	7.7	1.0
Max	264.0	11.4	1.0
SD	18.7	1.2	0.0

1.2.6.2. Breeding behaviour and mechanism of self-incompatibility in sunnhemp

Sunnhemp bears terminal raceme inflorescence with indeterminate growth habit. Flowers are typical standard type with a broad ovate standard petal with a strong midrib at the back of the petal. Wings are medium in size and keel petals are pointed and are slightly twisted. The flower is complete, zygomorphic and pentamerous. The flower comprises of five sepals which are fused together (gamosepalous), five free petals, ten free stamens present in two whorls and gynoecium represented by single pistil. Androecium exhibits anther dimorphism or hetero-anthery condition. The 1st whorl of androecium consists of five elongated adnate stamens on smaller filaments which dehisce earlier unlike 2nd whorl. The 2nd whorl lies in inner position of flower and is represented by five globose, basifixed anthers on slender and longer filaments.

Flower buds were divided into four stages for phenological studies (Fig 1.18) *viz*., S1 (closed bud), and S2 (petals start break out of bud), S3 (petals expanded) and S4 (open flowers). The assessment of relative growth of floral

parts among 4 stages showed that calyx didn't show any change or exhibits only minor changes. The petals especially standard petal exhibited rapid expansion (Table 1.30). Filament of 1st whorl remains almost same, while the filaments of 2nd whorl of androecium elongates in the later stages which is instrumental in pushing the pollen towards stigma upon its elongation thereby increasing the chances of self-pollination.

Fig 1.18: Four stages of sunnhemp flower buds

Table 1.30: Relative growth of floral parts of sunnhemp

Stage	Calyx (cm)	Standard petal (cm)	Style (cm)	Filament of 1st whorl (cm)	Filament of 2nd whorl (cm)	Anther length of 1st whorl (cm)	Anther length of 2nd whorl (cm)
S1	2.1	1.9	1.8	0.5	0.7	0.56	0.10
S2	2.1	2.2	1.8	0.5	0.8	0.41	0.10
S3	1.8	2.4	1.7	0.5	1.2	0.45	0.05
S4	1.7	2.4	1.8	0.4	1.1	0.45	0.06

Pollen viability was tested using acetocarmine staining method and pollen fertility by pollinating emasculated flowers from pollens of either of the whorls separately. The results indicated that pollens of both the whorl were viable and equally effective in bringing about fertilization (80 to 83% pod setting). Time of anther dehiscence in both the types of anthers were investigated. No anther dehiscence was reported at any time of the day in the flowers of S1 stage. The 1st round of anthers was found to dehisce at 08:15AM in the morning in the S2 stage of flowers and the 2nd round of anthers began to dehisce at 10:15AM in the flowers of S3 stage. Investigations were made to know the breeding behaviour of sunnhemp by subjecting the flower buds of two varieties i.e. black and yellow seed coloured to different pollination treatments (Table 1.31 and Fig. 1.19). Crossed and sib-mated flowers set 51.02% and 46.60 % of pods respectively, whereas manually selfed flowers set 2.89%, bagged flowers 3% and 0.93% setting in geitenogamy employed flowers. Which clearly indicates sunnhemp is not self-pollinated but cross pollinated crop In another treatment where complete bed was covered with mosquito net no pod setting was observed, which clearly showed that wind doesn't play any role in cross pollination and it is the insect which is responsible for cross pollination. We had spotted four species of insects pollinating our experimental field among those, *xylocopa spp.* is the major player in achieving cross pollination. Further the mechanism and type of self-incompatibility is need to be studied **(Source: JAFSP 2.3. Contributors: Maruthi, R.T., S. K. Pandey, Babita Chaudhary and S. K. Sarkar)**.

Table 1.31: Studies on breeding behaviour in sunnhemp

Treatments	Number of flowers treated	Pod set	Pod set (%)
Selfing manually	104	3	2.89
Geitenogamy	108	1	0.93
Sib-matins	103	48	46.60
Allogamy	98	50	51.02
Control	100	3	3

Fig. 1.19: (a-c) Different type of treatments applied to study breeding behaviour in sunnhemp (d) *Xylocopa* sp. pollinating sunnhemp flower

2. Seed Science and Technology

2.1 Seed Research

2.1.1 Effect of sulphur and potassium application on yield and quality of jute seed

The field experiments were conducted at CRIJAF, Barrackpore (North 24 Parganas) and CSRSJAF, Bud Bud (Burdwan) with jute (cv Ira) to study the effect of sulphur and potassium on yield and quality of jute seed. At Barrackpore, application of 75 kg K_2O/ha and 45 kg S/ha significantly improved the plant height of jute over all other treatment combinations (Table 2.1). The application of 50 kg K_2O/ha resulted in higher values of branches per plant, pod length as well as pods per plant were recorded as compared to control, 25 kg K_2O/ha and 75 kg K_2O/ha application. Significantly higher values of plant height, branches per plant, pod length and pods per plant were recorded with the application of 45 kg S/ha over all other sulphur doses including control (no S application). Application of 50 kg K_2O/ha resulted in significantly higher jute seed yield as compared to control and 25 kg K_2O/ha but it was at par with 75 kg K_2O/ha application. No significant improvement in 1,000-seed weight of jute was observed with potassium application. Sulphur application of 45 kg S/ha significantly increased the seed yield and 1,000-seed weight of jute compared to all other sulphur doses. Interaction effects between potassium and sulphur for plant height was significant but, all other interactions were non-significant.

Table 2.1: Effect of sulphur and potassium levels on plant height, yield attributes and seed yield of jute at Barrackpore

Treatment	Plant height (cm)	Branches per plant	Pods per plant	Pod length (cm)	1000- seed weight (g)	Seed yield (t/ha)
Potassium levels (kg K_2O/ha)						
0 (Control)	64.5	4.7	16.2	6.2	2.02	1.01
25	66.8	5.6	18.7	6.5	2.04	1.24
50	72.3	6.5	21.5	6.7	2.08	1.34
75	82.7	5.8	20.1	6.6	2.09	1.25
SEm (±)	2.49	0.17	0.69	0.21	0.054	0.062
LSD (P=0.05)	8.82	0.62	2.45	NS	NS	0.220
Sulphur levels (kg S/ha)						
0 (control)	64.4	4.7	15.2	5.9	1.95	0.95
15	69.7	5.1	18.6	6.3	2.04	1.13
30	73.6	5.8	20.2	6.6	2.07	1.29
45	78.6	6.9	22.5	7.3	2.16	1.47
SEm (±)	1.24	0.14	0.55	0.12	0.030	0.042
LSD (P=0.05)	3.64	0.41	1.61	0.34	0.088	0.124
Interaction (Main x Sub)						
SEm (±)	2.48	0.35	1.39	0.41	0.059	0.085
LSD (P=0.05)	7.26	NS	NS	NS	NS	NS

At Budbud application of 75 kg K_2O/ha and 45 kg S/ha significantly improved the plant height of jute over all other treatment combinations. However, application of 75 kg K_2O/ha resulted in significantly higher jute seed yield as compared to control and 25 kg K_2O/ha but was at par with 50 kg K_2O/ha application (Table 2.2). No significant improvement in 1,000-seed weight of jute was observed with potassium application. Application of sulphur significantly improved the seed yield and 1,000-seed weight of jute at Budbud. Significantly higher seed yield as well as 1,000-seed weight of jute were recorded with the application of 45 kg S/ha over all other sulphur doses. All other interactions were non-significant **(Source: JA 6.6, Contributors: Amarpreet Singh, Mukesh Kumar, Sonali P. Mazumdar, Amit Bera and D. K. Kundu)**

Table 2.2: Effect of sulphur and potassium levels on plant height and yield attributes of jute at Bud Bud (Burdwan)

Treatment	Plant height (cm)	Branches per plant	Pods per plant	Pod length (cm)	1000 Seed (g)	Seed yield (t/ha)
Potassium levels (kg K_2O/ha)						
0 (Control)	66.9	2.5	8.5	5.5	1.90	0.65
25	70.4	2.8	10.1	5.8	1.98	0.86
50	76.5	2.9	10.3	5.9	2.04	0.89
75	82.7	3.2	11.1	6.1	2.12	0.97
SEm (±)	1.92	0.09	0.44	0.12	0.059	0.029
LSD (P=0.05)	6.78	0.31	1.56	NS	NS	0.105
Sulphur levels (kg S/ha)						
0 (control)	65.5	2.2	8.3	5.4	1.90	0.66
15	70.9	2.7	9.7	5.7	1.97	0.75
30	75.8	3.1	10.6	5.9	2.02	0.92
45	84.3	3.4	11.3	6.1	2.16	1.04
SEm (±)	1.12	0.06	0.28	0.08	0.029	0.028
LSD (P=0.05)	3.29	0.16	0.81	0.25	0.088	0.083
Interaction (Main x Sub)						
SEm (±)	2.24	0.11	0.56	0.23	0.059	0.056
LSD (P=0.05)	NS	NS	NS	NS	NS	NS

2.1.2 Jute seed production in West Bengal: Exploring a new horizon

Jute sown during second fortnight of August on uplands (*Tarh*) (low fertility and low water holding capacity) resulted seed yield of 2.0-3.5 q/ha in Purulia district. In case of September second fortnight sown crop seed yield was 1.4-2.5 q/ha on uplands due to poor soil fertility. Therefore, based on previous years' results sowing should be done during middle of July (seed yield 6.5-7.0 q/ha) in upland condition. In Medium upland and medium land (fertile soil) sowing should be done during mid-August - 1st week of September (7.5-8.5 q/ha) for maximization of seed yield. Optimum package of practices has been developed through this project and demonstrated through RKVY Project **(Source: WB DST Funded project. Contributors: Amit Bera, C.S. Kar and H. Chowdhury)**

2.1.3 Seed quality enhancement for mitigating biotic and abiotic stresses in jute (*Corchorus olitorius*)

Seed priming technique through hydration and controlled

hydration has been standardized in this project. It was observed that steeping of seed for 2h followed by incubation period of 72h followed by drying to original MC improved seed germination and vigour index of jute seed **(Source: TMJ 10, Contributors: Amit Bera, C. S. Kar, H. R. Bhandari, S. K. Sarkar, M. Kumar)**

2.2 Seed production

Production and distribution of breeder seeds of all the national varieties of jute, mesta and sunnhemp as per the indent and allotment of the Seed Division of the Ministry of Agriculture, Department of Agriculture & Cooperation (DAC), Govt. of India under the National Seed Project (NSP) is the key mandate of Central Seed Research Station for Jute and Allied Fibres.

2.2.1 Seed production and distribution under National Seed Project

2.2.1.1 Breeder seed production & distribution

During *kharif,* 2013-14, 18.54 q breeder seed of 10 jute varieties (2 of *C. capsularis* and 8 of *C. olitorius*) was produced as per DAC indent of 17.4 q without any shortfall of target (Table 2.1). In addition to meet the demand of other newly released varieties, 0.88 q breeder seed of 5 jute varieties (CO-58, JROM-1 and JBO 1 of *C. olitorius* and JRCM 2 and JBC 5 of *C. capsularis*) and 3 sunnhemp varieties (SUIN 037, SUIN 053 and K12 Yellow) were produced. Breeder seed indent was restricted to 10 jute varieties including 2 *capsularis* [JRC 517 (Siddhartha) and JRC 532 (Sashi)] and 8 *olitorius* [JBO 2003-H (Ira), JRO 204 (Suren), Subala (S 19), JRO 128 (Surya), JRO 8432, JRO 66 (PBO 6), JRO 524 (Navin) and JRO 7835] for DAC indent.

Table 2.1: Variety wise breeder seed production at CSRSJAF, Bud Bud

Name of variety	DAC indent (q)	Actual production (q)
JRC 517 (Siddhartha)	1.05	1.24
JRC 532 (Sashi)	1.02	1.14
JBO 2003-H (IRA)	0.33	0.44
JRO 204 (Suren)	3.90	4.20
Subala (S-19)	1.15	1.30
JRO 128 (Surya)	1.18	1.30
JRO 8432	0.25	0.36
JRO 66 (PBO 6)	0.25	0.26
JRO 524 (Navin)	7.27	7.30
JRO 7835	1.00	1.00
Total	17.4	18.54

Single Window System (SWS) is under operation for coordinating all activities related to National Seed Project and ICAR Seed Project through Nodal officer (seeds). Implementation of Bar Coding of breeder seed is under process to facilitate easy tracking. Grow out test (GOT) was carried out for 15 varieties i.e., JRO 524, JRO 8432, JBO 2003-H, JRO128, JRO 204, JBO 1, JRO 66, CO 58, Monalisa, JRO 2407, S 19, JRC 532, JROM 1, JRC 517 and JBC 5 **(Source: BSP 1.1; Contributors: C. S. Kar, Amit Bera, H.R. Bhandari, S.K. Biswas).**

2.2.1.2 Production and maintenance of nucleus seeds

Nucleus seed of 62 varieties of fibre crops (24 of *tossa* jute, 19 of *white* jute, 12 of mesta and 7 of sunnhemp) were produced through maintenance breeding both at CRIJAF, Barrackpore and CSRSJAF, Bud Bud. A total of 803.6 Kg of nucleus seeds were produced during *kharif,* 2013.

2.2.2 ICAR seed project

Seeds of different crops were produced under this project for distribution among farmers. A total of 511.84 q seeds of jute, sunnhemp, mesta, dhaincha, paddy, wheat and mustard have been produced during *kharif,* 2013 (Table 2.3).

TL seeds (1.39 q) of varieties of jute, mesta and sunnhemp used as check were supplied to AINP on Jute and Allied Fibres for various trials (IETs and AVTs) during *kharif,* 2014. Besides TL seed (3.50 q) of tossa jute varieties i.e., JRO 204, CO 58, JRO 2407, JROM 1 and S 19 were supplied for FLD to be conducted by CRIJAF during *kharif,* 2014 at different districts of West Bengal. At Sunnhemp Research Station, Pratapgarh, 15 q sunnhemp seed of different varieties and at Ramie Research Station, Sorbhog, 50 q rhizome of ramie (variety-Kanai) were produced under this project. Sisal planting material (76,170 nos. bulbils) were raised through primary and secondary nursery at Sisal Research Station.

Under institute seed production programme during *kharif,* 2013, 17.58 q foundation seed (14.36 q of JRO 204 and 3.22 q of JRO 8432) and 44.54 q certified seed of jute (19.90 q of JRO 204, 6.44 q of JRO 128, 12.07 q of Ira) is under process of certification by State Seed Certification Agency, Govt. of West Bengal.

Table 2.3: Crop wise seed production under ICAR seed project

Crop	Target (q)	Production (q)
Jute (F + C+ TL)	20.00	97.14
Mesta (TL)	4.00	1.50
Sunnhemp (TL)	10.00	16.00
Paddy (TL)	150.00	228.00
Mustard (TL)	20.00	49.20
Dhaincha (TL)	15.00	30.00
Wheat (TL)	30.00	90.00

Seed Day: To create awareness regarding importance of quality seed as vital input for increasing productivity two "Seed Day" programmes were organized on 29th November, 2013 at Central Seed Research Station for Jute & Allied Fibres (CSRSJAF), Bud Bud and 16th January, 2014 at CRIJAF, Barrackpore. More than 400 farmers of different districts of West Bengal participated in these programmes and got acquainted with improved package and practices for quality jute seed production **(Source-ICAR Seed Project. Contributors: C. S. Kar, Amit Bera, H.R. Bhandari and S.K. Biswas).**

Fig. 2.2: Seed day celebration at CRIJAF, Barrackpore (a) and CSRSJAF, Bud Bud, Burdwan (b)

2.2.3 Production of quality jute seed under RKVY Programme in West Bengal

During 2013 *kharif*, 319 farmers (including 151 tribal farmers and women) of 10 blocks in Bankura and 4 blocks in Purulia were registered as certified seed grower. A total of 187 ha were sown with foundation seed of 5 newly released varieties i.e., JRO 128, JRO 204, JBO 2003 H, S 19 and JRO 8432. Maximum productivity of jute seed was 11.0 q per ha in Bankura district. Participatory farmers produced 130 q raw jute seed under certification programme and after processing 98.91 q certified seed were handed over to State Agril. Department for distribution to the farmers in different districts of West Bengal.

Demonstration of use of CRIJAF multi row seed drill, herbicide, pesticide and harvesting technique in jute seed production were carried out during 2013-14 through supply of necessary inputs and implements at farmer's door. More than 300 farmers were trained for quality jute seed production at different training cum workshops, Seed Days, Review Meetings at CRIJAF, Barrackpore, CSRSJAF, Bud Bud and different blocks at both Bankura and Purulia districts. For mechanized seed processing, procurement and installation of two high capacity (5q/h) specific gravity separators one each at CRIJAF, Barrackpore and CSRSJAF, Bud Bud have been completed for quality assurance. **(Source: RKVY component-II. Contributors: C.S. Kar, A. Bera, M. Kumar, R.K. De, S. Kumar, S. K. Pandey, S. Satpathy and A.B. Mandal).**

2.2.4 Adaptive research on jute seed production in West Bengal

During the third year (2013 *kharif*) of implementation of the project four jute varieties namely JRO 204, JBO 2003 H, JRO 8432, S 19 were tested for their adaptability to different land situations of Bankura (4 blocks namely Bankura-II, Chatna, Indpur and Onda) and Purulia (2 blocks namely Para and Purulia-II) in 10.27 ha area involving 20 farmers. CRIJAF Multi Row Seed Drill and CRIJAF Nail weeders were utilized for implementation of CRIJAF jute seed production. Participatory farmers were able to produce 11.5 q of certified seed of 4 varieties from 2.4 ha area with average productivity of 4.79 q per ha (range 2.5-6.5 q per ha). More than 100 farmers and 30 Field Assistants were trained for jute seed production under certification programme. **(Source: DAC project. Contributors: C.S. Kar and Amit Bera)**

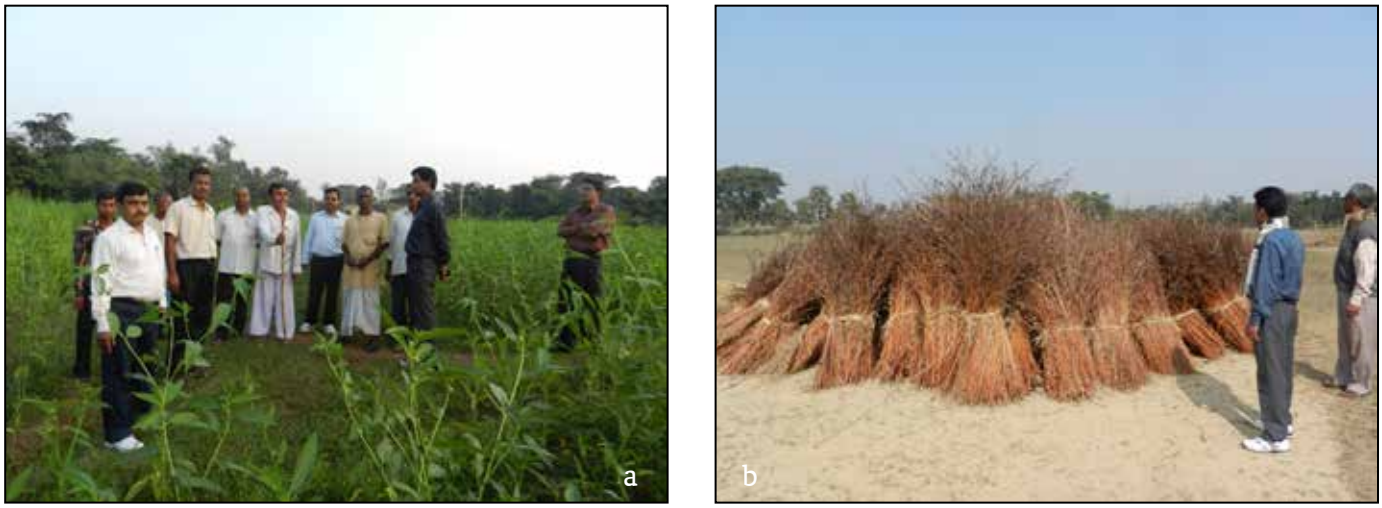


Fig. 2.3: (a) West Bengal state seed certification agency monitoring jute seed crop (b) matured jute seed crop produced under RKVY project at Bankura, West Bengal

Fig. 2.4: Distribution of Nail Weeder and Cono Weeder to farmers

3. Biotechnology

3.1 Development of bast fibre transcriptome of jute (*Corchorus capsularis*) using RNA-seq

RNA-seq based on Illumina HiSeq2000 pair-end (2 x 100) chemistry was performed to develop transcriptome of bast fibre tissues in jute (*Corchorus capsularis* L.). The objective was to compare the bast fibre transcriptome of a wild-type *C. capsularis* cultivar JRC 212 in relation to a lignified secondary phloem fibre-deficient (*dlpf*) mutant, in order to dissect the metabolic pathways involved in bast fibre development and identify genes that regulate lignin biosynthesis in jute.

Table 3.1. Raw read statistics of RNA-seq data set for *C. capsularis* cv. JRC 212 and mt. *dlpf*

Sample	Raw reads	Bases (bp)	Length range (bp)	Mean length (bp)	N50 (bp)	N%
JRC 212	72,750,724	14,550,144,800	100	100	100	0.05
dlpf	68,549,920	13,709,984,000	100	100	100	0.00

Raw reads, as shown in Table 3.1, were cleaned by removing ncRNAs followed by filtration for Illumina adapter contamination and low-quality reads (QV<20). High-quality clean reads (Table 3.2) were used for assembly.

Table 3.2. Clean read statistics of RNA-seq data set for *C. capsularis* cv. JRC 212 and mt. *dlpf*

Sample	Clean reads	Bases (bp)	Length range (bp)	Mean length (bp)	N50 (bp)
JRC 212	67,424,930	R1- 6,621,930,479	50-100	98	100
		R2- 6,504,322,176	50-100	96	100
dlpf	65,429,570	R1-6,376,935,933	50-100	97	100
		R2-3,923,720,149	50-100	98	100

CLC Genomics Workbench (v6.0) was used for the assembly of clean reads with default parameters and scaffolding option on. It resulted in the generation of scaffold sequences. As CLC does not perform gap filling itself, so we used GAPCloser which is part of SOAPdenovo package for filing 'Ns' in scaffold sequences using paired end information resulting in the generation of unigene sequences. CLC assembly statistics are shown in Tables 3.3 and 3.4.

We utilized a simulation-based tool, ESTcalc, to estimate the expected depth and breadth of transcriptome coverage for this data set. The model for transcriptome coverage backing ESTcalc was parameterized using the well-characterized *Arabidopsis thaliana* transcriptome and several "next-generation" sequencing runs using normalized and non-normalized cDNA libraries. A workflow was developed for calculating average read depth and number of reads mapped distribution (Fig. 3.1)

Table 3.3. CLC assembly statistics for *C. capsularis* cv. JRC 212

Description	Contigs	Scaffolds	Unigenes
Sequences	43,155	40,376	40,306
Base pairs (bp)	36,608,252	36,640,842	36,627,292
Average length (bp)	848	907	909
N50 (bp)	1,428	1,531	1,532
Minimum size (bp)	97	165	200
Maximum size (bp)	15,540	15,540	15,540

Table 3.4 CLC assembly statistics for *C. capsularis* mt. *dlpf*

Description	Contigs	Scaffolds	Unigenes
Sequences	42,269	40,654	40,577
Base pairs (bp)	30,688,207	30,724,946	30,708,511
Average length (bp)	726	756	756
N50 (bp)	1,090	1,134	1,134
Maximum size (bp)	48,426	48,426	48,426
Minimum size (bp)	62	159	200

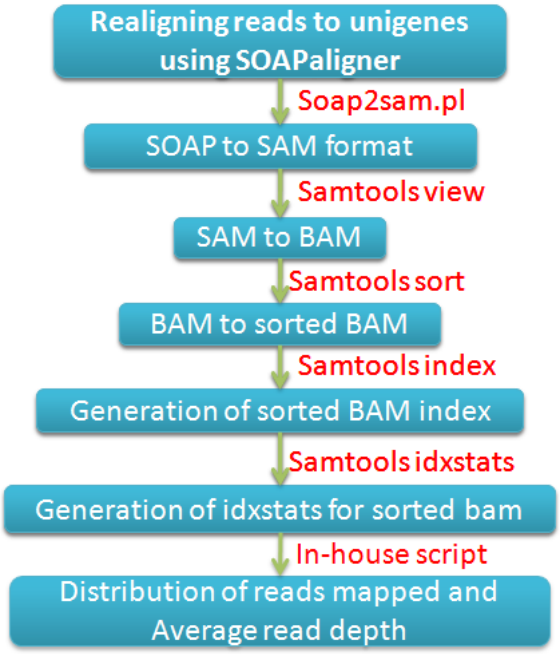


Fig. 3.1: A workflow for calculating average read depth and number of reads mapped distribution

Blastx (e<10-5) was used to align all the assembled unigene sequences against NCBI Nr (sequence-based alignment), Swiss-Prot (sequence-based alignment), KEGG (sequence-based alignment) and NCBI COG (domain-based alignment) databases, with the priority order of Nr > Swiss-Prot > KEGG > COG. Hit statistics of unigenes in the four databases was calculated. The number and percentage of 'unigenes' that have homologous sequences and non-homologous sequences were determined.

Table 3.5: Blastx statistics for *C. capsularis* cv. JRC 212 and mt. *dlpf* against all four databases on priority

JRC 212	Nr	SwissProt	KEGG	COG
Total	34,201	7,788	4,555	4,101
Aligned	26,413 (77.2%)	3,233 (41.5%)	454 (9.9%)	438 (10.7%)
Unaligned	7,788 (22.8%)	4,555 (58.5%)	4,101 (90.0%)	3,663 (89.3%)
dlpf	Nr	SwissProt	KEGG	COG
Total	29,514	6,210	3,294	2,800
Aligned	23304 (78.96 %)	2916 (46.96%)	494 (15%)	412 (14.71%)
Unaligned	6210 (21.04 %)	3294 (53.04%)	2800 (85%)	2388 (85.29%)

Blastx results were used to predict CDS from identified unigene sequences and to translate these CDS into peptide sequences using in-house pipeline. ESTScan was used to determine the sequence direction (5´→3´) of unaligned unigenes and then predict CDS from those unaligned unigenes. These CDS were translated into peptide sequences (protein).

For functional annotation, a complete set of assembled unigenes were searched against Nr followed by Swiss-Prot, KEGG and COG with an e-value < 10^{-5}. Results are shown in Table 3.6.

Table 3.6: Blast functional annotation of unigenes for *C. capsularis* cv. JRC 212 and mt. *dlpf*

	JRC 212 aligned	JRC 212 unaligned	dlpf aligned	dlpf unaligned
Total	34,201	-	29,514	-
NR	26,413 (77.2%)	7,788 (22.8%)	23,305 (78.9%)	6210 (21.0%)
SwissProt	20,633 (60.3%)	13,568 (39.7%)	17,296 (58.6%)	12218 (41.4%)
KEGG	5,746 (16.8%)	28,455 (83.2)	5,229 (17.7)	24,285 (82.3%)
COG	10,580 (30.9%)	23,621 (69.1%)	8,684 (29.4%)	20,830 (70.6%)

The high quality reads for each samples were mapped on their respective set of transcript contigs using SOAPaligner and FPKM was calculated using below mentioned formula: FPKM = 10^9 x C / (N x L), where, C is the number of reads mapped onto the transcript contigs, N the total number of mappable reads in the experiment and L the number of base pairs in the transcript contigs.

For differential gene expression between JRC 212 and *dlpf*, FPKM values were calculated and common hit accessions based on blast against Nr were identified followed by x2 test for each sample to identify significantly expressed transcripts ($P > 0.05$). The significantly expressed transcript contigs were further classified as up and down regulated based on their log fold change (FC) values (Fig. 3.2). A total of 1,747 genes were differentially expressed between JRC 212 and *dlpf*, out of which 348 were up-regulated and 1,399 were down-regulated *dlpf* as compared to JRC 212.

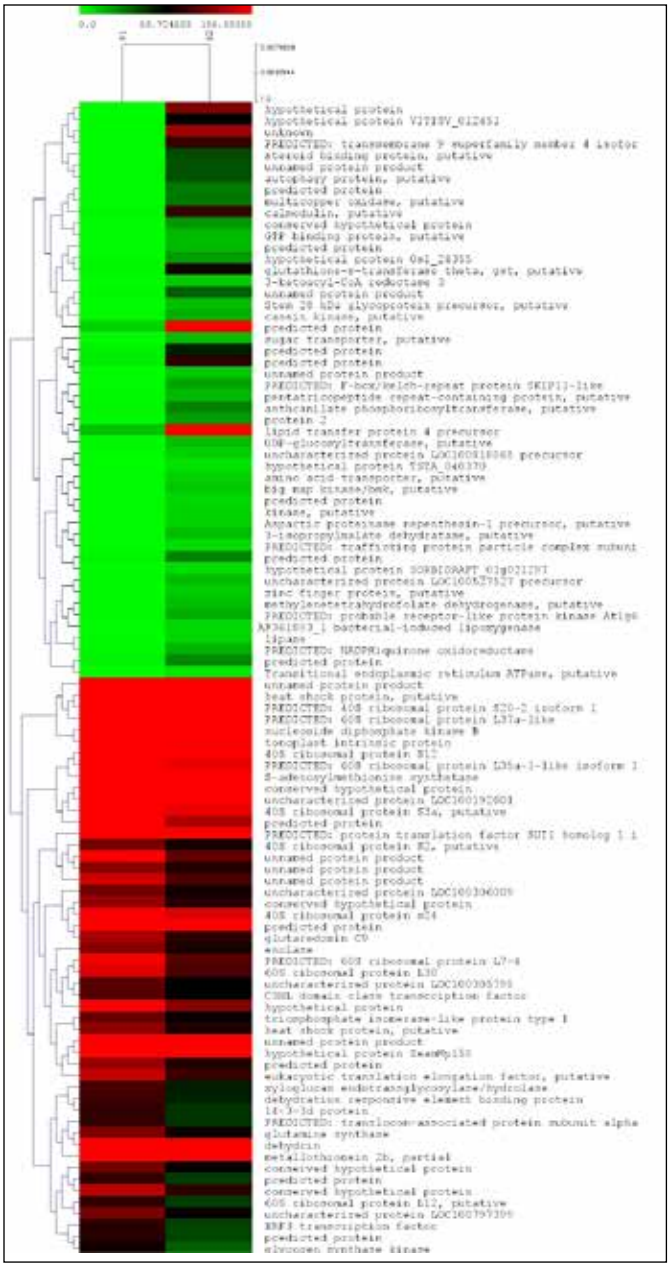


Fig. 3.2. Heat-map showing major up- and down-regulated genes in C. capsularis cv. JRC 212 and mt. *dlpf*

We used real-time qRT-PCR to validate major genes in shikimate, aromatic amino acids and phenylpropanoid biosynthetic pathways, regulating lignin biosynthesis in bast fibre tissues of jute (Table 3.7). Real- time PCR was carried out for relative quantification of 19 target genes using β-actin as a housekeeping gene. Results are shown in Table 3.7 **(Source: JBT. 4.1. Contributor: D. Sarkar and P. Satya).**

Table 3.7: Major genes involved in lignin biosynthesis in bast fibre tissues of *C. capsularis*

Shikimate-AAA pathway	Phenylpropanoid pathway
3-dehydroquinate synthase (*aroB*)	trans-cinnamate 4-hydroxylase (*C4H*)
Dehydroquinate dehydratase/ shikimate dehydrogenase (*DHQ-SDH*)	4-coumarate--CoA ligase (*4CL*)
5-enolpyruvylshikimate-3-phosphate synthase (*aroA*)	Phenylalanine ammonia-lyase (*PAL*)
Chorismate synthase (*aroC*)	Ferulate-5-hydroxylase (*F5H*)
Arogenate/prephenate dehydratase (*ADT, PDT*)	Caffeic acid O-methyltransferase (*COMT*)
Shikimate kinase (*aroK*)	Caffeoyl-CoA O-methyltransferase (*CCoAOMT*)
Aspartate aminotransferase (*GOT1*)	Cinnamoyl-CoA reductase (*CCR*)

3.2 Genomics for augmenting fibre quality improvement in jute (*Corchorus olitorius* L.)

3.2.1 Construction of high-density genetic maps of *Corchorus olitorius*

Restriction-site-associated DNA sequencing (RAD-seq) has become an attractive approach for relatively economical screening of a large number of genetic markers and individuals with very high coverage. For non-model organisms without reference genome sequences, RAD-seq allows genome-wide detection of single nucleotide polymorphisms (SNPs) and construction of dense linkage maps that can be used for comparative genomics and detection of QTL for economically important traits. Jute (*Corchorus olitorius* L.) is an important bast fibre crop belonging to the family Malvaceae, with least genomic information and resources. It has a narrow genetic base and is characterized by low polymorphism information content of anonymous DNA markers like AFLP, SSR, etc. The lack of an abundance of informative molecular markers has impeded the construction of a dense linkage

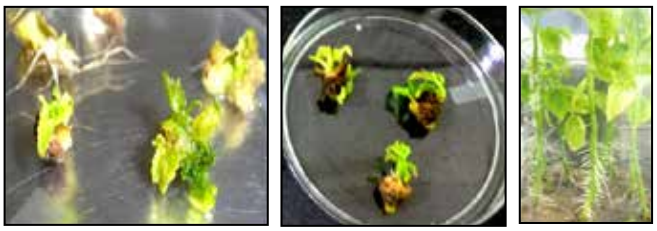
map of jute. We employed RAD-seq to detect genome-wide SNPs and constructed a dense SNP-based linkage map in jute. This linkage map was used for comparative genomics and QTL analyses of bast fibre yield and yield-related traits.

3.2.2 Association mapping for bast fibre quality traits in *Corchorus olitorius*

Second-year phenotyping of association mapping panel: Phenotyping of the AM population was carried out in three test environments, namely, CRIJAF (Barrackpore/Kolkata), CTRI Regional Station (Dinhata/North Bengal) and CRIJAF Regional Station (Budbud/Burdwan). At each locations, the experiment was conducted in a 15^2 partially balanced lattice design, with two replications (simple lattice). Observations were recorded on a large number of morphological traits including flowering times. Bast fibre quality traits, such as fibre fineness and tensile strength are presently being measured **(Source: NFBSFARA. Contributor: D. Sarkar).**

3.3. Tissue culture

Multiple shoot regeneration was achieved (Fig. 3.3) when immature cotyledonary explants from white jute (*C. capsularis)* var. JRC 321, JRC 517 was cultured on half strength Murashige and Skoog (MS, 1962) medium fortified with 5.4μM naphthalene acetic acid (NAA), 0.2 μM 2,4 Dichlorophenoxy acetic acid (2,4 D) in combination with 0,0.7, 0.6, or 0.5 μM indole-3-butyric acid (IBA) and 0, 8.9, 22.2, & 44.4 μM 6-BAP. Best media was MS containing 5.4 μM NAA, 0.5 μM IBA with 8.9 μM 6-BAP. This is expected to help in mass multiplication of specialized genetic stocks or transgenic lines *en massee.*



a b c

Fig. 3.3: Multiple shooting from immature cotyledon explants; (a) Induction of multiple shooting on 21 days cultured explants (b) Elongation of multiple shooting (c) Separated shoots grown to whole plantlets ready for hardening and field transfer

3.3.1 Organogenesis & callus-mediated whole plant regeneration

Leaf, cotyledonary explants (7 days old) from both *C. capsularis* and *C. oitorius* species were cultured on 1/2MS with vitamins of B_5, 5.4 μM IBA, 3.2 μM 6BAP (culture condition: 16/8 h L/D, 2000 lux 26$\pm$1^{0}C). Both shoot organogenesis as well rhizogenesis were observed (Fig. 1.2). Root induction for whole plant regeneration (MS with 0.2 μM IBA) also achieved after 70 days of culture.

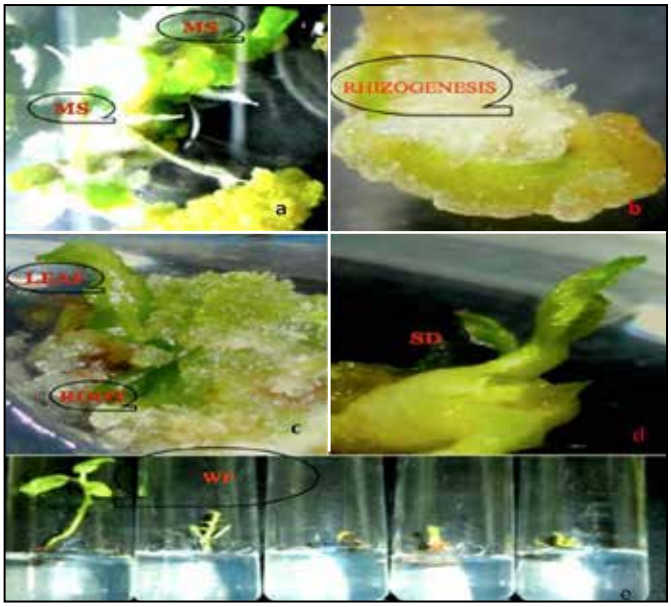


Fig. 3.4: Different stages of organogenesis and whole plant regeneration (a) Both caulogenesis (co) & rhizogenesis (rh) observed; (b) Rhizogenesis (rh) on cultured leaf explants at 30 days; (c) Shoot organogenesis after 30 days from cultured leaf explants; (d) Shoot organogenesis of cotyledonary explants; (e) Regenerated whole plants. Legends: SD – Shoot development, WP – Whole plantlet, MS- Multiple shoots

3.3.2. Somatic embryogenesis and plantlet regeneration:

An efficient and long-term somatic embryogenesis protocol with moderate plantlet regeneration was developed in jute. The protocol was found to be reproducible and highly efficient, in which long-term maintenance of morphogenetic capacity is discernible and less genotype dependency based maintenance media has been identified. This is plausibly the first report on the development of direct somatic embryogenic cultures from diverse explants of different jute varieties viz., JRO 524, JRO 8732 & JRC 517, JRC 321. This system is expected to offer an way out for efficient genetic transformation.

Direct somatic embryogenesis was induced from in vitro-derived leaf explants, with a magnitude of 7.5% following 8 weeks of culture on Murashige and Skoog (MS) medium supplemented with 3.0 mg/L 2,4-D and 30 g/L glucose.

Cotyledon, hypocotyl and root explants derived from of 30-days old seedlings were cultured on MS semi-solid and liquid medium fortified with 1.0 mg/ l. Extent of direct somatic embryo formation was found to be 100% when root explants were cultured in liquid medium. Histological analysis indicates that somatic embryos were initiated directly from the pericycle layers of root explants as early as on 10th day in liquid culture. Genotype did not affect the frequency of somatic embryo formation or the number of somatic embryos per explants. Four genotypes (JRO 524, JRO 8732 & JRC 517, JRC 321) were evaluated & displayed 80% somatic embryo induction.

Fig. 3.5: Direct somatic embryo (SE) induction and maturation from diverse explants in different varieties of jute; (a) Different stages of SE; (b) Embryonic callus with repetitive SE in long term maintenance media; (c-d) Whole plant regeneration from somatic embryogenesis ready for hardening and transfer to green house

An efficient protocol has been evolved for rapid and repetitive plantlet regeneration system in both *C. olitorius* and *C. capsularis* jute *via* primary and secondary somatic embryogenesis. Primary somatic embryogenesis was induced involving leaf discs, petiole, and tender root segments, which were cultured for 5 weeks on MS medium fortified with 0–0.50 mg/l IBA and 0.05 mg/l kinetin. Both primary and secondary somatic embryos were found to be germinated readily and developed into normal plantlets after 7 weeks of culture on half MS containing 20 g/l sucrose (Fig. 3.3). At 4–5 cm height, the plantlets were transferred to soil (1:1 v/v of peat moss and sand). The survival rate of hardened plantlets was found to be about 89% after 4 weeks under greenhouse condition.

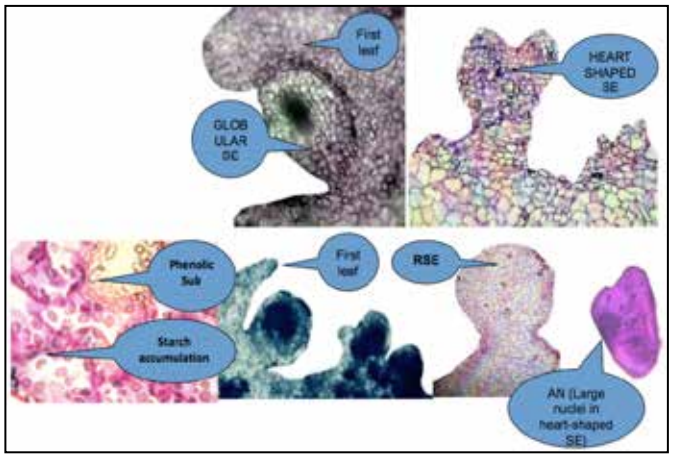


Fig. 3.6: Histological study of different stages of SE and starch grain accumulation as well as phenolic substance secreting cells on SE in capsularis jute var. JRO 524. Legends: RSE-Reparative SE, NA- Nucleic acid

Somatic embryos initiated directly from the upper surface of the leaf explants where vascular starches were found to be abundant (Fig. 3.6). In root explants, pericycle cell layers were found more totipotent to give rise somatic embryos. Genotype did not affect the frequency of somatic embryo formation or the number of somatic embryos per explants. All genotypes tested had about 80% somatic embryo inductions.

Embryogenic cell suspension culture (ECS) was developed after 4 weeks (0.03 mg/l IAA + 0.03 mg/ l BAP) from the date of culture initiation (Fig. 3.7). ECS would be used for protoplast culture in future **(Source: JB 9.3. Contributors: Asit B. Mandal and Mrs. Kanti Meena).**

3.1.3. Standardization of anther culture protocol to develop doubled haploid lines in *Corchorus capsularis*

Anthers containing uninucleated pollen grains for anther culture were selected for *in vitro* culture (confirmed by acetocarmine staining under microscope). Sterilization protocol for anther culture was also optimized concurrently. About 25-30 anthers from JRC 532, JRC 517 and JRC 321 were cultured onto each petri plate with callus induction medium containing different concentrations of auxins in dark until callus induction (Fig. 3.9). Different auxin combinations (0.5-4 mg/l NAA, 0.2-1.0 mg/l NAA and 0.2-1.0 mg/l IAA) were tried in JRC 517 (40%), 3.0 mg/l 2,4-D + 0.5 mg/l NAA + 0.2 mg/l IAA displayed maximum callus induction in white jute.

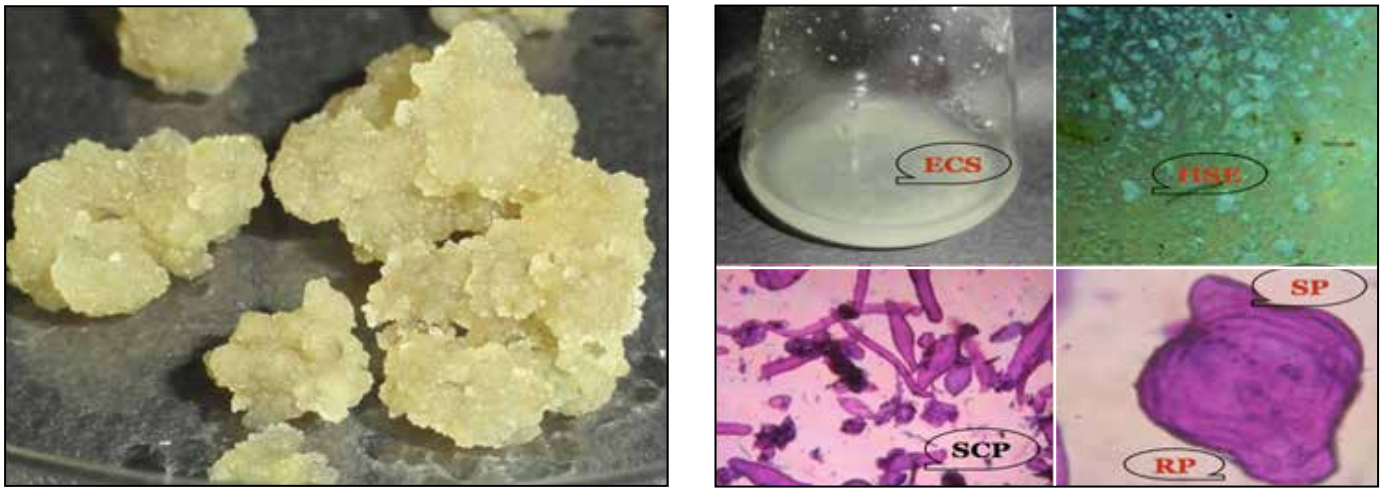


Fig. 3.7: Initial fast growing very fragile embryo genic callus used per embryogenic cell suspension culture development Legends: ECS: Embryogenic cell suspension; SCP: Suspended cell population; HSE: Heart shaped embryo; SP: Shoot pole; RP: Root pole

Callus induction range was found be in between 10-40 % .Induced callus displayed whitish colour and were found to be highly fragile in CIM. Induced calli were sub-cultured on fresh medium with half dose of hormones of CIM and shifted to culture room under 16/8h light/ dark. Callus derived from anthers were whitish in colour, however percentage of callus induction was found to be exceedingly low.

A few intact ovaries were also cultured, which resulted in 100 % callus induction on CIM containing 2 mg/l 2,4-D , 0.5 mg/l NAA. Calli were whitish in colour and were highly fragile. An experiment involving incubation of flower buds at 4 °C for 2, 4 and 8 days showed no substantial difference in respect of callus induction. Calli derived from anther culture of JRC 517, JRC 532 and JRC 321 were sub-cultured after 21 days on MS (with vit of MS and 3 combination with vitamin B_5 containing different combinations of auxins and cytokinins with 0.25 mM mannitol for 10-15 days (to impart shock through osmoticum management) in order to enhance plantlet regeneration work is in progress. MS (vit of B_5) + 3.0 mg/l 2,4-D + 1.0 mg/l NAA+ 3 mg/l Kinetin resulted appreciable callus proliferation, however, no plantlets could regenerate. Proliferated callus were exposed to MS medium supplemented with four combinations of hormone (auxin and cytokinins) and three adjuvants for plantlet regeneration along with control. No plantlet regeneration observed, however several green spots were discernible. **(Source: J.B. 9.4. Contributors: Kanti Meena and A. B. Mandal).**

JRC 517 JRC 532 JRC 321

Fig. 3.8: Callus sub-cultured on media fortified with different concentrations of auxin and cytokinins along 0.25 mM mannitol

4. Soil Health and Nutrient Management

4.1 Soil Health

4.1.1 Long term fertilizer experiment (LTFE)

A permanent field trial was initiated in 1971 at Central Research Institute for Jute and Allied Fibres, Barrackpore, West Bengal with jute-rice-wheat cropping sequence to evaluate the long-term effect of continuous application of farmyard manure and inorganic fertilizers either alone or in combination on crop yields, nutrient uptake and soil properties. During the period under report (the 42nd year), crops of jute (JRO 524), rice (khitish) and wheat (UP 262) were cultivated with different combination of fertilizer and manurial treatments. Yield, nutrient uptake and soil fertility status were evaluated and results are summarised below.

4.1.1.1 Crop yield: During 42nd year, yield of jute, rice and wheat ranged from 1.6 to 3.4 t/ha, 2.5 to 4.7 t/ha and 1.2 to 5.2 t/ha respectively under different treatments (Table 4.1). Crop yields were lowest in the control where neither fertilizers nor manures were applied for the last four decades and highest in 150% NPK. Reduction in the quantum of inputs (50% NPK) and exclusion of one or more nutrients resulted in significant reduction in yields of jute, rice and wheat than 100% NPK. Application of NPK, either through inorganic fertilizers or in combination with organic manures significantly increased the yields of jute, rice and wheat over control. The highest SYI (sustainable yield index) values of 0.45, 0.41 and 0.40 respectively for jute, rice and wheat were obtained with 150% NPK treatment. Among the cereal crops, SYI was greater for rice than wheat in all the treatments, with exception in 100% NPK + $ZnSO_4$ @ 10 kg/ha and 100% NPK as sulphur free source treatments. Thus, lesser SYI in S free treatment was attributed to significant loss of productivity in rice due to depletion of S level in soils indicating significant role of S in rice production. Higher SYI in NPK+FYM as compared to recommended dose of NPK could be due to addition of organics apart from N, P, and K supply, and resultant improvement in soil physical conditions and microbial activities.

4.1.1.2 Nutrient uptake: Uptake of NPK by component crops was significantly less under control and imbalanced use of fertilizers than those of balanced use of fertilizers (Table 4.2). Application of 150% NPK resulted in higher uptake of N, P and K in jute and rice and wheat as compared to 100% NPK+ FYM treatment.

4.1.1.3 Soil properties: The integrated nutrient management technique resulted in a positive influx of nutrients by increasing soil organic carbon, available nitrogen, phosphorus and potassium status varying respectively from 5.60 to 8.90 g/kg, 270 to 316 kg/ha, 40 to 120 kg/ha and 139 to 236 kg/ha (Table 4.3). There was reduction in DTPA-extractable Zn, Fe and Mn over initial value in all the treatments. Maximum DTPA-extractable micronutrients resulted from application of NPK+FYM **(Source: JC 5.2. Contributors: D.K.Kundu, A.R.Saha, B.Majumdar, A.K.Ghorai and S. Paul Mazumdar).**

Table 4.1: Yield and long term SYI of jute, rice and wheat

Treatments	Yield (t/ha)			Long term SYI		
	Jute	Rice	Wheat	Jute	Rice	Wheat
50%NPK	2.7^{d}	3.7^{f}	3.7^{d}	0.28	0.27	0.25
100%NPK	3.1^{c}	4.3^{bc}	4.3^{c}	0.39	0.35	0.32
150%NPK	3.4^{a}	4.7^{a}	5.2^{a}	0.45	0.41	0.40
100%NPK+HW	2.8^{d}	4.1^{cd}	3.9^{d}	0.37	0.35	0.32
100%NPK+Zn	3.1^{c}	4.3^{bc}	4.5^{bc}	0.32	0.30	0.31
100%NP	2.9^{d}	3.9^{ef}	3.5^{e}	0.33	0.33	0.31
100%N	2.9^{d}	3.4^{g}	3.7^{d}	0.29	0.29	0.26
100%NPK+FYM	3.3^{b}	4.4^{b}	4.8^{b}	0.45	0.40	0.35
100%NPK – S	2.9^{d}	4.0^{de}	4.0^{d}	0.35	0.29	0.33
Control	1.6^{e}	2.5^{h}	1.1^{f}	0.11	0.15	0.09

In a column, means followed by a common letter are not significantly different by DMRT at the 5% level

Table 4.2: Nutrient uptake by jute, rice and wheat crops

Treatments	Nutrient uptake								
	Jute (kg/ha)			Rice (kg/ha)			Wheat (kg/ha)		
	N	P	K	N	P	K	N	P	K
50%NPK	62.7^{e}	27.4^{e}	92.6c	69.3^{e}	13.1^{d}	87.2^{e}	77.6^{e}	16.9^{c}	83.6^{e}
100%NPK	76.7^{b}	32.3^{bc}	110.1^{b}	83.5^{bc}	16.3^{b}	104.7^{b}	98.0^{b}	20.6^{b}	103.3^{bc}
150%NPK	83.1^{a}	34.8^{a}	120.5^{a}	90.2^{a}	19.6^{a}	114.8^{a}	126.6^{a}	23.9^{a}	123.6^{a}
100%NPK+HW	69.1^{d}	30.9^{c}	103.6^{b}	78.4^{cd}	15.7b^{c}	96.9^{c}	87.6^{cd}	18.1^{c}	97.4^{cd}
100%NPK+Zn	75.6^{bc}	30.4^{cd}	108.4^{b}	82.5^{bc}	15.5b^{c}	99.0b^{c}	101.7^{b}	21.8^{b}	105.2^{b}
100%NP	73b^{cd}	27.5^{e}	94.8^{c}	74.0^{de}	14.8^{c}	88.2d^{e}	82.9d^{e}	17.3^{c}	70.1^{f}
100%N	71.2^{cd}	25.3^{f}	92.5^{c}	62.1^{f}	11.2^{e}	86.4^{e}	79.5d^{e}	14.1^{d}	60.4^{g}
100%NPK+FYM	77.5^{b}	33.2^{ab}	120.0^{a}	85.7^{ab}	18.9^{a}	105.3^{b}	120.8^{a}	21.4^{b}	123.1^{a}
100%NPK – S	70.1^{cd}	28.7^{de}	105.2^{b}	77.6^{cd}	15.2^{c}	94.6c^{d}	95.0b^{c}	18.2^{c}	95.0^{d}
Control	24.7^{f}	12.2^{g}	37.3^{d}	40.9^{g}	9.2^{f}	46.8^{f}	24.8^{f}	5.8^{e}	16.1^{h}

In a column, means followed by a common letter are not significantly different by DMRT at the 5% level

Table 4.3: Effect of chemical fertilizer and organic manures on physics-chemical properties of surface soil (0-15 cm)

Treatments	pH	EC (dS/m)	Organic C (g/kg)	Available N (kg/ ha)	Available P (kg/ ha)	Available K (kg/ha)
50%NPK				282^{ef}	65.0^{f}	176^{d}
100%NPK	7.62^{b}	0.17^{cd}	7.10^{b}	290^{de}	88.9^{d}	212^{b}
150%NPK	7.56^{c}	0.17^{cd}	7.10^{b}	321^{a}	107^{b}	232^{a}
100%NPK+HW	7.61^{b}	0.16^{d}	7.40^{b}	306^{bc}	89.1^{d}	195^{c}
100%NPK+Zn	7.60^{b}	0.17^{c}	7.60^{b}	312^{ab}	87.5^{d}	209^{b}
100%NP	7.62^{b}	0.16^{d}	7.10^{b}	306^{bc}	101^{c}	131^{e}
100%N	7.63^{b}	0.17^{c}	6.90^{b}	303^{bcd}	40.0^{g}	135^{e}
100%NPK+FYM	7.50^{d}	0.23^{a}	8.90^{a}	316^{ab}	120^{a}	236^{a}
100%NPK – S	7.63^{b}	0.18^{b}	7.10^{b}	294^{cde}	82.4^{e}	188^{c}
Control	7.66^{a}	0.16^{d}	5.60^{c}	270^{f}	40.7^{g}	139^{e}

In a column, means followed by a common letter are not significantly different by DMRT at the 5% level

4.2 Nutrient management

4.2.1 Soil test and resource based integrated plant nutrient supply system in jute based cropping system

4.2.1.1 Development of targeted yield equation: A fertility gradient was developed using maize as exhaust crop with the application of various levels of N, P and K which is evidenced by increasing trend of dry matter yield of maize from lower to higher fertility gradient as well as available P and K status. After harvesting of maize as an exhaust crop, the test crop viz., sunnhemp, rice and garden pea were grown and the basic data and

targeted yield equations for sunnhemp (Suin 037) and rice (GS 3) were developed (Table 4.4).

4.2.1.2 Follow-up trials on jute, rice and vegetable pea: The multi-locational field verification trial on jute (JRO 204) revealed that application of fertilizers on soil test and targeted yield basis (ST-TY) without and with FYM achieved the target of 40 q/ha fibre yield with (-) 2.74 and (+) 2.14 % yield deviation, respectively. Integration of FYM (5 t/ha) with fertilizers as per ST-TY recorded highest response ratio (21.2 kg/kg NPK) and B:C ratio (2.24) over RDF and farmers' practice (Table 4.5). Similarly, the follow up trials on rice (NDR-97) showed that application of fertilizers as per ST-TY without and with FYM achieved the target of 50 q/ha grain yield with (-) 5.00 and (+) 1.14 % yield deviation, respectively. Integration of FYM (5 t/ha) with fertilizers as per ST-TY equation recorded highest response ratio (26.27 kg/kg NPK) and B:C ratio (2.10) over RDF and farmers' practice (Table 4.6). The multi-locational follow up trials on garden pea (Azad P-3) revealed that application of fertilizers as per ST-TY without and with FYM achieved the target of 110 q/ha green pod yield with (-) 1.69 and (+) 1.14 % yield deviation, respectively. Integration of FYM (5 t/ ha) with fertilizers as per ST-TY recorded highest response ratio (33.04 kg/kg NPK) and B:C ratio (3.03) over RDF and farmers practice (Table 4.7) **(Source: JC 5.6. Contributors: A.R. Saha, B. Majumdar, S. Biswas, S. Paul Mazumdar and S. R. Singh).**

Table 4.4: Basic data and targeted yield equations for sunnhemp and rice

Basic Data	Sunnhemp (Suin 037)			Rice (GS 3)		
	(2013)			(2013)		
	N	P	K	N	P	K
Nutrient requirement (kg/q)	7.80	1.93	7.83	2.49	1.09	3.72
Soil efficiency (%)	28.28	30.45	33.25	27.91	32.27	43.10
Fertilizer efficiency (%)	58.18	36.66	77.65	36.06	46.62	158.57
Organic efficiency (%)	21.84	7.22	35.35	32.18	17.09	52.31
Targeted yield equations	Sunnhemp FN= 13.41 T - 0.49 SN - 0.38 ON FP= 5.28 T - 0.83 SP - 0.20 OP FK=10.08 T - 0.43 SK - 0.46 OK			Rice FN= 6.90 T - 0.77 SN - 0.89 ON FP = 2.33 T - 0.69 SP - 0.37OP FK = 2.35 T - 0.27 SK - 0.33 OK		

Table 4.5: Average fibre yield, response ratio, yield deviations, net return and B: C ratio against fixed target of jute (JRO 204) under follow-up trials during 2013-14

Treatments	Fibre yield (q/ha)	Response ratio (kg/kg NPK)	Yield deviation (%)	Net return (Rs/ha)	B:C ratio
Control (0:0:0)	20.0	-		6000	1.16
Farmers' practice (FP)	28.8	6.24		22106	1.54
Recommended dose of fertilizers (RDF)	36.4	10.3		38372	1.92
ST-TY (40 q/ha)	39.0	18.0	(-) 2.74	45082	2.11
ST-TY (40 q/ha) +FYM @ 5 t/ha	41.0	21.2	(+) 2.14	49846	2.24

Table 4.6: Average grain yield, response ratio, yield deviations, net return and B: C ratio against fixed target of rice (NDR 97) under follow-up trials during 2013-14

Treatments	Grain yield (q/ha)	Response ratio (kg/kg NPK)	Yield deviation (%)	Net return (Rs/ha)	B:C ratio
Control	28.5	-		7625	1.2
Farmers' practice (FP)	44.5	8.99		23483	1.7
Recommended dose of fertilizers (RDF)	46.4	11.19		26248	1.8
ST-TY (50 q/ha)	47.5	20.88	(-) 5.00	29213	2.0
ST-TY (50 q/ha) + FYM @ 5 t/ha	50.6	26.27	(+) 1.14	33219	2.1

Table 4.7: Average grain yield, response ratio, yield deviations, net return and B: C ratio against fixed target of garden pea (Azad P 3) under follow-up trials during 2013-14

Treatments	Green pod yield (q/ha)	Response ratio (kg/kg NPK)	Yield deviation (%)	Net return (Rs/ha)	B:C ratio
Control	66.3	-		23910	2.06
Farmers practice (FP)	76.8	13.93		29491	2.22
Recommended dose of fertilizers (RDF)	97.8	22.46		42697	2.66
ST-TY (110 q/ha)	108.1	28.86	(-) 1.69	49775	2.92
ST-TY 110 q/ha+ FYM @ 5 t/ha	111.2	33.04	(+) 1.14	52154	3.03

4.2.2 Long term effect of ST-TY equation based INM on nutrient budgeting and quality of soil under jute – rice - lentil sequence

Under the project "Long term effect of ST-TY equation based INM on yield, value addition, nutrient budgeting and quality of soil under jute-rice-lentil sequence" the targeted yield (40 q/ha) of jute fibre was achieved with fertilizer applied on soil test targeted yield basis (ST-TY) with (-) 7.5 % yield deviation. Integration of ST-TY with FYM achieved the targeted yield of jute fibre (35 q/ha) with (+) 6.0 % yield deviation (Table 4.8). In case of rice, application of fertilizers as per ST-TY achieved (48.6 q/ha) the targeted grain yield (50 q/ha) with (-) 2.8 % yield deviation. Integration of ST-TY with FYM, *Azotobacter* and PSB achieved the targeted yield of rice (40 q/ha) with (+) 13.0 % yield deviation (Table 4.9). Integrated application of FYM, *Azotobacter* and PSB with inorganic fertilizer (ST-TY) increased the agronomic efficiency of P & K fertilizers over RDF for jute & rice. Integrated application of fertilizers as per ST-TY with FYM significantly increased enzymatic activity over FP and RDF after rice. Application of fertilizer as per ST-TY with INM significantly increased the yield of jute fibre, rice and lentil. Application of fertilizers as per ST-TY with FYM significantly increased the available nutrient status over RDF. Application of fertilizer as per ST-TY along with FYM and biofertilizer significantly increased enzymatic activities over only ST-TY (Table 4.10 & 4.11) **(Source: JC 5.6A. Contributors: A.R. Saha, B. Majumdar, S. Biswas, S. Paul Mazumdar and S. R. Singh).**

Table 4.8: Effect of ST-TY based fertilizer application on fibre yield and AE of jute in jute-rice-lentil sequence

Treatments	Fertilizer dose (kg/ha) for jute			Fibre yield (q/ha)	Agronomic efficiency (kg/kg)		
	N	P_2O_5	K_2O		N	P_2O_5	K_2O
T_1= Control	0	0	0	20.1	-	-	-
T_2= ST-TY (40 q/ha)	161	48	74	37.0	10.5	35.3	22.83
T_3 = ST-TY (35 q/ha)	127	40	61	34.6	11.4	36.3	23.77
T_4 = T_3+FYM (5 t/ha)	117	37	57	37.1	14.52	45.94	29.82
T_5 = T_3+Azot+PSB	117	37	57	36.2	13.76	43.51	28.24
T_6= T_4+Azot.+PSB	117	37	57	38.4	15.64	49.46	32.10
T_7= FYM @ 5 t/ha	0	0	0	25.6	0.0	0.0	0.0
T_8= T_7+Azot.+PSB	0	0	0	27.3	0.0	0.0	0.0
T_9= RDF	80	40	40	32.4	15.38	30.75	30.75
T_{10}= FP	23	59	59	26.0	25.7	10.0	10.0
LSD (P=0.05)				4.62			

Table 4.9: Effect of ST-TY based fertilizer application on grain yield and AE of rice in jute-rice-lentil sequence

Treatments	Fertilizer dose (kg/ha) for rice			Grain yield (q/ha)	Agronomic efficiency (kg/kg)		
	N	P_2O_5	K_2O		N	P_2O_5	K_2O
T_1= Control	0	0	0	26.9	-	-	-
T_2= ST-TY (50 q/ha)	135	35	65	48.6	16.1	62.0	33.4
T_3 = ST-TY (40 q/ha)	82	25	46	44.5	21.4	70.4	38.2
T_4 = T_3+FYM (5 t/ha)	78	23	43	45.1	23.3	79.1	42.3
T_5 = T_3+Azot.+PSB	78	23	43	45.9	24.4	82.6	44.2
T_6= T_4+Azot.+PSB	78	23	43	45.2	23.5	79.6	42.6
T_7= FYM @ 5 t/ha	0	0	0	32.1	-	-	-
T_8= T_7+Azot.+PSB	0	0	0	34.8	-	-	-
T_9= RDF	80	40	40	43.9	21.3	42.5	42.5
T_{10}= FP	59	30	30	35.8	15.1	29.7	29.7
LSD (P=0.05)				4.51			

Table 4.10: Effect of different treatments on soil available nutrient status and enzymatic activities after jute harvest

Treatments	Available nutrient (kg/ha)			Enzymatic activity (μg/g of oven dry soil/hr)			
	N	P	K	FDHA	Dehydrogenase	Acid Phosphatase	Alkaline Phosphatase
T_1= Control	250.8	37.3	137.2	8.9	1.18	185.9	183.5
T_2= ST-TY (40 q/ha)	289.3	39.5	157.8	9.3	2.84	200.5	210.2
T_3 = ST-TY (35 q/ha)	282.5	36.2	171.2	9.5	2.26	228.7	207.7
T_4 = T_3+FYM (5 t/ha)	298.7	38.4	155.4	9.2	3.88	219.6	226.7
T_5 = T_3+Azot.+PSB	279.8	37.9	151.3	9.8	3.14	199.3	251.2
T_6= T_4+Azot.+PSB	318.6	47.3	181.5	10.7	3.96	249.8	345.3
T_7= FYM @ 5 t/ha	257.6	37.8	147.8	10.2	3.70	197.1	330.8
T_8= T_7+Azot.+PSB	281.2	36.4	159.3	10.4	3.74	224.9	326.4
T_9= RDF	274.3	41.3	139.4	9.1	2.33	188.5	218.2
T_{10}= FP	271.2	37.7	159.2	8.1	1.44	158.1	191.2
LSD (P=0.05)	7.46	0.45	3.83	0.75	0.44	4.88	6.02

Table 4.11: Effect of different treatments on available nutrient status and enzymatic activities after rice harvest

Treatment	Available nutrient (kg/ha)			Enzymatic activity (μg/g of oven dry soil/hr)			
	N	P	K	FDHA	Dehydrogenase	Acid Phosphatase	Alkaline Phosphatase
T_1= Control	260.2	36.3	135.7	4.8	1.26	173.2	176.0
T_2= ST-TY (50 q/ha)	277.2	38.3	152.7	6.7	1.99	187.6	178.7
T_3 = ST-TY (40 q/ha)	271.0	37.0	168.1	7.6	2.01	224.3	176.6
T_4 = T_3+FYM (5 t/ha)	292.6	39.4	150.0	6.0	1.91	201.2	192.7
T_5 = T_3+Azot.+PSB	277.2	41.0	150.8	6.9	2.35	188.6	205.5
T_6= T_4+Azot.+PSB	308.0	49.9	178.2	8.9	2.58	232.4	287.3
T_7= FYM @ 5 t/ha	256.4	38.2	144.5	8.3	2.41	181.2	277.5
T_8= T_7+Azot.+PSB	277.2	39.4	154.3	8.6	2.28	202.5	283.5
T_9= RDF	261.8	40.2	137.2	7.8	1.72	173.2	213.6
T_{10}= FP	262.2	36.2	158.6	6.8	1.68	141.3	162.5
LSD (P=0.05)	7.88	2.05	5.56	0.67	0.33	4.57	8.99

4.2.3 Phosphorus distribution and availability in an *Inceptisol* under intensive cultivation of jute-rice-wheat cropping system

Effects of continuous jute-rice-wheat cropping with contrasting nutrient management practices on status, content and distribution of phosphorus fractions and their relation with crop yield, uptake and nutrient availability was studied. Soil and plant samples were collected from six selected treatments (100 and 150% of recommended dose of NPK, 100% NP, 100% N, 100% NPK+ FYM, and no-fertilizer control) of the long-term field experiment initiated in 1971 at CRIJAF Farm, Barrackpore after the harvest of wheat during 2013.

Crop yield and P uptake increased significantly with P application. Among different inorganic P fractions, calcium phosphate (Ca-P) was the dominant form followed by aluminium phosphates (Al-P), iron phosphates (Fe-P) and saloid-P. The build-up of Ca-P, Al-P and saloid-P fractions in the soil was maximum under the NPK+FYM treatment followed by 150% NPK, while that of the Fe-P was maximum with 150% NPK treatment (Fig 4.1). All the inorganic fractions of P in the soil were significantly correlated. All the P fractions in surface soil together contributed 76% towards grain yield of wheat and 83% towards P uptake, with saloid-P fraction contributing significantly.

Size distribution of water stable aggregates (WSA) was influenced by fertilizer treatments. Total WSA were significantly higher in soils treated with NPK through inorganic fertilizers or in combination with organics as compared to control. Irrespective of treatments, micro-aggregates dominated total soil aggregate size distribution, followed by macro-aggregates **(Source: JC 6.4. Contributors: S. Paul Mazumdar, A.R. Saha and D.K. Kundu).**

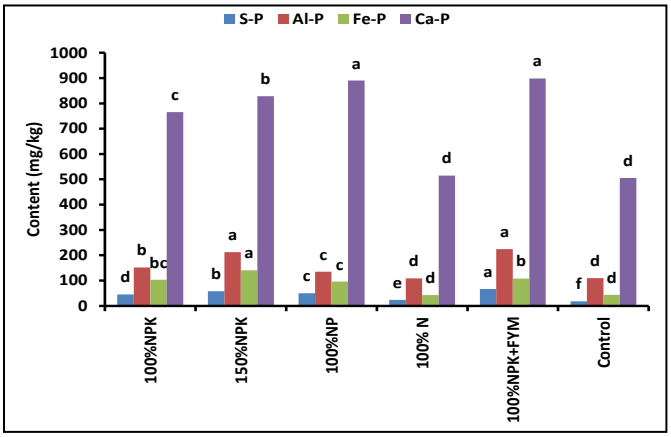


Fig 4.1: Inorganic P fractions (mg/kg) in post wheat soil

4.2.4 Improvement of nitrogen use efficiency (NUE) in jute

The project was initiated to understand the physiological and biochemical basis for NUE of jute and to identify the key components playing decisive role in the process of uptake as well as utilization of nitrogen thereby contributing to increased fibre yield of the crop. Twenty diverse indigenous and exotic *Corchorus olitorius* germplasm were collected from CRIJAF gene bank based on characters like stem pigmentation, plant height, base diameter, fibre yield, floral characteristics and eco-geographical region, etc., of which two exotics wild olit. Dwarf (OIN-010) and Bangkok (OEX-005) were selected for development of biparental mapping population (Table 4.12). Observations on growth parameters, chlorophyll content and nitrate reductase activity of six *C. olitorious* genotypes (S-19, JRO-8432, JRO-204, JRO-128, Tanganyika-1, JRO-524,) were measured under different N levels (0, 80 and 160 ppm) at 70 days after emergence (DAE) in glass house. The plants were grown in N-free vermiculite medium in earthen pots and nutrients – N (as per treatments) and other macro and micronutrients (general) were applied through Hoagland Nutrient solution modified for jute.

4.2.4.1 Development of biparental mapping population

Crossing programme was initiated at CRIJAF, Barrackpore during the crop season 2013 and F_1 seeds were raised at SBI, Coimbatore in January, 2014 to develop F_2 seeds and biparental mapping population.

4.2.4.2 Standardization of Hoagland nutrient solution

The standard Hoagland solution containing N, K, P, S, Ca, Mg @ 16, 6, 4, 2, 1 and 1 mM (224,235,160,62,32 and 24 ppm) respectively was modified for jute for both N-free and N-added (80 and 60 ppm N level) conditions on the basis of common ion effect. In N-free Hoagland solution, $Ca(NO_3)_2$, $4H_2O$ and $NH_4H_2PO_4$ was replaced by $CaCl_2$ $4H_2O$ and NaH_2PO_4 respectively. In 80 ppm N treatment, N was supplied through $NaNO_3$. In 160 ppm N solution, 112 ppm N was supplied through $Ca(NO_3)_2$, $4H_2O$ and rest 48 ppm N was supplied through NaH_2PO_4. In all the cases micronutrient and Fe-EDTA content was kept same. The modification was made on the basis of common ion effect.

4.2.4.3 Growth and physiology of jute at different nitrogen levels

At 70 DAE, increase in shoot length with added N was

maximum in Tangnyika 1 followed by JRO 524 at both 80 and 160 ppm levels. In case of root length, increase was significantly higher in S 19 followed by JRO 204 upto 80 ppm N dose while at 160 ppm N level, increase was more with Tangnyika 1 and JRO 524. In absence of added N, JRO 8432 recorded the higher shoot length followed by JRO 524, while at 80 and 160 ppm N, Tanganika 1 recorded the highest shoot length followed by JRO 524. The increase in total dry matter (TDM) with addition of 80 ppm N was maximum both in Tanganyika 1 and JRO 128 followed by JRO 524 while at 160 ppm N level, maximum increase in TDM was observed in JRO 204 and JRO 524. In all the growth parameters studied, the response of the test genotypes was significantly higher up to 80 ppm N. At 70 DAE, S 19, JRO 8432, Tanganyika 1 and JRO 524 recorded higher chlorophyll a, chlorophyll b and total chlorophyll content at 160 ppm N level while S 19 and JRO 524 recorded higher chlorophyll content (a, b and total) in absence of applied N also. Nitrate reductase (NR) activity was measured with modified substrate concentration (10 mM to 50 mM KNO_3) and reducing agent (400 μM to 800 μM NADH) concentration. The nitrate reductase activity was highest in JRO 524 leaves (15 days) when KNO_3 concentration was 40 mM and NADH concentration was 400 μM **(Source: TMJ 9. Contributors: S. Mitra, D. Sarkar, P. Satya, M. Kumar and A. Singh).**

Table 4.12. Initial germplasm used for selection of parents to develop biparental mapping population

Accession/ genotype	Common name	Country	Stem pigmentation	Plant height (cm)	Base diameter (cm)	Fibre weight/ plant (g)
JRO 620	JRO 620	India	Red	281.0	1.30	10.0
Chinsurah Green	Chinsurah Green	India	Green	296.0	1.40	10.0
Bidhan Rupali	Bidhan Rupali	India	Pale Green	325.0	1.63	11.9
Sudan Green	Sudan Green	Sudan	Green	243.0	1.00	5.4
Tanganyika-1	Tanganyika-1	Tanzania	Green	352.0	1.40	15.5
OEX-013	OEX-013	Australia	Red	299.0	1.10	7.4
OEX-032	Russian Green	Russia	Green	241.0	1.30	7.2
OIJ-254	Brazil Nonsoong	Brazil	Green	331.0	1.40	14.7
OEX-019	OEX-019	Germany	Green	236.0	1.20	5.0
OEX-007	Peaking	China	Red	338.0	1.20	11.8
OEX-005	Bangkok	Thailand	Green	329.0	1.20	10.9
OEX-021	Nigeria Ibadan	Nigeria	Green	235.0	1.00	4.10
OEX-009	Olit 3 Burma	Myanmar	Green	329.0	1.30	9.9
OIJ-002	KEN/DS/015C	Kenya	Red	211.0	1.00	3.4
OIJ-173	IDN/SU/053C	Indonesia	Red	207.0	2.00	8.5
OIJ-204	NPL/JRC/550	Nepal	Red	355.0	1.60	7.0
OIJ-297	Golden	Pakistan	Red	319.0	1.10	8.0
OIN-004	Binpur 1	India	Green	356.0	1.50	9.5
OIN-009	Olit. Deep Red	India	Red	242.0	1.00	5.8
OIN-010	Wild Olit. Dwarf	India	Red	226.0	1.00	3.9

5. Crop Husbandry

5.1. Jute

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

Five cropping sequences were assessed under nutrient and crop residue management practice for their productivity. The jute plant height was significantly lower in jute-rice-wheat sequence compared to remaining cropping sequence at all crop growth stages except 90 DAS (Table 5.1). The highest (30.6 q/ha) and the lowest fibre yield (28.8 q/ha) was recorded with jute-rice-baby corn- jute (leafy vegetable) sequence and jute-rice wheat sequence, respectively, although, the fibre yield was non-significant among the cropping sequence. Nutrient management practices did not affect significantly the jute plant height at 90 DAS and fibre yield but interaction between crop sequences and nutrient management was found significant for fibre yield (Table 5.2). Jute-rice-baby corn-jute (leafy vegetable) cropping sequence with 100% recommended dose of fertilizer (RDF) along with baby corn residue incorporated soil recorded the highest fibre yield and jute-rice-wheat with 75% RDF along with wheat crop residue incorporated soil recorded the lowest fibre yield. Wheat crop residue incorporation significantly reduced the fibre yield with both 75% and 100% RDF compared to corn and garden pea residue incorporation in jute-rice-baby corn-jute (leafy vegetable) and jute-rice-garden pea, respectively.

Table 5.1: Influence of cropping sequence and nutrient management on jute and rice yield

Treatments	Jute					Rice	
	Plant height (cm)				Fibre yield (q/ha)	Tillers/m^2	Yield (q/ha)
	30 DAS	60 DAS	90 DAS	At Harvest			
Cropping sequences							
Rice-rice						110	28.4
Jute-rice-wheat	40.7	105.0	209.0	306.3	28.8	124	33.5
Jute-rice-baby corn-jute (leafy vegetable)§	57.0	127.0	212.0	312.5	30.6	118	33.0
Jute-rice-garden pea	53.7	115.2	209.0	312.0	29.2	124	32.3
Jute-rice-mustard¥-mung§	52.5	115.0	207.0	308.5	28.5	118	32.5
SEm (±)	1.57	2.27	4.92	0.82	0.72	2.6	1.01
LSD (P=0.05)	4.59	6.62	NS	2.39	NS	7.7	2.92
Nutrient management							
75% RDF + No crop residue#	50.6	114.0	203.0	307.2	29.4	119	31.4
75% RDF + with crop residue	49.8	115.0	203.8	311.7	28.7	122	31.8
100 % RDF + No crop residue	54.4	116.8	210.7	308.0	29.0	119	32.0
100% RDF + with crop residue	49.2	116.0	210.3	312.5	30.0	116	32.6
SEm (±)	0.91	0.99	2.75	2.50	0.63	3.34	0.68
LSD (P=0.05)	2.67	NS	NS	NS	NS	NS	NS
Interaction	S	NS	NS	NS	S	NS	NS

¥: Mustard was sown in zero tillage: §crop was sown in relay with previous crop in sequence # crop residue of rice, wheat and corn @ 4t/ha and pea and mung @ 2t/ha incorporated in the respective cropping sequences; S - Significant; NS - Non significant.

Table 5.2: Interaction effect of cropping sequence and nutrient management for jute fibre yield (q/ha)

Cropping sequences	Nutrient management				Mean
	75% RDF + No crop residue	75% RDF + with crop residue	100 % RDF + No crop residue	100 % RDF + with crop residue	
Jute-rice-wheat	29.6	26.6	29.8	27.8	28.5
Jute-rice-baby corn-jute (veg)§	28.9	30.2	31.1	32.1	30.6
Jute-rice-garden pea	26.4	30.2	28.2	32.0	29.2
Jute-rice-mustard¥-mung§	27.9	29.4	26.9	31.0	28.8
Mean	29.4	28.7	29.0	29.9	
SEm (±) (at same cropping sequences)		1.25	LSD (P=0.05)		3.66
SEm (±) (at same nutrient management)		1.20	LSD (P=0.05)		3.50

¥: Mustard was sown in zero tillage: §crop was sown in relay with previous crop in sequence # crop residue of rice, wheat and corn @ 4t/ha and pea and Mung @ 2t/ha incorporated in their respective cropping sequences.

All jute based cropping sequences recorded significantly higher rice yield and effective tillers/m^2 compared to rice-rice cropping sequence (Table 5.1) may be due to nutrients recycled from leaf fall during crop growth and defoliation prior to retting for 3 days. Although, nutrient management did not affect significantly both tiller/m^2 and rice yield, but higher rice yield recorded with 100% RDF with and without crop residue incorporation treatments. The amount of nutrient returned by leaf fall during crop growth stages and by leaf shedding after harvesting has been quantified (Figure 5.1). The amount of leaf fall up to 105 DAS crop was about 9.3 q/ha, which contributed about 13.5 kg N/ha, 10.6 kg P/ha and 11.8 kg K/ha to the soil and amount of leaf at harvest of about 18.6 q/ha which returned about 39 kg N/ha N, 32 kg P/ha and 42 kg K/ha to the soil when plants were kept for 3 days in field after harvest. **(Source: JA 5.6. Contributors: Mukesh Kumar, S Mitra, A.K. Ghorai and S.R. Singh)**

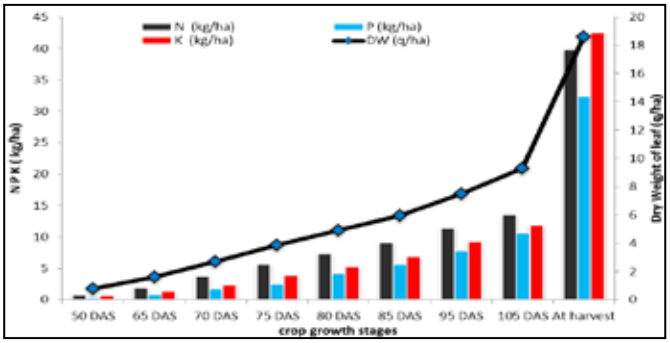


Figure 5.1: Leaf fall pattern and their nutrients (N, P and K) contribution at different crop growth stages and at harvest

5.1.2. Improving water productivity of jute and its retting under low volume water

Different irrigation methods/water conservation practices with nutrient management were evaluated for improving the water productivity for jute at CRIJAF Barrackpore.

Water conservation/irrigation methods in jute i): one flood irrigation in flat bed sowing with recommended dose of fertilizer (RDF) *i.e.* N:P_2O_5:K_2O::60:30:30 kg/ha, produced 31.2 q jute fibre/ha ii) open furrow sowing of jute and one irrigation on furrow with RDF, reduced the irrigation requirement by 40 % and produced 33.8 q fibre/ha which was 2.6 q/ha higher over traditional flat bed method of sowing iii) At RDF and one flood irrigation followed by soil mulching (at field capacity) by CRIJAF Nail Weeder produced 34.8 q jute fibre /ha and is 3.6 q/ha higher over traditional flood irrigation system. In large scale front line demonstrations on drought management of jute, in farmers' field of 55 ha soil mulching by CRIJAF Nail Weeder could save 1-2 irrigations in different locations of Hooghly, Murshidabad and North-24 Parganas and produced 30-35 q jute fibre/ha.

Nutrient Management: RDF and elemental sulphur @ 30 kg/ha increased jute fibre yield from 4-6 q/ha in soil low in available sulphur (<20 kg/ha).

5.1.3 Effect of salt stress on germination and early seedling growth on jute

To identify the salt tolerant variety of jute (*Corchorus capsularis* and *C. olitorius*) a lab experiment was conducted with five levels of salt concentration (0, 100, 160, 240 and 300 mM NaCl). The highest percentage of germination, root and shoot length, fresh and dry weight and salt tolerance index of seedlings were observed in *C. capsularis* varieties JRC 698, JRC 517 and JRC 532 at salt concentration up to 160 mM NaCl (Fig. 5.2). Variety UPC-94 was the most susceptible to salinity stress. A general decline in all the growth parameters was observed at 240 mM NaCl. In case of *C. olitorious;* JRO 632, JRO-128 and Ira were found relatively more salt tolerant than other varieties. Seed germination was completely inhibited at 300 mM NaCl. It can be concluded that *capsularis* is more tolerant than *olitorius* under salinity stress condition **(Source: Exploratory project, Contributors: M. Ramesh Naik, Amarpreet Singh, D.K Kundu and D. Barman).**

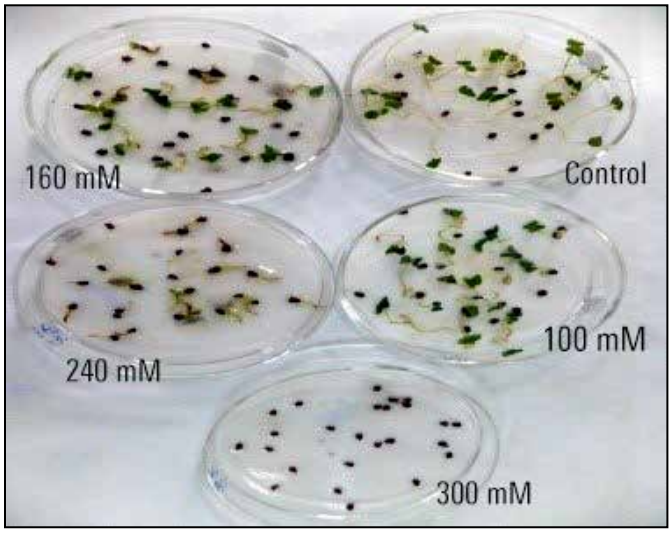


Fig. 5.2. Response of jute varieties to different levels of salinity

5.1.4 Prospects of growing medicinal and aromatic crops in jute based cropping system

The feasibility of growing medicinal and aromatic crops in jute-based cropping system was studied under field condition. Among the medicinal and aromatic crops, stevia gave the highest net income (₹ 176000/ha) followed by ashwagandha (₹ 41590/ha), isabgol (₹ 38000 /ha), menthol mint (₹ 31120/ha), coleus (₹ 26300/ha) and asalio (₹ 24300/ha) in jute-rice sequence. The return per rupee investment was maximum in ashwagandha (2.84) followed by isabgol (2.52), asalio (2.33), senna (2.20) and menthol mint (2.09). Ashwagandha was the most profitable crop in jute-rice cropping sequence (Fig. 5.3). Thus, ashwagandha, isabgol, asalio, senna and mint may be taken up in rotation in jute-rice sequence for higher income compared to conventional crops. **(Source: Exploratory project, Contributors: M.S. Behera, D. K. Kundu, S. Satpathy and Amarpreet Singh)**

Fig. 5.3 Field view of Ashwagandha.

5.1.5 Fibre cum seed production through stem cutting in tossa jute, C. olitorius

A field experiment was conducted to assess the prospect of jute fibre and seed production from the same jute crop for making individual farmers self-sufficient in seed production. The effect of stem cutting (of variable length of 20-40 cm) planted in 3 spacings (45 X 10 cm, 45 x 15 cm and 45 x 20 cm) on seed production was evaluated along with direct sowing and planting of 25 days old seedlings. Maximum seed yield of 5.1 q/ha was recorded when the stem cuttings of 40 cm size was planted at a spacing of 45×15 cm. Jute seed crop established by stem cuttings matured one month earlier compared to the seed crop raised by the conventional direct sowing. It reduces total time required for growing a fibre and a seed crop of jute in the same field and thereby offers farmers an opportunity to raise a third crop on time or in advance. The seed crop of jute raised by this technique will act as a catch crop between jute fibre and rice crops **(Source: Exploratory project, Contributors: M.S. Behera, D. K. Kundu and S. Satpathy).**

5.2. Mesta

5.2.1. Improving water productivity of mesta and its retting under low volume water

Different irrigation methods/water conservation practices with nutrient management were evaluated for improving the water productivity in roselle at MRS Amadalavalasa.

Water conservation/irrigation methods in roselle: At RDF ($N:P_2O_5:K_2O$::60:30:30 kg/ha) rainfed flat bed sowing produced 26.3 q roselle fibre/ha (Table 5.3) ii) At RDF, rainfed open furrow sowing produced 27.8 q roselle fibre/ha which is 1.5 q higher over traditional flat bed sowing iii) Rainfed roselle, under water conservation by soil mulching using CRIJAF Nail Weeder, produced 30.4 q roselle fibre/ha and is 4.0 q/ha higher over traditional rainfed system at RDF.

Nutrient levels: In rainfed system flat bed sowing, $N:P_2O_5:K_2O$:: 60:30:30+30 kg/ha, elemental sulphur yielded 29.9 q roselle fibre/ha, which was 3.11 q higher than RDF and $N:P_2O_5:K_2O$ :: 80:40:40 yielded 27.8 q roselle fibre /ha which 1.06 q higher than RDF.

Table 5.3: Effect of water conservation practices and nutrient management on plant height, basal diameter and fibre yield of roselle

Treatments	Plant height (cm)	Basal diameter (cm)	Fibre yield (q/ha)
Sowing and water conservation practices			
Rainfed Sowing	355	1.81	26.3
Sowing in furrow	359	2.10	27.8
Rainfed Sowing + Soil mulch with Nail weeder	373	2.54	30.4
SEm (±)	7.6	0.09	3.0
LSD (P=0.05)	16.0	0.20	6.4
Nutrient management ($N:P_2O_5:K_2O$)			
60: 30:30 kg/ha	350	2.06	26.8
60: 30:30 kg/ha + S 30 kg/ha	371	2.34	29.9
80 : 40: 40 kg/ha	366	2.05	27.8
SEm (±)	6.3	0.07	2.2
LSD (P=0.05)	13.1	0.11	4.2

***In situ* jute and mesta retting in low volume water:** In tarpaulin lined micro tank (2 decimal area and 4.5 feet depth) and in low volume ground/rain harvested water (v/v: 1:1.20) retting of jute (with retting agent e.g., retting tank soil, sunnhemp twig (60 kg), molasses (1.0 kg) and ammonium sulphate(1.0 kg) was completed with in 15-25 days. Following similar practices, in Amadalavalasa the mesta retting was completed witihin12-15 days (Fig. 5.4). **(Source: TMJ 5.0 : Contributors: A.K. Ghorai, D. K. Kundu, Amarpreet Singh, D. Barman, Shailesh Kumar and G. Jagannadham)**

Fig 5.4 Roselle fibre retting and extraction in tarpaulin lined micro pond using native retting culture at Amadalavalasa.

5.3 Sisal

5.3.1. Feasibility of growing annual intercrops in sisal plantation

The recommended spacing of sisal in double row planting system [4 m + 1 m × 1 m (4000 plants/ha)] keeps the inter row land area unutilized in between the rows during the initial 3 years of plantation establishment. The inter row space may be utilized by practising inter-cropping in double row sisal plantation. In this field experiment, annual legume intercrops were grown in between double row sisal plantation at Sisal Research Station, Bamra, Odisha. The legume intercrops were cowpea (cv. Triguna), green gram (cv. Pant Mung 5), green gram (cv. Pant Mung 6), black gram (cv. Sarada or WBU 108) and pigeon pea (cv. B 20/105). The intercrops were sown on 2nd September, 2013 after recession of heavy monsoon shower at western Odisha condition.

The number of sisal leaves harvested did not vary significantly with the different intercropping treatments and the same was between 41.0 thousand and 43.6 thousand/ha. The green weight of harvested sisal leaves were 6.24 – 7.08 t/ha. The sisal fibre yield was 287.0 to 307.3 kg/ha (Table 5.4).

Table 5.4 : Effect of legume intercrops on growth and yield of sisal

Treatments	Leaf length (cm)	Leaf number ($\times 10^3$)/ha	Weight of harvested leaf (t/ha)	Fibre yield (kg/ha)
Sisal + cowpea	75.6	43.0	6.45	299.7
Sisal + green gram (cv. PM6)	82.1	43.6	7.08	287.0
Sisal + green gram (cv. PM5)	74.4	42.6	6.25	307.3
Sisal + black gram	74.0	42.8	6.24	279.4
Sisal + pigeon pea	82.5	41.0	6.86	304.8
Sisal (sole)	74.3	42.8	6.35	310.5
LSD (P=0.05)	NS	NS	NS	NS

Annual legume intercrops such as cowpea, green gram, black gram and pigeon pea were grown in between the space of double rowed sisal plantation. The mean cowpea (green vegetable) productivity was 252 kg/ha when grown with sisal as intercrop (Table 5.5). The yield of pulses was 81 kg for green gram (cv. PM6), 79 kg (cv. PM5), 84 kg for black gram and 174 kg for pigeon pea in the sisal intercropped situation. The sisal equivalent yield from the system was the highest in case of pigeon pea (492 kg/ha) followed by cowpea (391 kg/ha) and green gram cv. PM 5 (384 kg/ha). Therefore, it may be inferred that the vacant space in between the double rowed sisal plantation may be utilized for growing legume intercrops like pigeon pea, cow pea, green gram and black gram during the initial three years of sisal plantation (Fig. 5.5) **(Source: SLC 1.4, Contributors: Sitangshu Sarkar, D.K. Kundu, A.R. Saha and B. Majumdar).**

Fig. 5.5 Cow pea as intercrop in sisal

Table 5.5 : Effect of legume intercrops on sisal equivalent yield in double row sisal plantation

Treatments	Sisal fibre yield (kg/ha)	Yield of intercrops (kg/ha)	Sisal equivalent yield of intercrops (kg/ha)	Total sisal equivalent yield (kg/ha)
Sisal + cowpea	299.7	252	91.64	391
Sisal + green gram (cv. PM6)	287.0	81	78.93	366
Sisal + green gram (cv. PM5)	307.3	79	76.98	384
Sisal + black gram	279.4	84	67.80	347
Sisal + pigeon pea	304.8	174	187.14	492
Sisal (sole)	310.5	-	-	311

Price of produce: cowpea (₹ 20/kg), green gram (₹ 53.59/kg), black gram (₹ 44.39/kg), pigeon pea (₹ 59.15/kg) and sisal fibre (₹55/kg)

5.3.2 Use of micro-irrigation and micronutrients to improve fibre yield and water use efficiency of sisal

A field experiment was undertaken to study effects of micro-irrigation and micronutrients on growth and fibre yield of sisal. Three main plot treatments (I_1-no irrigation, I_2-drip irrigation @ 4 l/hr for 2 hrs at 2 week interval & I_3-drip irrigation @ 4 l/hr for 4 hrs at 2 week interval) and four sub plot treatments (M_1- no micronutrient, M_2-zinc sulphate @ 20 kg/ha, M_3- borax @15 kg/ha and M_4- zinc sulphate @ 20 Kg + borax @15 kg/ha) in combination of 12 treatments were replicated thrice in strip plot design (Fig. 5.6). Application of micronutrients and micro irrigation showed significant effect on leaf length, number of harvested leaves and dry fibre yield of sisal (Table 5.6). Drip irrigation @ 4 l/hr per plant for 4 hrs at 2 weeks interval and soil application of zinc sulphate

Table 5.6: Effect of micro-irrigation and micronutrient treatments on growth and fibre yield of sisal recorded during third year after planting.

Treatment combination	Leaf length before harvesting(cm)	Number of harvested leaves per ha (× 10^3)	Weight of harvested green leaves (t/ha)	Dry fibre weight (t/ha)
I_1M_1	76.0	110.1	15.5	0.68
I_1M_2	76.6	110.7	18.0	0.69
I_1M_3	77.6	110.9	18.5	0.75
I_1M_4	78.1	114.7	18.8	0.75
I_2M_1	78.3	121.5	20.2	0.80
I_2M_2	80.5	124.8	23.8	0.92
I_2M_3	80.6	127.6	24.6	0.95
I_2M_4	84.4	140.0	26.4	1.09
I_3M_1	78.6	123.6	20.2	0.87
I_3M_2	80.6	135.5	25.7	0.95
I_3M_3	81.9	136.0	25.7	1.00
I_3M_4	85.0	150.3	32.5	1.10
SEm (±)	3.561	7.6	2.2	0.10
LSD (P=0.05)	I: 9.2 M: 7.8 IxM: 11.0	I: 13.0 M: 9.0 IxM: 23.5	I: 4.6 M: 5.80 IxM: 6.90	I: 0.18 M: 0.19 IxM: 0.32

I= Irrigation, M= Micronutrient ; Date of harvesting leaves for fibre extraction: 16th Dec, 2013

@ 20 kg/ha together with Borax 15 kg/ha (I_3M_4) produced the longest sized leaf (85.0 cm) before harvest, maximum number of harvested leaves (150.3x10^3 leaves/ha) and highest fibre yield (1.10 t/ha). Sisal fibre yield obtained with I_2M_4 (1.09 t/ha) was statistically at par with that of I_3M_4 (1.10 t/ha), which indicated that duration of drip irrigation to sisal could be reduced to half without any significant reduction in fibre yield **(Source: SLC 1.3. Contributors: D.K. Kundu, S. Sarkar, A.R. Saha and A.K. Jha).**

Fig. 5.6 Field view of micro irrigation experiment in sisal at SRS, Bamra.

5.4. Sunnhemp

5.4.1. Residual effect of sunnhemp on wheat in rice-wheat cropping system

Sunnhemp was grown as green manure during May to June and incorporated into the soil for decomposition before transplanting of rice crop. The sunnhemp (GM)-rice-wheat crop sequence was repeated for three consecutive years with recommended package of practices to build up the organic matter in the soil along with a control (rice-wheat). During the fourth year, wheat crop was grown with graded levels of nitrogen under green manure treated plots whereas with recommended dose of fertilizer (120:60:40 kg/ha) in control plots to assess the residual effect of green manuring. Yield and yield attributes of wheat were influenced significantly due to residual effect of green manuring. The yield of wheat increased significantly with increase in nitrogen dose up to 120 kg/ha being on par with the dose of 150 kg/ha in green manure treated plots (Table 5.7). The yield obtained (44.2 q/ha) from control plot (without green manuring) with the use of 120 kg N/ha was statistically similar to the yield recorded (44.2 q/ha) under the effect of 90 kg N/ha (with green manuring). Thus the residual effect of sunnhemp green manure applied to preceding rice crop was assessed to the tune of 30 kg N/ha on succeeding wheat crop **(Source: SNHA 1.6; Contributors: M.K. Tripathi and S.R. Singh).**

Table 5.7. Yield and yield attributes of wheat as influenced by residual effect of sunnhemp

Treatment	Plant height (cm)	Tillers/m^2	Spike length (cm)	Grains/spike	Grain yield (q/ha)	Straw yield (q/ha)
0 kg N/ha	78.3	210.1	8.6	26.3	19.2	32.3
30 kg N/ha	85.0	254.4	9.1	31.7	30.2	47.6
60 kg N/ha	91.2	288.9	9.6	35.0	38.6	58.0
90 kg N/ha	95.1	312.7	10.0	37.0	44.2	66.2
120 kg N/ha	99.4	330.8	10.4	38.9	49.3	73.9
150 kg N/ha	101.9	334.0	10.5	39.2	50.1	77.6
Control (120 kg N/ha)	95.5	313.5	10.0	37.0	44.2	68.4
S.Em. (±)	2.1	10.0	0.2	0.9	1.5	2.4
LSD (P=0.05)	6.7	30.8	0.7	2.9	4.7	7.4

5.5 Flax

5.5.1. Effect of NPK on growth and yield of flax (*Linum usitatissimum* L.)

Significant variations in yield and yield attributes of flax due to application of different levels of nitrogen and its scheduling (Table 5.8). The highest fibre yield (16.53 q/ha) was recorded in the treatment with nitrogen applied at the rate of 80 kg/ha being at par with 60 kg/ha (15.52 q/ha). Schedule of nitrogen application also exerted significant variations in yield and yield attributes of flax. The highest fibre yield (14.41 q/ha) was observed with the application of nitrogen in three split doses i.e. ⅓ basal + ⅓ at 21 DAS + ⅓ at 45 DAS followed by ½ basal + ¼ at 21 DAS + ¼ at 45 DAS (13.87 q/ha).

Application of phosphorus and potassium also showed significant increase in yield and yield attributes of fibre flax (Table 5.9). The yield increased significantly with increasing levels of phosphorus and potassium up to 40 kg/ha (16.73 q/ha and 15.56 q/ha, respectively) being at par with the application of 60 kg/ha (17.74 q/ha and 15.91 q/ha, respectively) **(Source: SNHA 2.0. Contributors: M.K. Tripathi, S.R. Singh and Babita Chaudhary).**

Table 5.8. Effect of nitrogen and its scheduling on yield and yield attributes of flax

Treatment	Plant height (cm)	Basal diameter (mm)	Green Biomass (q/ha)	Fibre yield (q/ha)
Nitrogen levels				
20 kg/ha	77.98	3.04	92.28	9.55
40 kg/ha	90.22	3.38	121.73	12.42
60 kg/ha	100.63	3.77	152.75	15.52
80 kg/ha	107.62	4.02	162.83	16.53
S.Em.±	2.64	0.11	4.26	0.38
LSD (P=0.05)	7.63	0.32	12.30	1.10
Nitrogen schedule				
½ basal + ½ at 21 DAS	87.16	3.29	120.61	12.62
½ at 21 DAS + ½ at 45 DAS	91.19	3.45	127.78	13.12
½ basal + ¼ at 21 DAS + ¼ at 45 DAS	97.80	3.69	138.43	13.87
⅓ basal + ⅓ at 21 DAS + ⅓ at 45 DAS	100.30	3.78	142.77	14.41
S.Em.±	2.64	0.11	4.26	0.38
LSD (P=0.05)	7.63	0.32	12.30	1.10

Table 5.9 Effect of phosphorus and potassium on yield and yield attributes of flax

Treatment	Plant height (cm)	Basal diameter (mm)	Green Biomass (q/ha)	Fibre yield (q/ha)
Phosphorus				
0 kg/ha	81.04	3.14	101.21	10.71
20 kg/ha	92.44	3.52	133.07	14.00
40 kg/ha	101.95	3.98	162.82	16.73
60 kg/ha	107.04	4.10	173.80	17.74
S.Em.±	2.11	0.13	4.13	0.38
LSD (P=0.05)	6.11	0.36	11.93	1.09
Potassium				
0 kg/ha	88.11	3.39	123.97	13.27
20 kg/ha	94.52	3.60	139.60	14.43
40 kg/ha	98.47	3.85	152.18	15.56
60 kg/ha	101.37	3.91	155.14	15.91
S.Em.±	2.11	0.13	4.13	0.38
LSD (P=0.05)	6.11	0.36	11.93	1.09

6. Biotic and Abiotic Stresses

6.1. Biotic stresses

6.1.1. Pest management

6.1.1.1. Jute

Reaction of jute germplasm against insect pests

Field screening of 15 germplasm each of *capsualris* and *olitorius* along with cultivated varieties for relative susceptibility against insect pests under natural field condition indicated that among the *capsularis* germplasm lines with least infestation of semilooper (2.94%), stem weevil (3.31%) and Bihar hairy caterpillar (BHC) (4.45%) were CIN 464, CIN 562 and CIN 13 respectively. In case of *olitorius* germplasm, the least population of yellow mite was observed in OIJ 052 and OIN 405 with 9.20 and 11.03 mites/cm^2 on second unfolded leaf whereas the least infestation of 3.33% plant damage by stem weevil was observed on OIN 470. Under glass house screening, the least yellow mite population was noticed in OIJ 63, OIN 202 with 13.16 and 26.33 mites/cm^2 on second unfolded leaf respectively. The lines OIN 402 and OIM 36 were found to be more susceptible to yellow mite with maximum of 101.33 and 122.00 mites/cm^2 on second unfolded leaf respectively. The germplasm line, OEX 002 was found to be more resistant with least stem weevil infestation (2.77%) **(Source: JE 1.2. Contributors: B S. Gotyal and S. Satpathy).**

Effect of cultivated and wild jute species on the feeding behaviour of Bihar hairy caterpillar (BHC)

Dual choice test

Pattern of relative feeding preference of BHC under dual choice condition indicated significant difference in larval feeding behaviour on cultivated and wild jute species. Among the different combinations of cultivated and wild jute species, the third instar larvae showed least preference for *C. aestuans* (5.00 larvae) as compared to *C. olitorius* (55.00 larvae) ($\chi^2_{24\,hrs}=40.01$, $N=60$) (Table 6.1). On the basis of proportion of total population migrated to particular species expressed as percent feeding preference, significant variation was observed. Among the wild species of jute, *C. aestuans* and *C. tridens* were the least preferred host with 7.00 and 13.33% preference respectively as compared to 28.33%, 25.00% and 18.33% for *C. pseudo-olitorius*, *C. fascicularis* and *C. trilocularis* respectively, whereas it was 81.66% preference for *C. olitorius* (cv. JRO 204). Suitability of host plants on the basis of leaf area consumed, indicated the least preference for *C. tridens* and *C. trilocularis* with consumption of 0.77 and 1.74 cm^2 of leaf whereas *C. aestuans* was immune with no feeding as compared to 10.93 cm^2 leaf area fed in *C. olitorius* ($\chi^2_{24\,hrs}=9.97$, $N=60$) **(Source: JE 1.2. Contributors: B.S. Gotyal and S. Satpathy).**

Multiple choice test

On the basis of proportion of larval settlement on particular host, among the wild species, *C. aestuans* was least preferred (1.00±0.01) as compared to *C. tridens* (4.33 ± 0.88), *C. pseudo-olitorius* (6.00±1.00), *C. fascicularis* (7.33±2.96) and *C. trilocularis* (9.00±0.57) (Table 6.2). The cultivated species, *C. olitorius* was significantly most preferred host with maximum (32.33±2.02) larval settlement. The feeding preference of third instar larvae made an active choice (53.88 ±3.38%) on *C. olitorius* as compared to the least larval feeding preference of 1.64± 0.02% and 7.22±1.47% on *C. aestuans* and *C. tridens* respectively. There was significant difference in the extent of consumption by BHC on host plants. *C. aestuans* and *C. tridens* recorded least consumption of 0.21±0.21 and 4.54±1.92 cm^2 leaf area respectively, whereas in *C. olitorius* 92.92±32.43 cm^2 of leaf area was fed **(Source: JE 1.2. Contributors: B.S. Gotyal and S. Satpathy).**

Table 6.1. Effect of jute species on feeding preference in dual choice test

Host plants/ combinations	No. of larvae settled*	Feeding preference(%)	Leaf area consumed (cm^2) N=60
C. olitorius	43.00	71.66	11.25
C. pseudo-olitorius	17.00	28.33	7.86
χ^2	10.41	17.91	0.76
C. olitorius	52.00	86.66	7.23
C. tridens	8.00	13.33	0.77
χ^2	30.81	52.32	5.01
C. olitorius	45.00	52.66	11.50
C. fascicularis	15.00	25.00	7.96
χ^2	14.01	12.09	0.05
C. olitorius	49.00	81.66	8.31
C. trilocularis	11.00	18.33	1.74
χ^2	22.81	38.85	4.46
C. olitorius	55.00	67.66	10.93
C. aestuans	5.00	7.00	0.00
χ^2	40.01	42.01	9.97

*N= 60

Table 6.2. Effect of jute species on feeding preference in multiple choice test

Host plants	No. of larvae settled	Feeding preference (%)	Mean leaf area fed (cm^2)
C. olitorius	32.33± 2.02[c*]	53.88 ± 3.38[c]	92.92±32.43[b]
C. fascicularis	7.33± 2.96[b]	12.11 ± 4.83[b]	9.72± 4.28[a]
C. trilocularis	9.00± 0.57[b]	14.99 ± 0.96[b]	19.18± 5.27[a]
C. pseudo-olitorius	6.00± 1.00[ab]	9.99 ± 1.66[bc]	11.32± 3.78[a]
C. tridens	4.33± 0.88a[b]	7.22 ± 1.47[ab]	4.54± 1.92[a]
C. aestuans	1.00± 0.01[a]	1.64 ± 0.02[a]	0.21± 0.21[a]
F Value	50.88	52.23	6.53
P Value	0.001	0.001	0.04

*Means (± SEM) followed by the same letter within a column are not significantly different among host plants (P<0.05, one-way ANOVA), N=60

Effect of jute species on oviposition preference of *Spilosoma obliqua* Walker

No-choice test

Pattern of relative preference for egg laying under no choice condition after 36 hrs of moth release on the basis of mean number of egg clusters there were significant differences in fecundity on different jute species (*F=2.29; df=2; P=0.11*) (Table 6.3). During 36 hrs of oviposition period, mean number of egg clusters were 3.66±0.33, 3.00±0.57, 3.33±0.33, 3.00±0.57, 1.00±0.57 and 2.00±1.15 on *C. olitorius, C. fascicularis, C. trilocularis, C. pseudo-olitorius, C. tridens* and *C. aestuans* respectively. Significant effect of jute species, were observed for oviposition preference based on number of eggs/cluster and it was found that *C. pseudo-olitorius* and *C. aestuans* were least preferred with least mean number of eggs/cluster i.e. 77.22±8.19 and 75.16±38.80 respectively as compared to 173.97±2.64 in case of *C. olitorius* (*F=2.17; df=2; P=0.12*) **(Source: JE 1.2. Contributors: B.S. Gotyal and S. Satpathy).**

Multiple choice

Generally, in multiple choice test the proportion of egg laying (clusters & eggs/cluster) was more in cultivated than the wild species (Table 6.3). Among the wild species there was a significant difference in the number of egg clusters. The wild species *C. tridens, C. aestuans, C. trilocularis and C. fascicularis* were found to be least preferred with 0.66±0.33, 0.33±0.33, 0.33±0.66 and 1.00±0.57 egg clusters respectively. *C. oliotorius* and *C. pseudo-olitorius* were found to be more susceptible with 5.66±0.88 and 4.00±0.57 egg cluster respectively (*F=13.23; df=2; P=0.001*). The total number of eggs/cluster varied across the cultivated and wild species. *C. aestuans* and *C. fascicularis* were found to be least preferred with minimum of 7.66±3.09 and 41.00±16.29 eggs/cluster respectively. *C. olitorius* and *C. trilocularis*, were more preferred with 603.66±8.35 and 335.00±9.75 eggs/cluster respectively **(Source: JE 1.2. Contributors: B S. Gotyal and S. Satpathy).**

Table 6.3. Oviposition preference of *Spilosoma obliqua* on jute species

Preference test/ jute species	Mean no. of egg clusters	Mean no. of eggs/cluster
No-choice		
C. olitorius	3.66 ± 0.33[b]	173.97± 2.64[b]
C. fascicularis	3.00 ± 0.57[ab]	152.28 ± 7.90[ab]
C. trilocularis	3.33 ± 0.33[b]	124.80 ± 14.11[ab]
C. pseudo-olitorius	3.00 ± 0.57[ab]	77.22 ± 8.19[a]
C. tridens	1.00± 0.57[a]	102.00 ± 51.39[ab]
C. aestuans	2.00 ± 1.15[ab]	75.16 ± 38.80[a]
F Value	2.29	2.17
P Value	0.11*	0.12*
Multiple choice		
C. olitorius	5.66 ± 0.88[c]	603.66 ± 8.35[b]
C. fascicularis	1.00 ± 0.57[a]	41.00 ± 16.29[a]
C. trilocularis	0.33 ± 0.66[b]	335.00 ± 9.75[b]
C. pseudo-olitorius	4.00 ± 0.57[b]	152.00 ± 3.30[a]
C. tridens	0.66 ± 0.33[a]	43.66 ± 22.51[a]
C. aestuans	0.33 ± 0.33[a]	7.66 ± 3.09[a]
F-Value	13.232	9.918
P Value	0.001**	0.001**

*Means (± SEM) followed by the same letter within a same are not significantly different among host plants (P<0.05, One-way ANOVA)

Comparative biology of Bihar hairy caterpillar (BHC) on cultivated and wild species of jute

Effect of food plants on larval growth and development

Sources of resistance in cultivated and wild jute species against BHC was determined on the basis of antibiosis effect. The growth of 8-day old larvae indicated maximum antibiosis effect of *C. tridens* and *C. aestuans* on *S. obliqua* (Table 6.4). On the basis of percent larval survival at 5 days after feeding (DAF) significantly least survival was on *C. tridens* (3.33%) followed by *C. aestuans* (13.33%) and the larvae completely failed to survive after 9 days of feeding in both these species (Table 6.4). Among the other species, the survival of larvae at 9 DAF was in the order of 63.33%, 33.33%, 46.66% and 53.33% in *C. trilocularis*, *C. pseudo-olitorius*, *C. fascicularis* and *C. olitorius* (cv. JRO-204) respectively.

Maximum antibiosis effect was observed at 5 DAF during which, the larval weight in wild species ranged from 3.33-154.00 mg and it was significantly less as compared to the *C. olitorius* (268.33 mg). The pupal weight of the larvae feed on the wild species were, 328.26, 118.03 and 207.20 mg in *C. trilocularis*, *C. pseudo-olitorius* and *C. fascicularis* respectively as compared to 397.76 mg in *C. olitorius* (cv. JRO-204) after 17 DAF. Among the wild species, only *C. trilocularis* supported the pupation of 79.43 % as compared to 91.66% in *C. olitorius*. The mean pupal weight of larvae fed on cultivated species, *C. olitorius* was 285.50 mg as compared to 197.3 mg when the larvae were fed on *C. trilocularis*. The highest adult emergence (72.16%) was recorded in *C. olitorius* as compared to 40.00 % in *C. trilocularis*. It may be due to high antibiosis effect of wild species on larval growth and development (Table 6.5) **(Source: JE 1.2. Contributors: B S. Gotyal and S. Satpathy).**

Table 6.4. Effect of cultivated and wild host plants on larval survival of *Spilosoma obliqua*

Host Plants	Larval survival (%) at different days after hatching			
	8	11	13	17
C. tridens (WCIN-188)	100.00 (90.00)*	70.00 (56.79)	3.33 (10.51)	0.00 (0.00)
C. trilocularis (WCIN-186)	100.00 (90.00)	100.00 (90.00)	96.66 (79.47)	63.33 (52.73)
C. pseudo-olitorius (WCIN-182)	100.00 (90.00)	93.33 (75.03)	50.00 (45.00)	33.33 (35.26)
C. aestuans (WCIN-179)	100.00 (90.00)	63.33 (52.73)	13.33 (21.41)	0.00 (0.00)
C. fascicularis (WCIN-202)	100.00 (90.00)	93.33 (75.03)	70.00 (56.79)	46.66 (43.08)
C. olitorius (JRO-204)	100.00 (90.00)	100.00 (90.00)	56.66 (48.83)	53.33 (46.91)
LSD (P=0.05)	NS	28.37	18.12	10.00

*Figures in the parenthesis are arc sin transformed values

Table 6.5. Larval weight, pupation, pupal weight and adult emergence of *Spilosoma obliqua* on different jute species

Host Plants	Larval weight (mg) at different days after hatching				Pupation (%)	Pupal weight (mg)	Adult emergence (%)
	8	11	13	17			
C. tridens (WCIN-188)	28.66	26.36	3.33	0.00	0.00 (0.00)*	0.00	0.00 (0.00)*
C. trilocularis (WCIN-186)	36.00	82.00	154.00	328.26	79.43 (63.03)	197.33	40.00 (39.23)
C. pseudo-olitorius (WCIN-182)	29.00	53.83	111.70	118.03	0.00 (0.00)	0.00	0.00 (0.00)
C. aestuans (WCIN-179)	25.33	33.33	16.66	0.00	0.00 (0.00)	0.00	0.00 (0.00)
C. fascicularis (WCIN-202)	31.33	62.22	131.33	207.20	0.00 (0.00)	0.00	0.00 (0.00)
C. olitorius (JRO-204)	31.66	117.66	268.33	397.76	91.66 (73.21)	285.50	72.16 (58.15)
LSD (P=0.05)	6.17	23.03	23.50	66.89	10.91	36.63	9.03

*Figures in the parenthesis are arc sin transformed values

Table 6.6. Correlation of biochemical content on biology of *Spilosoma obliqua* at different days after feeding in cultivated and wild species of jute

Biochemical content	Larval survival (%)*				Larval weight (mg)*				Pupation (%)	Adult emergence (%)
	8	11	13	17	8	11	13	17		
Polyphenol oxidase (µg/ml)	-0.31	-0.04	-0.02	-0.05	0.02	-0.29	-0.21	-0.19	-0.51	-0.49
Total phenol (µg/g)	-0.44	-0.52	-0.51	-0.47	-0.31	-0.34	-0.37	-0.35	-0.33	-0.25
Protein (µg/g)	0.15	0.54	0.47	0.55	0.22	0.73	0.72	0.63	0.61	0.65

*Days after hatching

Correlation study between biology and biochemical content of cultivated and wild species of jute

The biochemical components *i.e* polyphenol oxidase, total phenol and protein contents in wild and cultivated jute species having variable effect on biology of BHC had certain correlation with the life stages of BHC. The protein had significantly positive correlation with larval survival (%), on larval weight, pupation and adult emergence (%) of *S. obliqua*. Polyphenol oxidase and total phenol recorded negative effect on survival, growth, pupation and adult emergence (Table 6.6) **(Source: JE 1.2. Contributors: B S. Gotyal and S. Satpathy).**

Age-specific and fecundity life table of jute hairy caterpillar, *S. obliqua* Walker

The early instars (up to third instars) were more vulnerable to the density dependent mortality factors. Two braconid larval parasitoids, *Meteorus spilosomae* Narendran & Rama and *Protapanteles obliquae* (Wilkinson) were the key mortality factors with the K-value of 0.18 whereas in late instars, mortality due to virus was more with 0.21 K-value. The generation survival was 0.39. The population of *S. obliqua* has been predicted to be much higher in the ensuing generation as trend index was positive. The net reproductive rate (NRR) and intrinsic rate of increase (rm) have been determined to be 122 females/female/generation and 1.10 females/female/day, respectively. The mean generation time was 45.1 days and it is predicted that the population would double within a span of 6.2 days with the existing finite rate of increase of 3.02. Other growth indices including generation time (days) (Tc), capacity for increase (rc), weekly multiplication rate (WMR) and corrected generation time (days) (T) were 43.40, 1.06, 2.52 and 42.64 respectively **(Source: JE 1.3. Contributors: K. Selvaraj, S. Satpathy and B.S. Gotyal).**

Joint toxicity of new insecticides against *S. obliqua* under laboratory condition

Leaf dip bioassay of new insecticides, flubendiamide 480 EC, emamectin benzoate 5 SG, chlorantraniliprole 18.5 SC, lamda cyhalothrin 5 EC and profenophos 50 EC singly and in combinations against third instar larvae of *S. obliqua* was conducted under laboratory condition (Fig. 6.1). The LC_{50} values of individual insecticide, flubendiamide, emamectin benzoate, chlorantraniliprole, lamda cyhalothrin and profenophos were 0.232, 0.511, 0.212, 0.986 and 3.263 ppm, respectively after 24 hrs (Table 6.7). Whereas, the LC_{50} values for the insecticide mixtures, flubendiamide LC_{50} + lamda cyhalothrin $LC_{50,}$ emamectin benzoate LC_{50}+ lamda cyhalothrin $LC_{50,}$ chlorantraniliprole LC_{50} + lamda cyhalothrin LC_{50} and profenophos LC_{50} + lamda cyhalothrin LC_{50} were 0.131, 0.271, 0.209 and 2.931 ppm respectively. However, among these combinations, flubendiamide LC_{50}+ lamda cyhalothrin LC_{50} was found most toxic with least LC_{50} value (Table 6.7) **(Source: JE 1.3. Contributors: K. Selvaraj, V. Ramesh Babu and B.S. Gotyal)**.

Bio-efficacy of insecticides mixture against *S. obliqua* under field condition

The promising insecticide combinations with least LC_{50} value were evaluated for their bio-efficacy against *S. obliqua* under field condition at concentrations twice the LC_{50} value. All the treatments were found effective in reducing the infestation of *S. obliqua* significantly in comparison to control with maximum fibre yield. Sole application of flubendiamide, emamectin benzoate, chlorantraniliprole, lamda cyhalothrin and profenophos resulted in 61.64, 55.14, 68.54, 60.26, 29.82 and 57.46, 41.25, 47.47, 43.83, 34.83% reduction in *S. obliqua*

Table 6.7. Toxicity of insecticides and insecticide mixtures against third instar larvae of *S. obliqua*

Insecticide	LC_{50} (ppm)	Fiducial limits (ppm)	Chi-square
Flubendiamide 480 EC	0.232	0.184-0.279	1.78
Emamectin benzoate 5 SG	0.511	0.378-0.665	0.85
Chlorantraniliprole 18.5 EC	0.212	0.162-0.259	1.65
Lamda cyhalothrin 5 EC	0.986	0.740-1.271	1.60
Profenophos 50 EC	3.263	2.450-4.586	0.20
Flubendiamide LC_{50}+Lamda cyhalothrin LC_{50}	0.131	0.097-0.165	0.66
Flubendiamide LC_{25}+Lamda cyhalothrin LC_{75}	0.437	0.323-0.580	0.57
Flubendiamide LC_{75} +Lamda cyhalothrin LC_{25}	0.103	0.085-0.120	2.73
Emamectin benzoate LC_{50}+Lamda cyhalothrin LC_{50}	0.271	0.190-0.366	0.94
Emamectin benzoate LC_{25}+Lamda cyhalothrin LC_{75}	0.775	0.557-1.098	0.22
Emamectin benzoate LC_{75}+Lamda cyhalothrin LC_{25}	0.333	0.246-0.437	0.51
Chlorantraniliprole LC_{50}+Lamda cyhalothrin LC_{50}	0.209	0.172-0.253	2.29
Chlorantraniliprole LC_{25}+Lamda cyhalothrin LC_{75}	0.637	0.459-0.885	0.34
Chlorantraniliprole LC_{75}+Lamda cyhalothrin LC_{25}	0.345	0.264-0.443	0.86
Profenophos LC_{50}+Lamda cyhalothrin LC_{50}	2.931	2.158-3.919	0.04
Profenophos LC_{25}+Lamda cyhalothrin LC_{75}	1.975	1.425-2.612	0.26
Profenophos LC_{75}+Lamda cyhalothrin LC_{25}	3.323	2.306-4.745	0.06

infestation during first and second spray, respectively (Table 6.8). Likewise, insecticide combinations i.e. flubendiamide LC_{50}+ lamda cyhalothrin $LC_{50,}$ emamectin benzoate LC_{50}+ lamda cyhalothrin $LC_{50,}$ chlorantraniliprole LC_{50}+lamda cyhalothrin LC_{50} and profenophos LC_{50}+lamda cyhalothrin resulted in 85.22, 83.83, 72.82, 63.07% and 81.02, 71.56, 73.26, 39.23% damage reduction respectively during first and second spray respectively (Table 6.8). The four insecticide combinations standardized in the present study reduced the *S. obliqua* infestation better than their component applied individually. However, flubendiamide LC_{50}+ lamda cyhalothrin LC_{50} was found superior insecticide combination with 85.22% reduction in infestation during both the sprays and yielded maximum fibre yield (36.17q/ha) **(Source: JE 1.3. Contributors: K. Selvaraj, V. Ramesh Babu and B.S. Gotyal).**

Fig. 6.1 Leaf dip bioassay of Bihar hairy caterpillar.

Table 6.8. Bio-efficacy of insecticide mixtures on *S. obliqua* damage and yield under field conditions

Treatments	First spray at 90 DAS			Second spray at 105 DAS			Fibre yield (q/ha)
	Infestation (%)			Infestation (%)			
	Pre-spray	2 DAT	Reduction (%)	Pre-Spray	2 DAT	Reduction (%)	
Flubendiamide 480 EC	26.5	10.17 (18.59)*	61.64	22.33	9.50 (17.95)	57.46	34.67
Emamectin benzoate 5 SG	30.8	13.83 (21.83)	55.14	26.67	15.67 (23.32)	41.25	30.17
Chlorantraniliprole 18.5 EC	35.5	11.17 (19.52)	68.54	26.33	13.83 (21.83)	47.47	31.17
Lamda cyhalothrin 5 EC	25.2	10.00 (18.43)	60.26	27.00	15.17 (22.92)	43.83	28.50
Profenophos 50 EC	28.5	20.00 (26.57)	29.82	29.67	26.17 (30.77)	34.83	26.17
Flubendiamide LC_{50}+ Lamda cyhalothrin LC_{50}	33.8	5.00 (12.92)	85.22	36.00	6.83 (15.15)	81.02	36.17
Emamectin benzoate LC_{50}+ Lamda cyhalothrin LC_{50}	39.2	6.33 (14.58)	83.83	37.50	10.67 (19.06)	71.56	33.83
Chlorantraniliprole LC_{50}+ Lamda cyhalothrin LC_{50}	32.5	8.83 (17.29)	72.82	31.17	8.33 (16.78)	73.26	32.17
Profenophos LC_{50}+ Lamda cyhalothrin LC_{50}	29.3	10.83 (19.22)	63.07	30.17	18.33 (25.35)	39.23	30.50
Untreated Control	39.2	40.33 (39.42)	-	38.00	42.00 (40.40)	-	23.33
SEm±	-	5.35	-	-	4.36	-	1.78
LSD (P=0.05)	-	15.88	-	-	14.93	-	5.30

DAT-Days after treatment * Figures in the parenthesis are arc sin transformed values

Multi-pest yield loss to damage functions and economic injury levels in jute

Yield-infestation relationships were established through multiple regressions to determine the multiple-pest economic injury levels (EILs) on JRO 204 jute variety at different crop growth stages. The yellow mite (YM) population varied from 32.20-34.06 mite /cm^2 area on second unfolded leaf at 40 DAS (Table 6.9) which attained the peak at 50 DAS with 117.62 mite/cm^2. In case of Bihar hairy caterpillar (BHC) and semilooper (SL), the infestation ranged from 13.69-17.18% plant damage at 50 DAS (Table 6.10). The peak infestation (58.42%) was recorded at 70 DAS. With increase in pest infestation, fibre yield was reduced in various treatments as with lowest mite infestation (0.5-33.86 mite/cm^2) in (T_4) highest yield (35.42 q/ha) was recorded and combined infestation of yellow mite and lepidopteran pests, reduced the yield to maximum extent (24.35 q/ha). The crop protected with insecticide had significantly more yield than the unprotected crop. Two spray for each of spiromesifen 240 SC at 41 DAS and 51 DAS against YM and profenophos 50 EC at 51 DAS and 61 DAS against lepidopteran pests recorded significantly highest yield. Hence, two sprays for each were found to be optimum against YM and lepidopteran pests. Based on pest infestation at different crop growth stages and fibre yield, the multiple damage functions derived for combined infestations of YM and lepidopteran pests (BHC and SL) was Y=35.42-0.369 (YM)-0.056 (BHC+SL), (R^2=0.88) at 60 DAS. Single species as well as multiple species EILs were developed using these damage functions. The EILs were determined during the crop stage at which both the pests significantly affected the yield. Individual EIL for yellow mite and lepidopteran pests were 45 mites/cm^2 area on second unfolded leaf and 5% plant damage respectively. Further multiple regression was used to determine iso-loss points. Based on which, iso-loss equations were established through regressing incidence of one pest on another **(Source: JE 1.4. Contributors: K. Selvaraj and B.S. Gotyal).**

Table 6.9. Mean yellow mite population on jute (cv. JRO 204) in different treatments for yield infestation relationships during 2013

Treatments	Insecticide applied at different DAS		Yellow mite/cm² leaf area					Fibre (q/ha)
	Spiromesifen	Profenophos	40 DAS	50 DAS	60 DAS	70 DAS	80 DAS	
T_1-Yellow mite (YM) alone	-	51,61	32.20	121.27	75.05	14.25	3.01	26.50
T_2-Semilooper (SL) and Bihar hairy caterpillar (BHC) alone	41,51		34.06	18.50	15.70	1.69	0.44	32.30
T_3-YM+SL+BHC (no spray)	-	-	32.87	117.62	69.44	17.68	3.74	24.35
T_4-Insect-free crop (completely protected)	41,51	51,61	33.86	11.21	10.39	2.41	0.5	35.42
SEm±	-	-	1.42	5.57	3.08	0.95	0.33	1.03
LSD (P=0.05)	-	-	3.09	12.10	6.70	2.07	0.71	2.23

Table 6.10. Mean lepidopteran pest infestation (%) on jute (cv. JRO 204) in different treatments for yield infestation relationships during 2013

Treatments	Insecticide applied at different DAS		Infestation (%)					Fibre (q/ha)
	Spiromesifen	Profenophos	50 DAS	60 DAS	70 DAS	80 DAS	90 DAS	
T_1-Yellow mite (YM) alone	-	51,61	15.08 (22.85)*	5.09 (13.04)	3.48 (10.76)	0.61 (4.46)	1.33 (6.61)	26.50
T_2-Semilooper (SL) and Bihar hairy caterpillar (BHC) alone	41,51		13.69 (21.72)	56.75 (48.88)	58.42 (49.85)	42.53 (40.70)	11.90 (20.18)	32.30
T_3-YM+SL+BHC (no spray)	-	-	17.18 (24.49)	36.75 (36.95)	36.79 (37.34)	22.48 (28.30)	15.49 (23.18)	24.35
T_4- Insect-free crop (completely protected)	41,51	51,61	16.21 (23.75)	4.17 (11.78)	3.50 (10.78)	0.98 (5.68)	0.11 (1.90)	35.42
SEm±	-	-	1.40	1.31	0.85	1.73	1.23	1.03
LSD (P=0.05)	-	-	3.04	2.86	1.84	3.75	2.67	2.23

** Figures in the parenthesis are arc sin transformed values

Temperature dependent development of *Spilosoma obliqua* life stages

Effect of constant temperatures viz., 9±1, 12±1, 15±1, 18±1, 21±1, 24±1, 27±1, 30±1, 33±1, 36±1 and 39±1°C was assessed on the egg hatching, larval and pupal development and adult survival of S. obliqua in laboratory condition. However, the entire life cycle was studied only at 18±1, 21±1, 24±1, 27±1, 30±1

and 33±1°C whereas at 9±1, 12±1, 15±1, 36±1 and 39±1°C only egg hatchability was observed in order to determine the highest and lowest temperature limit for pest development. Development rate of egg, larva and pupa gradually increased with increase in temperature, while total developmental period and adult survival period decreased. Mean developmental period of the pest decreased from 93.73 days at 18±1°C to 31.2 days at 33±1°C. The lowest and the highest temperatures at which no development took place were found to be 12±1°C and 39±1°C, respectively. At 12±1°C eggs did not hatch even after one month, while at 36±1°C eggs hatched but larvae did not survive and died immediately after hatching. Temperature increase from 18±1°C to 33±1°C reduced incubation period from 9.5 days to 2.0 days, while mean development duration of small larvae (upto third instar), large larvae (4-5th instar), pupae and adult survival decreased from 32.33 to 14.00, 25.18 to 8.54, 17.20 to 4.66, 9.52 to 2.00 days, respectively (Table 6.11). Total developmental duration of S. obliqua was 93.73, 76.37, 64.35, 45.08, 38.91 and 31.20 days at 18±1, 21±1, 24±1, 27±1, 30±1 and 33±1°C, respectively. Egg hatchability increased with increasing temperature, from 79.20% at 18±1°C to 96.8% at 33±1°C (Table 6.12). Number of larvae reaching fourth instars also increased from 90.1% at 18±1°C to 96.5% at 33±1°C. Likewise, with temperature increased from 18±1 and 33±1°C, pupation and adult emergence increased from 82.3 to 97.7% and 92.5 to 97.3%, respectively. Similarly, overall survival of *S. obliqua* stages varied from 54.50% at 18±1°C to 90.54 % at 33±1°C. Temperature thus influenced incubation period more than it influenced egg hatchability, pupation and adult emergence **(Source: TMJ 7.0. Contributors: K. Selvaraj, B.S. Gotyal V. Ramesh Babu and S. Satpathy).**

Table 6.11. Effect of temperature on development of different stages of *Spilosoma obliqua*

Temperature (°C)	Duration of different life stages of *S. obliqua* (days±SD)					Total developmental period (days)
	Egg	Small larvae (1-3rd instar)	Large larvae (4-5th instar)	Pupae	Adult	
18±1	9.5±0.50	32.33±0.66	25.18±0.26	17.20±0.39	9.52±0.50	93.73
21±1	7.5±0.50	26.16±0.50	20.11±0.26	15.40±0.26	7.20±0.50	76.37
24±1	5.5±0..50	23.60±0.50	16.30±0.70	13.2±0.26	5.75±0.50	64.35
27±1	4.5±0.50	18.33±0.57	10.20±0.29	7.75±0.39	4.30±0.50	45.08
30±1	3.0±0.00	17.0±1.00	9.60±0.32	6.75±0.47	2.56±0.50	38.91
33±1	2.0±0.00	14.00±1.00	8.54±0.51	4.66±0.30	2.00±0.00	31.2

Table 6.12. Effect of temperature on survival of *S. obliqua* under laboratory conditions

Temperature (°C)	Egg hatchability (%)	Larvae reaching fourth instar (%)	Total pupation (%)	Adult emergence (%)	Overall development (%)
18±1	79.20	90.10	82.30	92.50	54.50
21±1	85.00	92.20	84.20	94.30	64.25
24±1	93.30	93.70	92.10	95.70	68.12
27±1	95.30	95.30	94.00	95.80	78.65
30±1	95.70	96.20	95.30	96.40	81.92
33±1	96.80	96.50	97.70	97.30	90.54

Development threshold and thermal constant for *S. obliqua*

Regression equations between development rate and temperature were found to be Y= 0.0189X-0.1998 (R^2=0.88) for egg, Y=0.00122X-0.0248 (R^2=0.83) for small larva, Y=0.0058X- 0.0675 (R^2=0.76) for large larva, Y=0.0074X-0.1075 (R^2=0.94) for pupa and Y=0.0142X-0.4363 (R^2=0.79) for adults. Developmental threshold were determined to be 10.57, 11.27, 11.55, 15.28 and 10.92°C for egg, small larva, large larva, pupa, and adult respectively with corresponding thermal constant being 52.91, 344.82, 243.90, 142.85 and 70.42 degree days (DD) (Table 6.13) **(Source: TMJ 7.0. Contributors: K. Selvaraj, B.S. Gotyal V. Ramesh Babu and S. Satpathy).**

Table 6.13. Determination of threshold temperatures and thermal constant for different developmental stages of *S. obliqua*

Developmental stage	Regression equation	Thermal constant (K) (K=1/b)	Temperature threshold (T_0) (T_0= a/b)	R^2
Egg	Y= 0.0189X-0.1998	52.91	10.57	0.88
Small larva (1-3rd inatar)	Y= 0.0122X-0.0248	344.82	11.27	0.84
Large larva (4-5th inatar)	Y= 0.0058X-0.0675	243.90	11.55	0.76
Pupa	Y= 0.0074X-0.1075	142.85	15.28	0.94
Adult	Y= 0.0142X-0.4363	70.42	10.92	0.79

Isolation of *Bacillus thuringiensis* isolates for management of major lepidopteran pests of jute

Soil samples were collected from diversified jute growing regions of West Bengal (Bankura, Purulia, 24 North Parganas and Murshidabad) for isolation of native microbial bioagents i.e. *Bacillus thuringiensis* using non-selective and selective medium like Nutrient agar, Luria Bertani Agar and T3 medium. All established isolates produced creamy white coloured mat like colonies on Luria Bertani Agar after an incubation of 48-72 hrs at 30°C followed by gram staining. Purification and isolation of the cry toxin from the Bt cultures and their evaluation for toxicity against lepidopteran pests of jute is under study. Preliminary bioassay with a commercial formulation of *Bt var. kurstaki* against 5-day old larvae of Bihar hairy caterpillar, *Spilosoma obliqua*, indicated the lethal concentration to be 0.74 (F. L. 0.285-0.445) and 0.36gm/l (F.L. 0.588-0.969) at 24hrs and 48hrs, respectively **(Source: JE 1.5 Contributors: V. Ramesh Babu, B.S. Gotyal, K. Selvaraj, and S.P. Gawande)**

Isolation of entomopathogenic microbials from naturally infected larvae from field

Infected larvae of jute semilooper, *Anomis sabulifera* were collected from Budgchia village of North 24 Parganas district of West Bengal. The bacterial culture was grown on nutrient agar medium at 30°C for 24hrs. Two types of bacteria colonies have been identified that appeared in red and white coloured with rough and smooth textures. The bacteria was established and maintained for further characterization to evaluate the biocontrol potency on insect pests of jute. Based on the colony morphology and cultural characterization and staining with Gram stains kit the isolate was identified as *Serratia* spp. Besides, *Bt* isolates other allied microbial biocontrol agents *viz*. entomopathogenic fungi namely *Metarhizium anisopliae, Beauveria bassiana* and *Nomureau rileyi* are maintained in respective media for conducting bioassays with larvae of insect pest infesting jute **(Source: JE 1.5 Contributors: V. Ramesh Babu, B.S. Gotyal, K. Selvaraj, and S.P. Gawande).**

Endophytic *Beauveria bassiana* reduced stem weevil infestation in white jute under field condition

Twelve *B. bassiana* strains viz., ITCC 6552, 6551, 5409, 4796, 6063, 4668, 5408, 6645, 6869, 4563, 6892 and 6726 were introduced into white jute (cv. JRC 212) plants in a field experiment through seed treatment with conidial suspensions (10^8 cfu/ml) for managing stem weevil. The effect of different endophytic strain of *Beauveria bassiana* was prominent in suppressing the stem weevil infestation (Fig 6.2). In the treated plots highest incidence of 38.32% was recorded in ITCC 6726. The lowest infestation of 18.13% and 19.18% were recorded in ITCC 6551 and ITCC 4668 treated plots respectively compared to 70.14% in the untreated check **(Source: JM 8.1. Contributors: C. Biswas, S. Satpathy and B. S. Gotyal).**

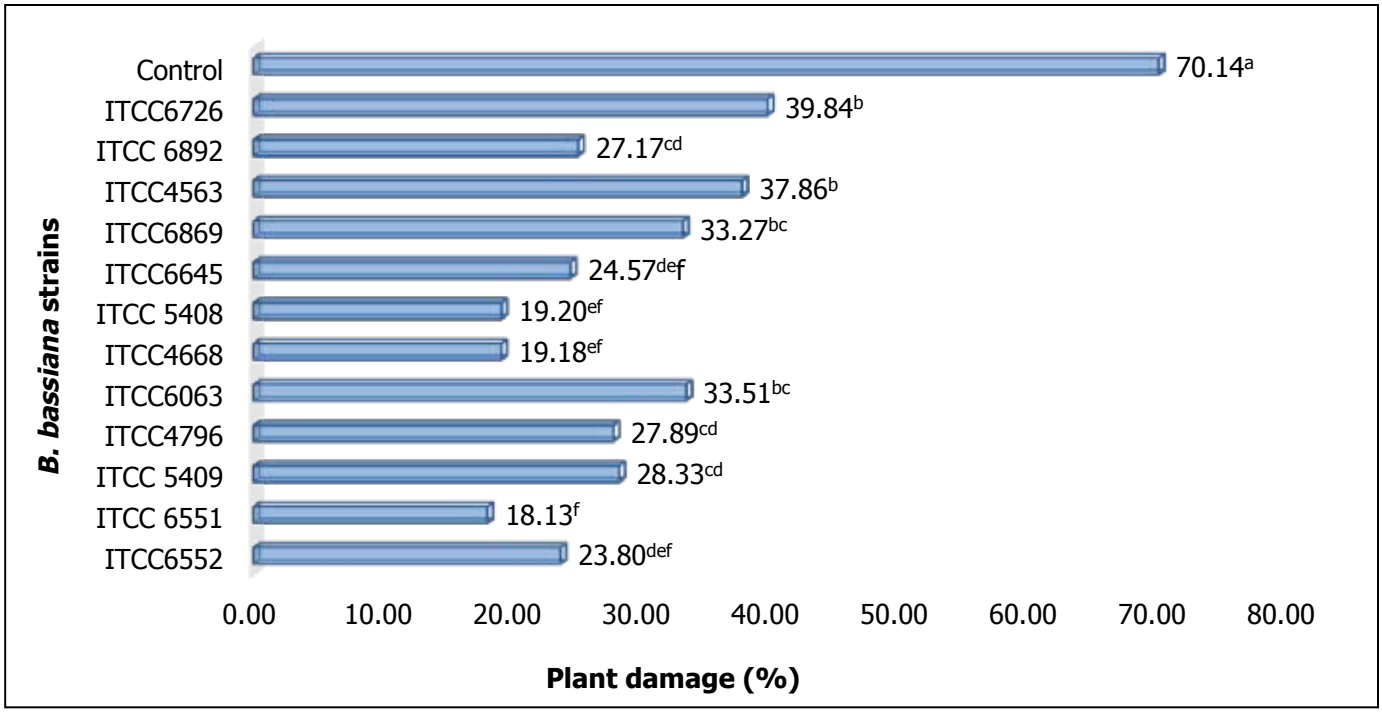


Fig. 6.2. Infestation of stem weevil in different *Beauveria bassiana* treatments

6.1.1.2. Mesta

Effect of different insecticides on infestation of spiral borer in mesta

The treatments consisting of soil application and seed treatment with neonicotinoids, carbofuran, chlorpyriphos and neem cake were evaluated under field condition against the infestation of spiral borer, *Agrilus acutus* in mesta. Post-treatment observations indicated significant effect of the treatments on this cryptic insect which causes internal spiral galls on the base of the plants. During the first observation at 65 DAS, least plant infestation was recorded in the seed treatment with chlorpyriphos 20 EC @ 5ml/kg with (1.33%) plant infestation being at par with other treatments (1.50-2.33%) and significantly less than the control (4.67%) (Table 6.14). During the later periods, although there was gradual increase in the extent of plant infestation in the untreated control (14.33-21.33%) the plots treated with seed treatment of thiamethoxam 70 WS @ 5g/kg, imidacloprid 600 FS@ 5ml/kg and chlorpyriphos 20 EC @ 5ml/kg contained the spiral borer infestation to maximum extent recording significantly least plant infestation. Soil application of neem cake @ 60 kg/ha and carbofuran 3 G @ 30 kg/ha recorded significantly less plant infestation than control till 85 DAS, later the level of damage in these treatments were at par with control. Overall mean plant damage across all the period of observations also recorded least plant infestation (8.06%) in thiamethoxam treated crop being at par with seed treatment of chlorpyriphos (8.26%) compared to 15.13% infestation in untreated control **(Source: JM 1.1. Contributors: S. Satpathy and B. S. Gotyal).**

Host suitability of kenaf species for resistance against mealybug, *Phenacoccus solenopsis*

To enumerate the mechanism of resistance in kenaf, 7 released varieties along with 2 wild species i.e., *Hibiscus acetocella* (WHIN-50) and *Hibiscus* sp. (WHIJ-47) were evaluated for relative susceptibility to mealybug in terms of feasibility for growth and survival. In replicated CRD experiment, 10 uniform crawlers were released on the terminal leaf of each 25-day-old kenaf seedlings which were kept in isolation to restrict the inter-plant crawler movement. The observation recorded 25 days after release indicated that the relative number of crawlers multiplied and settled on different host plants varied from 7.00/plant in *Hibiscus* sp. (WHIJ-47) to 83.00/plant in *H. acetocella* (WHIN-50) (Fig. 6.3). The crawler settlement on other varieties of *H. cannabinus* varied from 18.00/plant in JRM-3 to 59.00/plant in HC-583. This indicates *H. acetocella* to be the most susceptible to mealybug and *Hibiscus* sp. to be relatively more resistant. Among the cultivars, JRM-3 was least susceptible to

mealybug harboring 18.00 crawlers/plant **(Source: JM 1.1. Contributors: S. Satpathy and B. S. Gotyal).**

Record of parasitoids associated with *Phenacoccus solenopsis*

Field survey were conducted in jute and mesta fields at CRIJAF, Research Farm for mealybug and its natural enemies. Plant parts containing these mealybug mummies were separated from the plant and kept in plastic jars provided with brass mesh for proper ventilation for emergence of parasitoids in the laboratory. The emerged parasitoids were preserved in 70% alcohol and got identified from Insect Identification Service, Division of Entomology, IARI, New Delhi. The parasitoids were identified as *Aenasius bambawalei* Hayat (Chalcidodea: Encyrtidae) and *Promuscidea unfasciativentris* Girault (Chalcidodea: Aphelinidae). The later species had earlier been reported as a hyperparasitoid on the encyrtid. This was the first record of the parasitoids in jute and mesta ecosystem in West Bengal. The extent of parasitization on mealybug in these plants ranged from 15-32% **(Source: JM 1.1. Contributors: S. Satpathy B. S. Gotyal and K. Selvaraj).**

Table 6.14. Spiral borer infestation in different insecticide treatments in mesta

Treatments	Plant infestation (%)*					
	65 DAS	75 DAS	85 DAS	95 DAS	105 DAS	Mean
ST with imidacloprid 600FS @ 5ml/kg	1.50 (6.96)^{b}	7.00 (15.31)^{bc}	8.33 (16.73)^{c}	13.33 (21.32)^{bc}	16.67 (23.91)^{abc}	9.36 (17.81)^{d}
ST with thiamethoxam 70WS @ 5g/kg	1.67 (7.15)^{b}	5.67 (13.72)^{c}	7.67 (16.02)^{c}	11.00 (19.35)^{c}	14.33 (22.19)^{c}	8.06 (16.49)^{e}
SA of neem cake @ 60kg/ha	2.33 (8.74)^{ab}	9.67 (18.01)^{b}	13.00 (21.01)^{b}	14.33 (22.14)^{abc}	18.67 (25.49)^{abc}	11.60 (19.90)^{c}
SA of carbofuran 3G @ 30kg/ha	2.33 (8.74)^{ab}	10.00 (18.33)^{b}	12.33 (20.51)^{b}	20.00 (26.50)^{a}	20.33 (26.80)^{ab}	13.00 (21.12)^{b}
ST with chlorpyriphos 20EC @ 5ml/kg	1.33 (6.96)^{b}	6.67 (14.95)^{bc}	9.00 (17.44)^{bc}	9.33 (17.76)^{c}	15.00 (22.78)^{bc}	8.26 (16.70)^{e}
Untreated control	4.67 (12.13)^{a}	14.33 (22.21)^{a}	17.33 (24.57)^{a}	18.00 (25.06)^{ab}	21.33 (27.50)^{a}	15.13 (22.89)^{a}
SEm±	3.76	3.73	3.62	5.27	5.19	0.23
LSD (P=0.05)	3.52	3.51	3.46	4.17	4.14	0.88

ST-Seed treatment, SA-Soil application DAT-Days after sowing * Figures in parentheses are arc sin transformed values

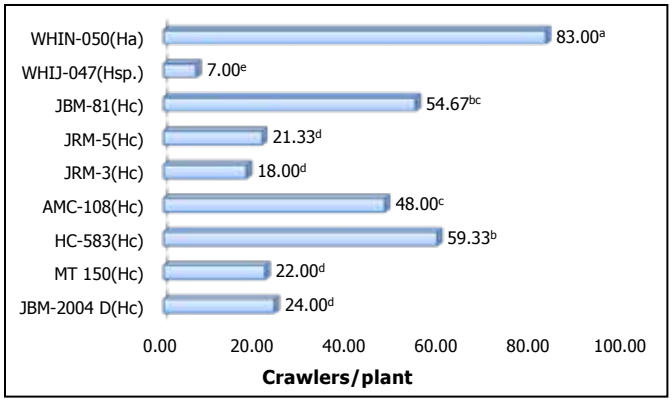


Fig. 6.3. Relative settlement of mealybug crawlers in kenaf lines of different species

6.1.1.3. Ramie

During past few years the changes in pattern of pest status in ramie has been witnessed. Some new insect pests were observed and identified. The activity period and incidence of these pests have been recorded during 2013 in Assam condition. Among the insect pest *viz*., Indian red admiral caterpillar, leaf beetle, leaf eating caterpillar, epilachna beetle, yellow coaster butterfly, leaf folder, white grub and termites have been observed in ramie (Table 6.15). For insect pest identification, insects collected from infested ramie plants in different fields of RRS, Sorbhog was sent to NPIB, New Delhi for

identification. These insects were identified as mealybug (*Maconellicoccus hirsutus* Reg. No. 2176-2178/13), termite (*Microtermes* sp. Reg. No. 2179-2182/13) and white grub (*Lepidiota* sp. Reg. No. 314-318/13) (Fig. 6.4) **(Source: RBN 2.5; S.P. Gawande, B.S. Gotyal, A.N. Tripathi and A.K. Sharma).**

Table 6.15. Seasonal occurrence, incidence of insect pest of ramie

Pest	Scientific name	Period of occurrence	Incidence (%)	Temp. (°C)
Indian red admiral caterpillar	*Vanessa indica*	Nov-Apr	5-10%	13.0-27.0
Ladybird beetle	*Cheilomenes sexmaculata* *Micraspis discolor*	Mar-Aug	5-15%	20.0-30.0
Hairy caterpillar	*Spilosoma obliqua*	Apr-Sep	Sporadic	24.0-31.5
Leaf beetle	*Pachnephorous bretinghami*	May- Aug	5-10%	25.0-32.0
Termite	*Microtermes* sp.	Apr-Aug	5-30%	21.0-32.0
White grub	*Lepidiota* sp.	Apr- May	Sporadic	20.0-30.0
Mealybug	*Maconellicoccus hirsutus*	Aug-Oct	Sporadic	24.0-31.5

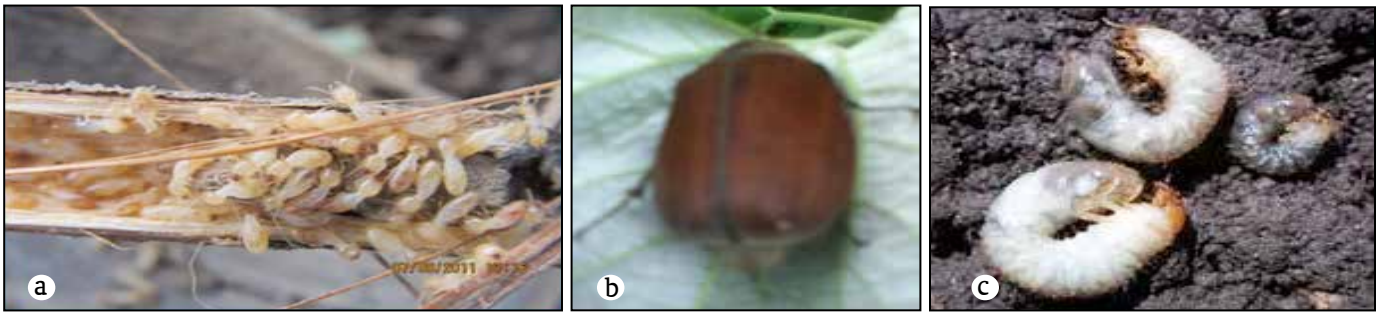


Fig. 6.4. Termite (a), White grub (adult-b, grub-c) and Mealybug (d) of ramie

6.1.2. Disease Management

6.1.2.1. Jute

Effect of fertilizers on the incidence of stem rot of jute

The effect of different dosages of nitrogen, phosphate and potashic fertilizers on the incidence of stem rot caused by *Macrophomina phaseolina* in jute (Cv. JRO 8432) indicated that application of high doses of nitrogenous fertilizer enhanced stem rot of jute (Table 6.16). In contrary, phosphatic and potashic fertilizers suppressed the stem rot incidence. Maximum stem rot (46.58%) was recorded in N: P: K @ 120:30:30 kg/ha, followed by 120:40:40 (41.76%), 80:40:40 (39.39%) and 100:30:30 (37.81%). Lowest stem rot incidence (31.02%) was noticed in check plot with no fertilizer. With increase in N from 40 to 120 kg/ha, stem rot increased gradually from 20.29 to 46.58%. High P and K levels with same nitrogen levels in N: P: K @ 120:30:30 and 120:40:40 moderated the stem rot incidence. Jute stem rot incidence increased rapidly from 0.49% at 15 DAS to 16.27% at 60 DAS and 46.58 % at 120 DAS with higher dosage of nitrogenous fertilizer i.e., N: P: K @ 120:30:30. Progress of stem rot was also fast in other treatments with higher dosage of nitrogenous fertilizer **(Source: JM 8.0. Contributor: R.K. De).**

Table 6.16. Effect of different dosages of fertilizers on the incidence of stem rot of jute (Cv. JRO 8432)

Treatments	Stem rot incidence (%)*							
N: P: K (kg/ha)	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS
40:30:30	0.10 (1.77)	1.01 (5.60)	2.59 (9.26)	4.57 (12.33)	9.64 (18.09)	12.63 (20.75)	16.60 (24.02)	20.29 (26.75)
60:30:30	0.54 (4.20)	0.92 (5.49)	3.62 (10.97)	5.82 (13.94)	15.83 (23.45)	22.01 (27.98)	25.39 (30.25)	28.84 (32.48)
80:30:30	0.38 (3.50)	1.59 (7.22)	4.69 (12.46)	8.98 (17.43)	18.17 (25.21)	25.29 (30.19)	28.65 (32.36)	34.65 (36.06)
100:30:30	0.58 (4.36)	2.72 (9.40)	6.50 (14.75)	11.65 (19.93)	17.63 (24.81)	28.22 (32.08)	33.23 (35.20)	37.81 (37.95)
120:30:30	0.49 (3.94)	3.23 (10.20)	9.49 (17.92)	16.27 (23.78)	26.78 (31.15)	35.50 (36.56)	40.62 (39.59)	46.58 (43.03)
80:40:40	0.47 (3.91)	3.89 (11.40)	8.68 (17.13)	15.05 (22.80)	24.21 (29.47)	33.03 (35.08)	35.29 (36.44)	38.39 (38.29)
120:40:40	1.06 (5.91)	3.84 (10.65)	10.41 (18.82)	14.69 (22.53)	22.20 (28.10)	30.54 (33.54)	38.79 (38.52)	41.76 (40.25)
Control	0.21 (2.60)	1.06 (5.84)	2.59 (9.26)	5.88 (14.03)	14.11 (22.06)	20.88 (27.17)	26.06 (30.69)	31.02 (33.84)
SEm±	0.46	1.81	0.61	0.80	0.86	0.97	0.73	0.94
LSD(P=0.05)	0.98	3.81	1.29	1.67	1.82	2.04	1.52	1.98

*Figures in the parentheses are angular transformed values

New fungicides for stem rot management in jute

The effect of new fungicides applied as pre-sowing seed treatment (0.1%) and foliar spraying (0.1%) at 45 days after sowing on the incidence of stem rot caused by *M. phaseolina*, indicated that tebuconazole 25.9 EC was most effective against stem rot of jute showing only 21.59% disease incidence compared to 32.86% in check (Table 6.17). Carbendazim 50 WP, hexaconazole 5 EC, tricyclazole 75 WP, copper oxychloride 50 WP, propiconazole 25 EC and mancozeb 75 WP were also effective against stem rot incidence compared to 32.86% in check. In all the fungicide treated plots the growth of stem rot disease was arrested significantly over the untreated check indicating high efficacy of these fungicides. So, carbendazim 50 WP and tebuconazole 25.9 EC not only managed the stem rot of jute effectively but also decreased the build-up of disease over the crop growth period drastically. At the harvest (120 DAS) of the crop, the variation in incidence of stem rot significantly ranged from a minimum of 21.59% in tebuconazole 25.9 EC to a maximum of 32.86% in untreated check **(Source: JM 8.0, Contributor: R. K. De).**

Table 6.17. Effect of new fungicides on the incidence of stem rot of jute (Cv. JRO 8432) during 2013

Treatments*	Mean disease incidence (%)*							
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS
Propiconazole 25 EC	0.09 (1.69)**	2.17 (8.47)	4.20 (11.83)	5.77 (13.89)	9.10 (21.04)	21.44 (27.58)	27.68 (31.73)	30.60 (33.59)
Mancozeb 75 WP	0.05 (1.28)	1.74 (7.54)	3.16 (10.23)	5.34 (13.34)	10.20 (18.62)	23.01 (28.66)	27.95 (31.92)	31.57 (34.18)
Tricyclazole 75 WP	0.16 (2.29)	1.73 (7.53)	3.99 (11.50)	6.06 (14.23)	7.76 (16.14)	18.10 (25.14)	22.41 (28.26)	28.24 (32.09)
Tebuconazole 25.9 EC	0.08 (1.58)	1.25 (6.42)	3.76 (11.17)	6.10 (14.29)	8.47 (16.92)	13.32 (21.40)	17.25 (24.53)	21.59 (27.69)
Hexaconazole 5 EC	0.05 (1.28)	1.57 (7.19)	3.45 (10.70)	4.93 (12.83)	8.86 (17.31)	16.02 (23.59)	21.87 (27.87)	25.78 (30.51)
Copper oxychloride 50 WP	0.27 (2.98)	3.56 (10.87)	7.19 (15.55)	9.64 (18.08)	12.26 (20.49)	19.78 (26.40)	26.99 (31.30)	29.56 (32.93)
Carbendazim 50 WP	0.32 (3.24)	2.18 (8.49)	4.96 (12.87)	7.09 (15.45)	10.01 (18.42)	16.10 (23.65)	20.55 (26.95)	25.65 (30.42)
Control	0.34 (3.34)	4.44 (12.16)	7.67 (16.08)	12.08 (20.34)	15.45 (23.14)	22.79 (28.51)	26.41 (30.92)	32.86 (34.98)
SEm±	0.18	0.92	0.98	0.87	4.00	1.67	1.48	1.31
LSD(P=0.05)	0.09	0.44	0.47	0.41	1.91	0.79	0.71	0.62

*Two applications: i) Seed treatment before sowing @ 0.1 % a.i. and ii) Foliar spraying @0.1% at one month after sowing.
**Figures in the parentheses are angular transformed values

Use of bleaching powder [Ca $(OCl)_2$] as an alternative for management of *M. phaseolina*

In vitro food poisoning bioassay of bleaching powder (5000 μg/ml) against *M. phaseolina* could completely check the growth of the fungus both after 24 and 48 hours of incubation (Table 6.18). As dose was lowered to 2.0 μg/ml, growth inhibition decreased. At 100 and 1000 μg/ml, 87.3%, 93.3 % and 93.6%, 96.6% inhibition was observed after 24 and 48 hours, respectively. In the field, the stem rot incidence was lowest in 7-day pre-sowing soil application of bleaching powder @ 30 kg/ha during all the observations from 30-120 DAS. It reduced the stem rot of jute to 2.1 and 6.0% as compared to 15.1 and 24.0% in untreated check at 90-120 DAS, respectively. As the dose of soil application of bleaching powder increased from @ 5-100 kg/ha, the jute stem rot decreased slowly reaching minimum at 30 kg/ha. The reason for reduction of jute stem rot using bleaching powder may be attributed to increasing soil pH and adding calcium to soil, besides direct detrimental effect on pathogen itself. It could be a promising ecofriendly management option for stem rot not only in jute but many other crops susceptible to *M. phaseolina* **(Source: JM 8.0, Contributors: R. K. De).**

Table 6.18. Effect of soil application of bleaching powder [Ca $(OCl)_2$] on stem rot of jute (cv. JRO 8432)

Treatments*	Disease incidence (%)				Reduction (%)
	30 DAS	60 DAS	90 DAS	120 DAS	
Soil application @ 5 kg/ha (2 days-pre-sowing)	0.21 (2.36)**	0.61 (4.41)	3.46 (10.71)	8.27 (16.67)	65.51
Soil application @ 10 kg/ha (2 days-pre-sowing)	0.22 (2.69)	0.48 (3.94)	2.70 (9.40)	7.37 (15.74)	69.34
Soil application @ 20 kg/ha (2 days-pre-sowing)	0.25 (2.24)	0.56 (4.30)	2.29 (8.44)	6.97 (14.98)	71.00
Soil application @ 30 kg/ha (7 days-pre-sowing)	0.12 (1.97)	0.39 (4.12)	2.16 (8.37)	6.02 (14.14)	74.95
Soil application @ 50 kg/ha (7 days-pre-sowing)	0.26 (2.87)	0.74 (4.24)	2.30 (8.66)	6.10 (14.26)	74.62
Soil application @ 80 kg/ha (10 days-pre-sowing)	0.22 (2.63)	0.79 (4.97)	2.95 (9.62)	6.39 (14.47)	73.41
Soil application @ 100 kg/ha (15 days-pre-sowing)	0.31 (2.44)	0.68 (5.47)	3.11 (9.41)	6.83 (14.84)	71.58
Control	0.50 (3.99)	2.32 (8.75)	15.16 (22.90)	24.04 (29.33)	-
SEm±	(1.03)	(1.21)	(1.86)	(1.64)	-
LSD (P=0.05)	(2.17)	(2.54)	(3.91)	(3.44)	-

* Soil application of Ca (OCl)2 at different doses with full P + full K +1/3 N basal during sowing + 1/3 N at 30 DAS + 1/3 N at 60 DAS **Figures in the parentheses are angular transformed values

Isolates of *M. phaseolina* infecting jute causing stem rot

Ten isolates were purified from diseased (jute stem rot) samples collected from five locations i.e. Barrackpore (2), Goaldaha (1), Budbud (1), Bahraich (1), Bankura (1), RRS, Sorbhog, Assam, (2) and farmers' field, Sorbhog, Assam (2). The relative pathogenicity of these isolates on the plants of *C. olitorius* - JRO 8432 and *C. capsularis* - JRC 412 were tested by sowing the seeds in the pots filled with inoculated soil. All the isolates proved to be pathogenic and produced typical symptoms of jute stem rot and seedling blight. These were re-isolated in pure culture and it happened to be identical isolates which were inoculated earlier. Variation in growth pattern and colony characters of isolates of *M. phaseolina* was observed in potato dextrose agar medium. These isolates were maintained for further study **(Source: JM 8.3, Contributors: R. K. De).**

Standardization of stem inoculation technique of stem rot of jute

To improve over earlier technique of leaf inoculation and pre- and post-sowing soil inoculation, a new method was devised. The stem inoculation technique comprised the steps of growing inoculum of *M. phaseolina* on PDA for 3 days at 28±1°C followed by mixing sterile sand with 3 day old culture of *M. phaseolina* and gently rubbing the stem base of 30-45 day old jute plants with the inoculated sand at 10-20 cm above soil. This stem inoculation technique is highly efficient and caused 100 % infection with typical stem rot symptoms with brown rotting spots of different length and intensity encircling the stem in jute plants (Cv. JRO 524) grown in pots. Two different isolates were inoculated separately. The variation in virulence pattern of the isolates was also evident, as more virulent isolate (from Sorbhog, Assam) produced longer and darker brown stem rot lesion than less virulent strain (from Barrackpore, West Bengal) (Table 6.19). For mass scale evaluation of large number of genotypes against jute stem rot, this simple stem inoculation method may be very useful. **(Source:JM 8.0. Contributors: R.K. De, S.K. Sarkar and C. Biswas).**

Table 6.19. Extent of disease expression through stem inoculation technique with *M. phaseolina* isolates

Inoculation method	Barrackpore isolate		Sorbhog isolate		Remarks
	Stem rot (%)	Colour	Stem rot (%)	Colour	
Stem inoculation	32	Brown	54	Dark brown	Typical symptoms of stem rot
Check with sterile sand	0	-	0	-	No symptom
Control (uninoculated)	0	-	0	-	No symptom

Evaluation of elite *olitorius* jute lines against stem rot under challenged inoculations in the developing sick plot

Lowest PDI of 2.21 was recorded in case of OIN 853; it was followed by JRC 80 with 2.77. Other entries with PDI lower than 10 were OIN 651, OIN 154, OIN 154 G, OIN 125, OIN 853 G and OIN 125 G, respectively, with 3.39, 4.59, 5.14, 5.70, 7.90 and 8.61 PDI respectively. However, highest PDI of 81.51 was observed in most susceptible lines, namely, JRC 412. Entries showing PDI score between 10-20 were OIN 651 G, JRC 321, OIN 932, JRC 4444, OIN 270, OIJ 052 and OIJ 150 with 10.89, 11.29, 12.29, 13.29, 15.67, 19.55 and 19.91 PDI respectively. **(Source: JM 8.3. Contributors: R.K. De, A.N. Tripathi and C.S. Kar).**

Evaluation of jute species against stem rot in the field

Out of 9 *Corchorus* species of jute including 7 wild species, *C. capsularis* (cv. JRC 412) showed highest stem rot of 48.55 % and *C. olitorius* (cv. JRO 524) recorded 20.41 % stem rot (Table 6.20). *C. pseudo-olitorius* (WCIJ 34) and *C. aestuans* (WCIJ 79) were free from stem rot disease. In *C. pseudo-capsularis* (WCIJ 07) stem rot incidence reached upto 100% and no seed was produced. *C. fascicularis* (WCIJ 14) showed low stem rot of 2.52%. *C. tridens* (WCIJ 49) exhibited 11.67% stem rot. In *C. urtifolius* (WCIN 162) and *C. trilocularis* (WCIJ 01), stem rot of 19.68 and 31.92% was noticed. **(Source: JM 8.0. Contributors: R.K. De, S.K. Sarkar and C. Biswas).**

Table 6.20. Evaluation of nine species of jute against stem rot in the field during 2013

Species	Mean stem rot (%) *			
	45 DAS	60 DAS	75 DAS	90 DAS
C. urtifolius (WCIN 162)	2.38 (9.00)	3.49 (10.75)	11.43 (19.75)	19.68 (26.33)
C. tridens (WCIJ 49)	2.55 (9.77)	5.36 (13.33)	8.54 (16.98)	11.67 (19.92)
C. trilocularis (WCIJ 01)	18.14 (25.20)	21.84 (27.85)	26.55 (31.01)	31.92 (34.39)
C. pseudo-capsularis (WCIJ 07)	16.72 (24.12)	33.84 (35.56)	71.70 (57.86)	100.00 (90.00)
C. fascicularis (WCIJ 14)	0.98 (5.66)	1.51 (7.00)	1.84 (7.68)	2.52 (9.12)
C. aestuans (WCIJ 79)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
C. pseudo-olitorius (WCIJ 34)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
C. capsularis (Cv. JRC 412)	5.14 (13.05)	8.28 (16.72)	37.30 (37.64)	48.55 (44.17)
C. olitorius (Cv. JRO 524)	2.52 (8.92)	3.92 (11.41)	6.12 (14.31)	20.41 (26.78)
SEm±	0.59	0.91	0.81	1.25
LSD (P=0.05)	1.24	1.92	1.71	2.63

*Figures in the parentheses are angular transformed values

Multiplex PCR based detection of field released *Beauveria bassiana*

To monitor the survival of field released *B. bassiana* a rapid and efficient detection technique is essential. Conventional methods such as plating method or direct culture method which are based on cultivation on selective media followed by microscopy are time consuming and not so sensitive. PCR based methods are rapid, sensitive and reliable. A single primer PCR may fail to amplify some of the strains. However, multiplex PCR

increases the possibility of detection as it uses multiple primers. Therefore, a multiplex PCR-based method was developed by multiplexing SCA 14, SCA 15 and SCB 9. The PCR profile and the reaction conditions were standardized for detecting *B. bassiana* from soil as well as foliage (Fig. 6.5) **(Source: JM 8.1. Contributors: C. Biswas, S. Satpathy and B.S. Gotyal).**

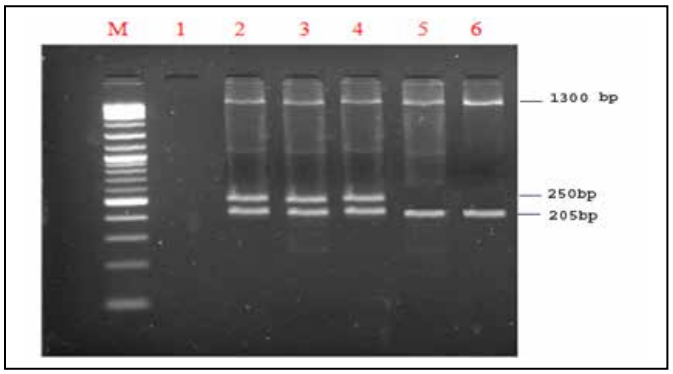


Fig. 6.5. Multiplex PCR of different *B. bassiana* strains from soil in jute field. Lane M: 50 bp DNA ladder, Lane 1: untreated check, Lane 2: ITCC 6063, Lane 3: ITCC 4563, Lane 4: ITCC 4795, Lane 5: ITCC 4644, Lane 6: ITCC 4925

Compatibility of *Beauveria bassiana* with common pesticides

Compatibility of *B. bassiana* ITCC 6063 with some commonly used pesticides was studied by poison food technique. The fungal entomopathogen was found compatible with cypermethrin, lambda cyhalothrin, profenophos, quinalphos and dicofol upto the concentration of 300 ppm. Moreover, cypermethrin and lambdacyhalothrin stimulated the hyphal growth at lower concentrations (50 and 100 ppm). The results indicated that these pesticides can be safely applied to *B. bassiana* treated plants **(Source: JM 8.1. Contributors: C. Biswas, S. Satpathy and B. S. Gotyal).**

***In planta* detection of *M. phaseolina* from jute by a direct PCR method without DNA extraction**

M. phaseolina, the stem rot pathogen of jute was detected from field samples by a simple method of direct PCR (dPCR) which obviates the steps of DNA extraction. The leaf bits were treated with a lysis buffer at 65^{0}C for 25 min, whereas the stem pieces were initially incubated at 65^{0}C for 5 min followed by incubation at 60^{0}C for 25 min and the lysate was used as PCR template. Based on the type of tissue the composition and concentration of lysis buffer systems were optimized. For leaf samples the optimized buffer system composed of 20 mmol l^{-1} tris (hydroxymethyl aminomethane (Tris)-Cl (pH 8.0), 1.5 mmol l^{-1} ethylene diamine tetra acetate (EDTA) (pH 8.0), 1.4 mol l^{-1} sodium acetate and 200 μg/mL proteinase K. Further, 3 % PVP (w/v) and β-marcaptoethanol (1% w/v) were additionally added into the buffer. In case of stem samples, PVP was not applied and higher concentrations were used for other components. The pathogen could be detected from both leaf and stem samples by *M. phaseolina*-specific ITS primer generating amplicon of 350 bp (Fig 6.6). It is the first report of detecting *M. phaseolina* by a direct PCR method without DNA extraction **(Source: TMJ 7.0. Contributor: C. Biswas).**

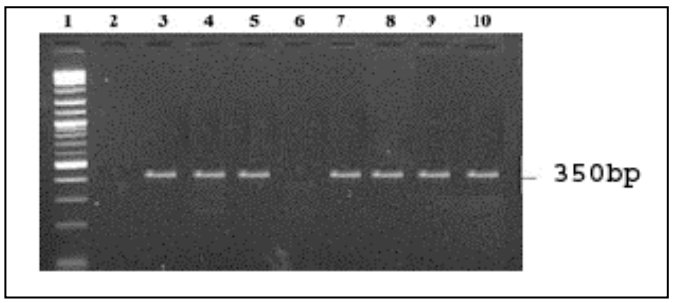


Fig. 6.6. Direct PCR amplification of *M. phaseolina* infected stem and leaf samples of jute. Lane 1: 100bp ladder, Lane 2: healthy stem sample, Lane 3-5: stem samples, Lane 6: healthy leaf sample, 7-9: leaf samples, Lane 10: *M. phaseolina* culture

Designing ITS primers for PCR based detection of *M. phaseolina*

Two pairs of internal transcribed spacer (ITS) primers were designed and synthesized for specific detection of *M. phaseolina* which could detect all the seven different isolates of the pathogen tried generating amplicon of 350bp. But the primer pairs did not amplify the DNA isolated from other fungi such as *Fusarium*, *Pythium*, *Colletotrichum* etc **(Source: TMJ 7.0. Contributor: C. Biswas).**

Effect of plant essential oil on *Macrophomina phaseolina*

Bioassay of the essential oils of citronella, menthal, lippia and turmeric oil (extracted from rhizome powder) against *M. phaseolina* (stem rot of jute) was conducted under laboratory condition. Essential oils were found effective in controlling fungal growth of *M. phaseolina.* Among the oils, turmeric oil recorded highest radial growth inhibition against *M. phaseolina* in poison food technique (PDA media). Turmeric oil was much higher in efficacy than the curcumin mixture (yellow pigments of turmeric powder). The LC_{50} values of the oils ranged from 0.011-0.022%, turmeric oil being the most effective

(Table 6.21). LC_{50} of curcumin mixture was 0.123%. LC_{25} values of the oils ranged between 0.007-0.015%. The LC_{25} value of curcumin mixture was 0.061%. Mixtures of turmeric rhizome oil with the individual leaf oils (at LC_{25} dose level) were found more effective in controlling the fungal growth than turmeric oil alone. At LC_{25} dose level turmeric oil and curcumin mixture were also more effective than the oil alone. Curcumin mixture when mixed with other leaf oils their efficacy was also increased. Chemical characterization of the oils revealed similarities in composition among the leaf oils but turmeric rhizome oil differed in composition from the leaf oils (Table 6.22) **(Source: JC 6.4. Contributors: H. Chowdhury, S.K. Sarkar and R.K. De).**

Table 6.21. Effect of plant extracts on *M. phaseolina* causing stem rot disease of jute

Extract	LC_{50} (%)	95% Confidence limit (%)		LC_{25} (%)	95% confidence limit (%)	
Citronella oil	0.013	0.012	0.014	0.009	0.008	0.009
Mentha oil	0.018	0.015	0.021	0.013	0.010	0.016
Turmeric oil	0.011	0.010	0.011	0.007	0.006	0.007
Lippia oil	0.002	0.018	0.026	0.015	0.012	0.018
Curcumin mixture	0.123	0.060	0.376	0.061	0.010	0.111

Table 6.22. Chemical constituents of plant essential oils

Constituent (ppm)	Lemon oil	Mentha oil	Citronella oil	Lippia oil	Turmeric oil
Citronellal	14.078	0.000	8.306	19.856	0.000
Menthol	2.438	3.376	2.517	0.000	0.000
Eugenol	0.020	0.036	0.037	0.000	0.015
Citral	19.222	0.000	20.645	10.246	0.012
Carvone	0.547	47.874	0.331	0.210	0.00

Basic study on process of stem rot disease development in jute

Infection through seed

Sclerotia of the pathogen *M. phaseolina* were harvested from 10 days old fungal colonies growing on potato dextrose agar (PDA) medium. Sclerotia germination was determined by suspending them in distilled water and incubating at 25±0.5°C overnight. Seeds were either inoculated with 250 sclerotia per gram seed or coated with actively growing mycelium by rolling the seeds on 7 days old PDA culture. Seeds were sown in plastic pots containing sterilised field soil watered regularly to maintain optimum moisture level. Seed germination was not affected by any of the inoculation methods compared to control. However, significant difference in plant stand was observed 7 days after inoculation (DAI). Plants started dying in treatments where seeds were inoculated. Both the methods of inoculation produced similar results (26.7% plant death) 7 days after inoculation (DAI). However, at 14 DAI significantly higher plant death was recorded in seeds coated with mycelium (63.3%) compared to seeds inoculated with sclerotial suspension (43.3%). Plants did not produce typical stem rot symptoms **(Source JM 8.5: Contributors: K. Mandal, C. Biswas and C.S. Kar).**

Infection through root and stem

Young (42 h after sowing) seedlings were inoculated by dipping the roots in fungal suspension for overnight. Such seedlings were transplanted on sterile water agar (1%) plates or, in soil. Seedling death was visible from 2 days after transplanting onwards. More than 60% seedlings died within 7 days of transplanting. However,

typical stem rot symptoms were not produced. Mature (100 days after sowing) jute plants were inoculated at three locations on the stem viz., base (15 cm above soil), middle (150 cm above soil) and tip. For inoculation, an injury was made at the designated point of stem by removing bark using a cork borer. This was covered by actively growing mycelia on PDA. This portion was wrapped with Parafilm® for 24 h to prevent it from drying. Significantly highest lesion size was produced when the middle portion of stem was inoculated. Lesion lengths were 3.9 and 6.3 cm during 2 and 6 DAI, respectively. Tip portion developed initial necrotic lesion but it did not progress further and ultimately it shed. Hence, for further study plants were inoculated at the middle portion. Plants of varying ages (30, 40, 50 and 60 days after sowing) were inoculated at stem. Lesion size was significantly influenced by plant age. Plants showed variation in susceptibility in terms of progress of lesion size. Host susceptibility towards the pathogen increased as plants aged. At 14 DAI lesion length produced on oldest plants were 56.3% higher than those of youngest plants **(Source JM 8.5: Contributors: K. Mandal, C. Biswas and C.S. Kar).**

Infection through leaf

A detached leaf inoculation technique was developed to screen different genotypes. Leaves of varying age (second to sixth from top) were injured by pin prick and placed on sterile 1% water agar, upper side of leaf remaining in contact with the agar surface. Advancing mycelia (3 mm diameter) on PDA was removed by a cork borer and placed on the leaf in such a way that the mycelia remain in contact with the leaf surface. The leaves were incubated at 25±0.5 °C. Lesion development was visible at 24 h after inoculation. Lesion size was measured by tracing on a graph paper 48 h after inoculation. Different leaf age groups did not vary significantly with respect to the lesion size (Fig. 6.7). The experiment was repeated once more and difference in lesion size among the leaves could be detected. However, lesion size varied considerably between the experiments (conducted at a gap of one month). Probably, the reaction was influenced by crop phenology. Hence, for screening purpose, the experiment needs to be done at same time. Also, considering consistency, data from second leaf is recommended for determination of host reaction **(Source JM 8.5: Contributors: K. Mandal and C. Biswas).**

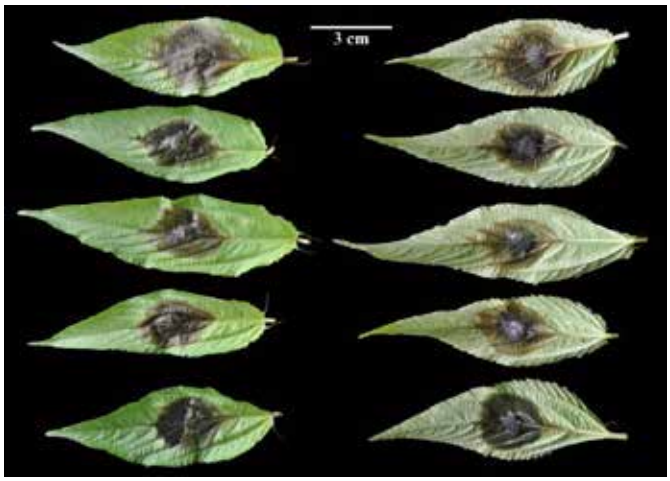


Fig. 6.7. Lesion developed on 2nd to 6th leaves at 48 h after inoculation with *M. phaseolina*

Screening of jute cultivars and wild species

Ten *C. olitorius* and eleven *C. capsularis* cultivars were screened for resistance against *M. phaseolina* under the field conditions by stem inoculation method. Lesion length was measured 7 DAI (Table 6.23). *C. capsularis* cultivars were comparatively more susceptible to the disease compared to those of *C. olitorius*. Among the *C. capsularis* cultivars, JRC212 showed resistance reaction while JRC 4444, JRC 532 and JRCM 2 were most susceptible. JRO 204 was highly resistant among the *C.*

Table 6.23. Lesion length on stems of different jute cultivars due to inoculation with *M. phaseolina* (at 7 DAI)

C. olitorius	Lesion length (cm)	*C. capsularis*	Lesion length (cm)
JROM 1	4.1	JRCM 2	6.4
JRO 2407	3.6	JBC 5	3.9
JBO 1	3.5	Monalisa	4.9
CO 58	3.9	JRC 517	5.8
IRA	3.3	JRC 532	6.6
JRO 204	1.5	JRC 80	4.6
S 19	3.3	JRC 698	5.1
JRO 128	3.2	JRC 4444	6.9
JRO 8432	3.3	JRC 7447	4.7
JRO 524	3.2	JRC 212	2.9
SEm (±)	0.5	SEm±	0.7
LSD (P=0.05)	1.1	LSD (P=0.05)	1.5

olitorius. Rest of the cultivars were statistically similar with each other but significantly differing from JRO 204.

Six wild *Corchorus* spp. were also inoculated at stem to determine their reactions towards *M. phaseolina* infection. Among these, *C. tridents* and *C. trilocularis* were highly susceptible, *C. aestuans*, *C. pseudo-capsularis* and *C. pseudo-olitorius* were resistant while *C.fascicularis* was highly resistant **(Source TMJ 7.0. Contributors: K. Mandal and C. Biswas).**

Evaluation of fungal antagonists and PGPR for biocontrol potential and compatibility to fungicides

Native isolates of *Trichoderma* spp. were isolated on *Trichoderma*-selective medium. Referral fungal bioagents including strains of *T. harzianum* and *T. viride* were also maintained for comparative studies with native isolates with respect to morphological characterization and profiling for biocontrol potential against jute stem rot pathogen, *M. phaseolina*. On the basis of morphological and cultural characterization, strains of *Trichoderma* were categorized into two groups i.e. white coloured colony (NBAII TV-01, NBAII TV-10, NBAII TV-23, MTCC No-8799, MTCC No-3144) and green coloured colony (IARI TH-1, NBAII TH-8, NBAII TH-10, MTCC No-793). Biocontrol potential of strains of *T. harzianum* and *T. viride* were evaluated under *in vitro* by using of dual culture technique and bangle method. On the basis of mycelial growth inhibition of *M. phaseolina*; two strains of *T. viride* i.e., NBAII TV-23 and MTCC No-3144 were found more effective. Strains of *T. harzianum* and *T. viride* were screened for tolerance towards newer fungicides viz. pencuron 25% EC, fenamidone 10% + mancozeb 50% WG, tebuconazole 25% EC, fosetyl Al 80% WP, azoxystrobin 25% EC, trifloxystrobin 75% WG and plant essential oils namely turmeric oil, mentha oil and citronella oil at concentration of 500, 1000, 1500 ppm by using of poison food technique. On the basis of mycelial growth, all tested strains showed tolerance towards tested molecules in all concentration except tebuconazole 25% EC and citronella oil Table 6.24 **(Source: JM 8.4: Contributors: A.N. Tripathi, R.K. De and S.K. Sarkar).**

Collection and maintenance of *M. phaseolina* strains from different localities

Seven *M. phaseolina* isolates were established from infected jute plants obtained from different locations of North 24 Parganas district of West Bengal. All isolates were morphologically characterized after incubation of 6 days on PDA at 28 °C. These isolates were maintained on PDA at 4°C ***(*Source: TMJ 7.0: Contributors: A.N. Tripathi and C. Biswas*).***

Table 6.24. Comparison of fungicides/essential oils tolerant-*Trichoderma* strains based on colony diameter (cm) after 8 days of incubation

Fungicide	Concentration (ppm)			Mean	Concentration (ppm)			Mean
	MTCC-3114				NBAII Tv-23			
	500	1500	2000		500	1500	2000	
Pencuron 25 EC	8.65	8.49	8.35	8.50	8.34	8.50	8.64	8.50
Tebuconazole 25 EC	0.15	0.09	0.14	3.35	0.15	0.09	0.14	3.35
Fenamidone 10 + mancozeb 50 WG	7.07	5.40	4.51	6.50	8.4	7.09	6.48	6.50
Fosetyl Al 80 WP	4.40	2.49	2.60	3.41	4.59	3.00	3.39	3.41
Azoxystrobin 25 EC	3.90	3.49	3.10	6.00	8.59	8.50	8.39	6.00
Trifloxystrobin 75 WG	0.15	0.14	0.00	1.47	0.15	0.14	0.00	1.47
Turmeric oil	4.82	4.15	4.01	6.16	8.17	7.84	7.98	6.16
Mentha oil	3.65	2.99	2.35	5.75	8.84	8.50	8.14	5.75
Citronella oil	0.15	0.14	0.00	2.35	0.15	0.14	0.00	2.35
Mean	4.41	3.91	3.77	-	4.41	3.91	3.77	-
SEm±	0.02			0.03	0.02			
CD (P=0.05)	Concentration=0.04; Fungicide=0.07; Concentration X Fungicide X Strain=0.18							

In vitro* evaluation of bioagents against *M. phaseolina

Fungal bioagents including 4 strains of *Trichoderma harzianum* (NBAII TH-8, NBAII TH-10, IARI TH-1, MTCC No- 8799) and 5 strains of *T. viride* (NBAII TV-01, NBAII TV-10, NBAII TV-23, MTCC No- 793, MTCC No-3144) were evaluated by using dual culture technique against jute stem rot pathogen, *M. phaseolina*. Two strains of *T. harzianum* (NBAII TH-8 and NBAII TH-10) were found most effective against *M. phaseolina* (Table 6.25) **(Source: TMJ 7.0. Contributors: A.N. Tripathi and S.K. Sarkar).**

Evaluation of new fungicides/molecules against stem rot

Chemo-sensitivity of *M. phaseolina* were tested towards newer fungicides viz. pencuron 25% EC, fenamidone 10% + mancozeb 50% WG, tebuconazole 25% EC, tebuconazole 50% EC + trifloxystrobin 75% WG, fosetyl Al 80% WP, azoxystrobin 25% EC and plant essential oils namely turmeric oil, mentha oil and citronella oil at concentration of 500, 1000, 1500 ppm by using poison food technique. On the basis of mycelial growth inhibition (%), among the fungicides, tebuconazole 50% EC + trifloxystrobin 75% WG was found most effective however pencucuron 25% EC was least effective. Citronella oil was found most effective against test isolates of *M. phaseolina* **(Source: TMJ 7.0. Contributors: A.N. Tripathi and R.K. De).**

Table 6.24. *In- vitro* mycelial growth and growth inhibition of *T. harzianum* strains against *M. phaseolina* after 6 days of incubation

M. phaseolina isolates	*T. harzianum* (strains)			
	NBAII TH-8		NBAII TH-10	
	Mycelial growth(mm)	Growth inhibition (%)	Mycelial growth (mm)	Growth inhibition (%)
MP1	45.00	47.00	55.00	32.90
MP2	45.00	47.00	50.00	41.17
MP3	45.00	47.00	50.00	41.17
MP4	55.00	35.29	55.00	32.29
MP5	45.00	47.00	50.00	41.17
Control	85.00	-	85.00	-
Mean	53.33	44.65	57.50	37.74
SEm±	1.68	0.92	1.68	0.92
CD (P=0.05)	4.01	2.23	4.01	2.23

6.1.2.2. Mesta

First report of *Sclerotinia* stem rot caused by *Sclerotinia sclerotiorum* on seed crop of roselle

The incidence of *Sclerotinia* stem rot of roselle have recorded for the first time in the seed crop with alarmingly high level of 50% plant infection at CRIJAF Farm, Barrackpore. White mycelial mat with large irregular black sclerotia (0.5-1.5 cm), typical of *Sclerotinia sclerotiorum*, were present on diseased stems and bolls (Fig. 6.8). The isolates were identified as *S. sclerotiorum* (Lib.) de Bary based on morphological characteristics of mycelia and sclerotia as well as pathogenicity test. **(Source: TMJ 7.0. Contributors: A.N. Tripathi, S.K. Sarkar, H.K. Sharma and P.G. Karmakar).**

Fig. 6.8. Incidence of stem rot on roselle

6.1.2.3. Ramie

Germplasm screening against anthracnose leaf spot disease of ramie

Among all exotic cultivated genotypes, only Saikishon was highly resistant whereas 10 indigenous (R-1424(1), R-1425, R-1426, R-1429, R-37,R-45, R-47, R-51, R-09-21, R-09-22) and 19 wild creeper (MB-3, MB-11, MB-12, MB-13, MB-32, MB-37, MB-38, R-09-7, R-09-19, R-09-24, R-09-38, R-09-41, R-09-43, R-09-44, R-09-47 R-09-51, R-09-53, R-09-57, R-09-59) genotypes showed highly resistant reaction during the study (Table 6.26). However single indigenous genotypes R-1424 was resistant against anthracnose leaf spot. In case of wild creeper most of the genotypes were categorized under highly resistant (19), whereas only two wild creeper genotypes (MB-33, R-09-55) were susceptible. Most of the exotic cultivated genotypes were graded in between resistant to susceptible. Most of the wild creeper and indigenous genotypes were resistant. **(Source: RB 1.0. Contributors: A.K. Sharma and S.P. Gawande)**

Table 6.26. Reaction of ramie germplasms against anthracnose leaf spot under field condition

Disease reaction	Genotypes	
Highly resistant	Exotic	Saikishan
	Indigenous	R-1424(1), R-1425, R-1426, R-1429, R-37, R-45, R-47, R-51, R-09-21, R-09-22
	Wild creeper	MB-3, MB-11, MB-12, MB-13, MB-32, MB-37, MB-38, R-09-7, R-09-19, R-09-24, R-09-38, R-09-41, R-09-43, R-09-44, R-09-47 R-09-51, R-09-53, R-09-57, R-09-59
Resistant	Exotic	R-1410, R-1411, R-1412, R-1415, R-1428, R-1452, R-6720, Hakuhi, R-6751, R-6752, R-40, R-41, R-43, R-46, R-48, R-49, R-50, R-52, RH-1
	Indigenous	R-1424
	Wild creeper	MB-2, MB-10, MB-16, MB-36, R-09-01, R-09-004, R-09-05, R-09-06, R-09-09, R-09-10, R-09-11, R-09-13, R-09-16, R-09-25, R-09-26, R-09-27, R-09-29, R-09-30, R-09-34, R-09-35, R-09-37, R-09-39, R-09-40, R-09-43, R-09-46, R-09-49, R-09-52, R-09-54, R-09-60
Moderately Susceptible	Exotic	R-1417, R-1418, R-1419, R-1420, R-1421, R-1422, R-1427, R-1446, R-1449, R-1451, R-1453, R-67-46, R-67-34(Kanai)
	Indigenous	R-38, R-39, R-42, R-44
	Wild creeper	MB-1, MB-4, MB-7, MB-8, MB-17, MB-18, MB-23, MB-30, MB-34, R-09-02, R-09-08, R-09-17, R-09-18, R-09-23, R-09-28, R-09-32, R-09-33, R-09-36, R-09-50
Susceptible	Exotic	R-1413, R-1438, R-1445, R-1447, R-1450, MB-14, MB-15, MB-27, MB-29
	Wild creeper	MB-33,R-09-55
Highly susceptible	Exotic	R-1414, R-1416, MB-22 (Creeper)

Survey and surveillance of diseases of ramie

The diseases such as *Cercospor*a leafspot, anthrancnose leaf spot, Curvularia leaf blight, damping off and yellow mosaic were found to be the prominent diseases of ramie crop (Table 6.27). The infected samples causing anthracnose and leaf blight in ramie were collected and isolated in the laboratory on PDA medium. These fungal isolates were further studied and identified on the basis

of symptoms and microscopic observations and were also sent to Indian Type Culture Collection (ITCC), New Delhi for further confirmation. These two fungal pathogens were identified as *Colletotrichum gloeosporioides*, (ITCC Id. No.9150.13) causing anthracnose leaf spot and *Curvularia eragrostidis* (ITCC Id. No.9151.13) causing leaf blight in ramie (Fig.6.9, 6.10). This is the first report of occurrence and incidence of this diseases in ramie in India **(Source: RBN 2.5; S.P. Gawande, B.S. Gotyal, A.N. Tripathi and A.K. Sharma).**

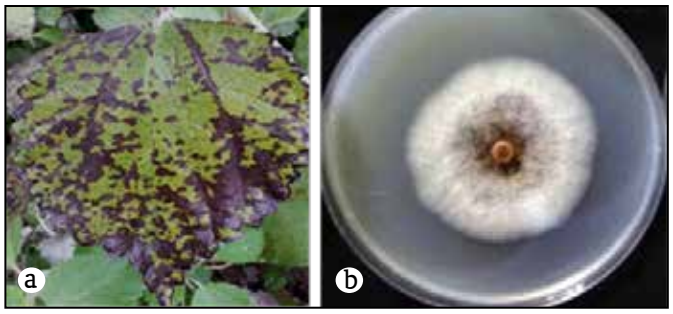
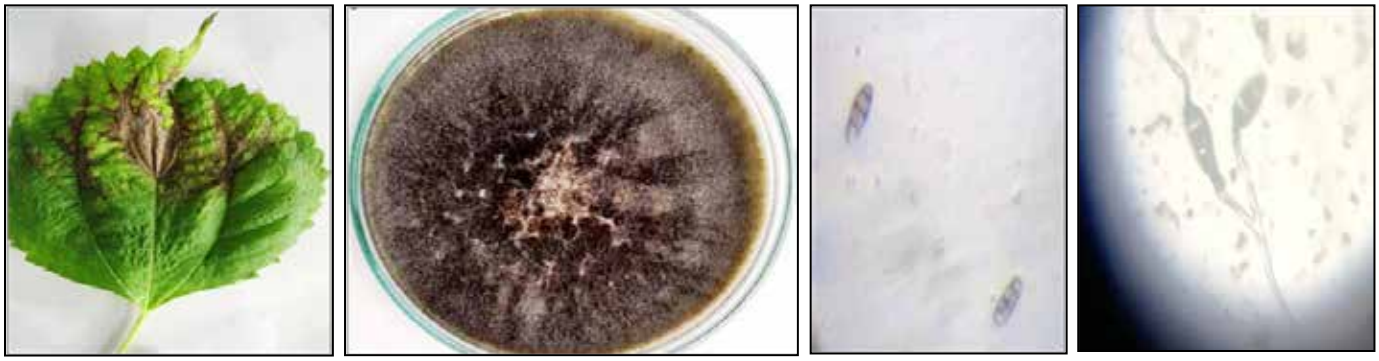


Fig.6.9 a) Severely infected leaf b) Growth of *Colletotrichum gloeosporioides* on PDA medium

Table 6.27. Seasonal occurrence, incidence and epidemiology of diseases of ramie

Disease	Scientific name	Period of occurrence	Incidence (%)	Temp. (°c) Max.-Min.
Anthracnose leaf spot	*Colletotrichum gloeosporioides*	Dec-May	30-90%	15.0-27.5
Cercospora leaf spot	*Cercospora boehremia*	Mar-Oct	2-20%	23.0-31.0
Curvularia leaf Blight	*Curvularia eragrostidis*	Aug-Oct	5-25%	25.0-31.0
Collar rot	*Sclerotium rolfsii*	Apr-Oct	Sporadic	23.0-32.0
Wilt	Complex disease	Apr-Jul	Sporadic	23.0-31.0
Damping off of seedling	*Rhizoctonia* spp.	Throughout year (seed nursery)	Sporadic	20.0-31.0
Yellow Mosaic	Viral disease	Oct-Mar	30-70%	15.0-28.0



a b c d

Fig. 6.10 a) Infection of *Curvularia eragrostidis* on ramie leaf b) Growth on PDA medium c) Conidia of *Curvularia eragrostidis* and d) Conidium with conidiophores

6.1.2.2. Sisal

Distribution, intensity and identification of sources of resistance against zebra disease of sisal

The incidence of zebra disease on two types of sisal i.e. *Agave sisalana* and Bamra Hybrid-1 was recorded in 19 villages of Jharsugura, Sambalpur and Sundargarh districts of Odisha selected for the study of distribution of the disease. Observations on number of leaves infected and percent leaf area infected were recorded following 0-5 rating scale. The PDI in *A. sisalana* ranged from 16.8 to 29.7 whereas in case of Bamra Hybrid-1 the incidence was more and it varied from 21.60 to 47.20 (Table 6.28).

Table 6.28. Zebra disease (*Phytophthora* spp.) reaction in different sisal types at 15 days interval

Date of observation	Agave sisalana			Bamra Hybrid -1		
	Lesion area (cm²)*	PDI*	Linear length of lesion (mm)**	Lesion area (cm²)*	PDI*	Linear length of lesion (mm)**
15 June' 13	0.6	3.2	1.8	0.5	4.3	1.0
30 June' 13	0.8	3.6	2.4	0.6	5.2	1.7
16 July' 13	12.7	11.6	6.5	9.8	14.6	4.5
31 July' 13	25.7	22.5	16.7	21.3	38.5	12.7
16 Aug' 13	28.5	26.4	18.9	24.7	40.5	14.7
31 Aug' 13	32.5	33.6	23.5	28.5	44.8	16.2
15 Sept' 13	35.6	34.8	24.6	29.4	45.4	18.1
30 Sept' 13	36.7	36.5	25.7	30.7	47.8	18.5
15 Oct' 13	38.6	37.4	25.7	31.8	48.8	19.2

*Age of plant: 3-4 years old **Age of plant: 4-5 months old (nursery stage)

Out of 11 spp. tested under natural epiphytotic condition, none was found resistant to the disease. One species (*A. miradorensis)* showed moderately resistant reaction and three spp. (*A. cantala*, *A. aungustifolia* and *A. ameniensis*) showed moderately susceptible reaction and rest 7 species showed susceptible and highly susceptible reaction (Table 6.29).

Table 6.29. Zebra disease (*Phytophthora* spp.) reaction in different sisal types

Sisal species	PDI	Reaction
A. furcraea gigantea	56.7	HS
A. fourcroydes	61.5	HS
A. miradorensis	8.2	MR
A. angustifolia	21.6	MS
A. cantala	14.3	MS
A. americana	52.8	HS
A. veracruz	71.6	HS
A. nirvana	62.7	HS
A. ameniensis	12.7	MS
A. sisalana	35.7	S
Bamra hybrid-1	51.8	HS

Out of 58 germplasm tested under natural epiphytotic condition, 10 germplasm showed resistant reaction, 13 germplasm showed moderately resistant reaction and 35 germplasm showed susceptible to highly susceptible reaction (Table 6.30) **(Source: SLM 1.0, Contributors: A.K. Jha, S. Sarkar, R.K. De).**

Table 6.30. Zebra disease (*Phytophthora* spp.) reaction in different germplasm

PDI	Reaction	Germplasm
0-5.0 %	R	APR-60, APR-58, APR-57, APR-54, APR-53, APR-52, APR-36, APR-34, RST/PK/05/03, RST/PK/05/02
5.1-10.0 %	MR	APR-79, APR-74, APR-73, APR-70, APR-67, APR-66, APR-59, APR-31, APR-18, APR-17, APR-13, APR-11, NA-3/53
10.1-25.0 %	MS	APR-69, APR-33,NA-03/44, RST/PK/05/05
25.1-50.0 %	S	APR-56, SBC-01/102, AMDJ-04/48, AMDJ-04/35, AMDJ-04/30, AMDJ-04/29, NA-03/65, NA-03/63, NA-03/52, NLA-03/08, YMG-307, AD-03/32, AD-03/06
>50.0 %	HS	NM/02-106, NM/02-71, NM/02-68, NM/02-39, NM/02-34, AMDJ-04/56, AMDJ-04/32, AMDJ-04/21, AMDJ-04/15, YMG-347,AD-03/11, NA-03/43,NA-03/42, NLA-03/38, NLA-03/27, RST/PK/05/04, RST/PK/05/01, SBC-01/24

6.1.2.3. Flax

Vascular fusarial wilt of flax caused by *Fusarium oxysporum* f. sp. *lini*

Localized outbreak of the flax wilt caused by *F. oxysporum* f. sp. *lini* (Schlecht) was noticed at CRIJAF research farm during December 2013-January 2014. Out of seven genotypes, JRF 2 was the most susceptible with 80% disease incidence followed by JRF 1 (60%) and JRF 3 (40%). However, wilt incidence was least on JRF 4, FT 850, FT 896 and FT 897. Initially wilt infected plants appeared sickly yellowing, started wilting at the top followed by whole plant wilting and eventually the plant dried with brown discolouration both on stem and leaves (Fig. 6.11).

Fig.6.11. Symptom of complete and partial wilt of flax

The pathogen was isolated from the stem section of the infected plant but not from root. Pure culture was established and the pathogen was identified as *Fusarium oxysporum* f. sp. *lini* **(Source: TMJ 7.0. Contributors: A.N. Tripathi and S.K. Sarkar).**

Fig 6.12(a) Composite weed control in jute at Singur, Hooghly using CRIJAF nail weeder

6.1.3. Weed management

6.1.3.1. Jute

Development of low cost ecofriendly technologies for weed management in jute and mesta

Experiments were conducted to develop economically viable and ecofriendly weed management technologies for jute at CRIJAF, Barrackpore and for mesta at MRS, Amadalavalasa, ANGRAU.

Pre-emergence herbicides: Butachlor 5G @ 1.5 kg/ha and one hand weeding produced 33.2 q jute fibre/ha. Pretilachlor 50% EC @ 0.9 litre/ha and one hand weeding applied at 48 hour of sowing with irrigation produced 33.3 q jute fibre/ha (Table 6.31). It controlled grass and broad leaved weeds *Trianthema portulacastrum* in particular in jute field.

Post-emergence herbicides: Quizalofop ethyl 10 EC @ 38 ml /ha and one manual weeding produced 32.7 q jute fibre/ha. Propaquizafop 10 EC @ 120 ml/ha and one hand weeding produced 32.0 q jute fibre /ha. Ethoxysulfuron 15% WD @175 g/ha (commercial formulation) controlled composite weeds in jute but it was phytotoxic for jute and produced only 22.2 q jute fibre/ha.

Mechanical weeding: In broadcast jute, CRIJAF-Nail Weeder operation at 4-5 days after emergence (DAE) followed by one hand weeding produced the highest fibre yield of 35.0 q/ha. It controlled composite weeds in early stage and developed line arrangement in broadcast jute. CRIJAF-Nail Weeder could save 150 man days/ha in Hooghly district where the fields were infested with *Trianthema* spp. (Fig 6.12 a&b). CRIJAF-Nail Weeder operation after application of pretilachlor 50% EC @ 0.5 litre/ha and one hand weeding produced fibre yield of 34.3 q/ha. These weed management practices can save 50 to 70% of total weeding cost incurred in jute.

Fig. 6.12(b) Simultaneous weed control, line arrangement and soil mulching in broadcast jute using CRIJAF nail weeder

Table 6.31. Effect of weed control treatments on fibre yield of jute

Ttreatments	Fibre yield (q/ha)
Unweeded check	14.5
Manual weeding twice (15 and 30 DAS)	29.2
Butachlor 5G @1.5 kg/ha as PE+ one HW	33.2
Pretilachlor 1 lit/ha as PE+ one HW	33.3
Quizalofop ethyl 10 EC @ 38 ml/ha as PoE+ 1 HW at 30 DAS	32.7
Propaquizafop ethyl 10 EC @120 ml/ha as PoE+1 HW	32.0
Nail weeder twice at 5 DAS and 12 DAS + 1 HW	35.0
Pretilachlor 50 EC @ lit/ha as PE + Nail Weeder at 5 DAS+ 1 HW	34.3
Quizalofop ethyl 5 EC @ 60 g/ha as PoE+ 1 HW	30.9
Propaquizafop ethyl 10 EC @ 90 g/ha as PoE+ 1 HW	30.1
Ethoxysulfuron 135 g/ha (commercial) as PoE+ 1 HW	22.2
SEm (±)	1.88
LSD (P=0.05)	5.67

Weed control by smothering: *Cyperus rotundus* was smothered upto 56% by intercropping green gram with jute (1:1). Initial monocot and dicot weeds were controlled by pretilachlor 50% EC @ 0.9 lit/ha, applied at 45-48 hours of intercrop sowing with irrigation. Intercropping of jute (cv. JRO-204 at 37.5 cm row space) and green gram (cv.TMB-37, matured in 54 days) in 1:1 row arrangement recorded the jute equivalent yield (JEY) of 42-53 q /ha at 120 DAS (31 q jute fibre and 8.8 q pulse grains/ha) and produced 2 t pulse wastes/ha (equivalent to 8 tonnes FYM) which was used as organic manure in between standing jute (55 DAS) rows under two irrigations (Fig 6.13). However, under three irrigations, the JEY increased up to 71 q/ha (jute 46 q/ha and pulse grain 9.48 q/ha, jute population 7.8 lakhs/ha and pulse population 2.2 lakhs/ha) with gross return of Rs.1, 42,000/ha with cost of cultivation Rs. 70,000/ha, (approx).

Green gram cultivars, i.e., Pant Mung-5 and Samrat (matured in 55-56 days) produced 39-48 q jute fibre equivalent /ha (7.5 to 9.34 q pulse grains and 21-22 q jute fibre/ha) under two irrigation when intercropped at 37 cm row space in 1:1 ratio. Green gram cultivar Sonali (matured in 65 days) and produced 45 q jute fibre equivalent/ha (6.40 q pulse and 25 q jute fibre/ha). All pulses matured synchronously and harvested once. Manual weeding twice produced only 29.2 q jute fibre/ha **(Source: TMJ 4.0 Contributors A.K. Ghorai, Mukesh Kumar, S.K Jha, Shamna, A, G. Jagannadham and Mrs. Amarjyoti P.).**

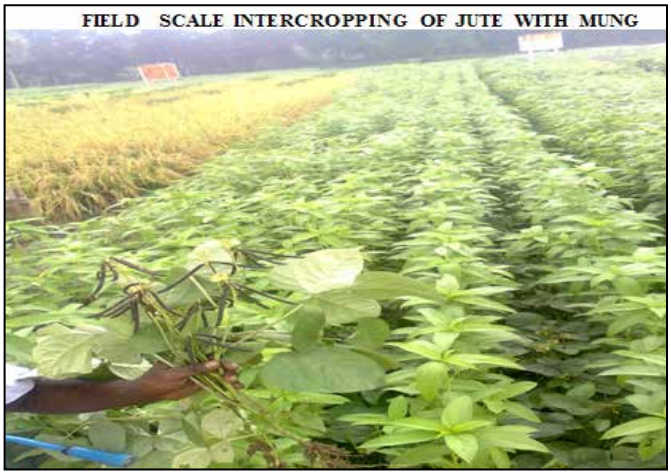


Fig.6.13. Weed smothering in jute (cv. JRO-204) by green gram (cv. TMB-37) intercropping (1:1)

6.1.4. 2. Mesta

Chemical weed control

Pre-emergence herbicides: Butachlor 5G @ 1.5 kg ai/ha and one hand weeding produced 20.7 q roselle fibre /ha. Pretilachlor 50 EC 1.0 litre/ha and one hand weeding produced 20.4 q roselle fibre/ha.

Post-emergence herbicide: Quizalofop ethyl 5 EC @ 75 g ai/ha and one manual weeding produced 18.68 q roselle fibre/ha. Glyphosate 42 SL @ 1.47 litre/ha at 20 DAE in between rows and one hand weeding produced 17.5 q roselle fibre /ha.

Mechanical weeding : CRIJAF Nail weeder operation at 4-5 DAE and one hand weeding produced 17.6 q roselle fibre /ha.

6.2. Abiotic stresses

Determination of water productivity of tossa jute under deficit moisture condition

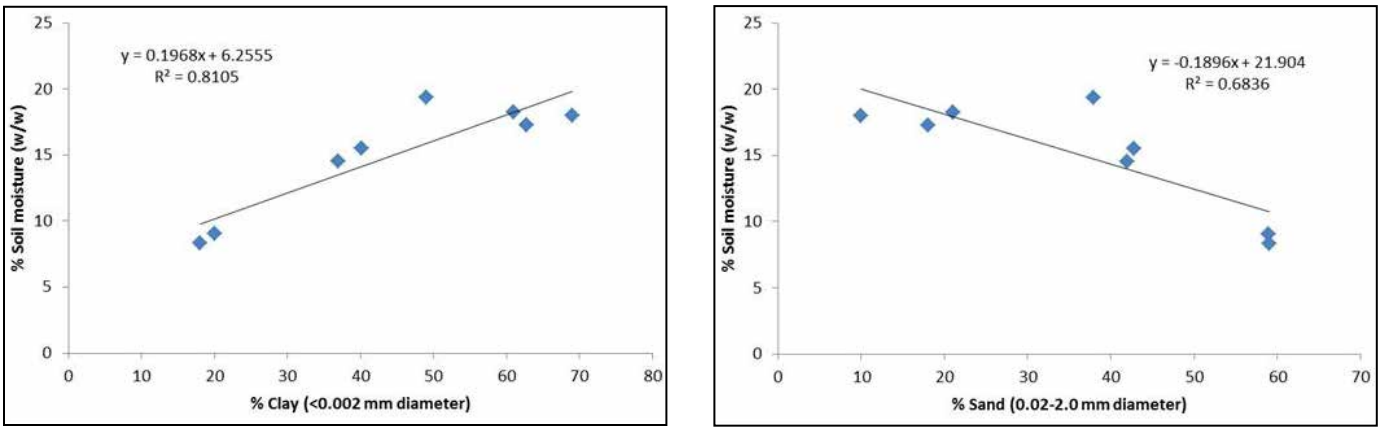
Pedotransfer functions (PTFs) were developed by using

the data set of 8 different surface soils taken from the experimental Farm, CRIJAF, Barrackpore. The PTFs can be used to predict soil moisture content up to the 20 cm soil depth during the pre-jute sowing period, March if clay or sand content is known for a particular soil in an area. There is a decreasing trend in rainfall amount during the early growth period of jute. This requires irrigating the jute crop for which measurement of crop evapotranspiration (ET_c) was calculated from the change in root zone soil moisture content in successive samples from the following equation:

$$ET_c = \Sigma \{(\Theta 1i - \Theta 2i)/100\} * (\rho/\Gamma) * D$$

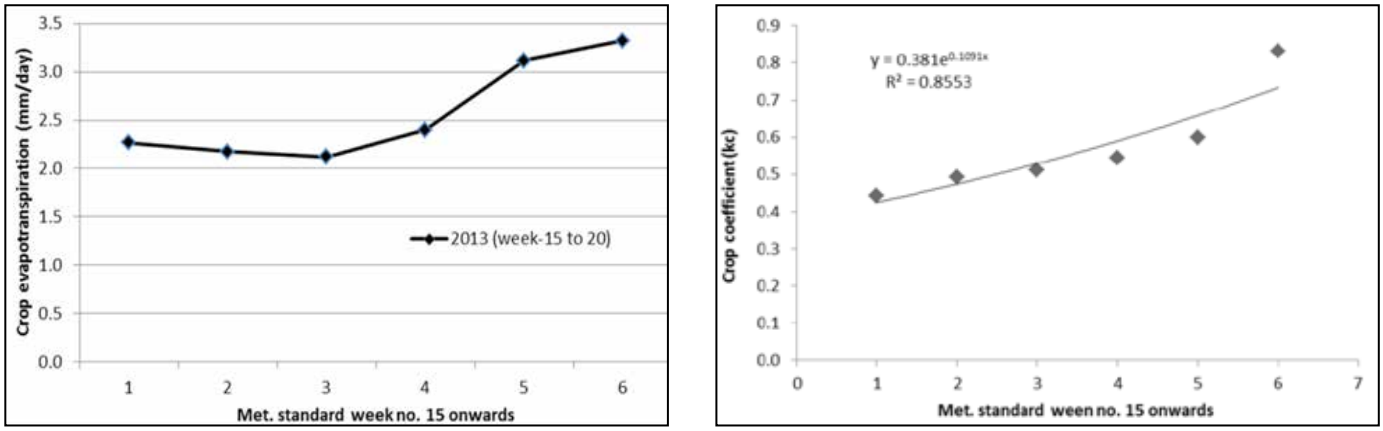
where, ETc-evapotranspiration from root zone for 7 days sampling interval (mm), n-number of soil layers sampled in the root zone depth, D; Θ1i-gravimetric water content (%) at the time of first sampling in the ith layer; Θ2i-gravimetric water content (%) at the time of second sampling in the ith layer; the ratio ρ/Γ- bulk specific gravity in which ρ-bulk density (g /cm³); Γ-density of water (g/ cm³) and D- depth of the ith layer of the soil (mm).

In 2013 at Barrackpore, the average weekly crop evapotranspiration (ETc) for JRO 524 ranged between 2.12 and 3.32 mm/day with the average of 2.72 mm/day during the jute growth period from week number 15 to week number 20 (9th Apr to 20th May). In this specific growth period, total ET_c was calculated as 114.24 mm (Fig. 6.14). The Kc value was computed on weekly basis using the Eq., $K_c = ET_c / ET_0$ and its plotting showed the exponential increasing trend between the meteorological standard week number 15 and 20 in the year of 2013 (Fig. 6.15) **(Source: JC 6.5, Contributors: D. Barman, D.K. Kundu, A.K. Ghorai and S. Mitra).**



a b

Fig. 6.14. Relationship between soil moisture content with (a) clay and (b) sand content in surface soil



a b

Fig. 6.15. Crop evapotranspiration (a) and crop coefficient (b) value of JRO 524 during the early growth period

7. Farm Mechanization and Post Harvest Technology

7.1. Farm mechanization

7.1.1. Development of improved ramie and sisal fibre extractor

A portable improved ramie and sisal fibre extractor was designed, developed and tested (Fig 7.1). The design of beater cylinder and fixed knife unit of the machine has been simplified to reduce the fabrication cost. The machine is operated either by single- phase 3 HP electrical motor or by 3.5 HP diesel engine. The machine provides improved processing of ramie and sisal with less energy input and reduced cost, in comparison to the existing "raspador" decorticator. The machine needs two workers for its operation; one for material feeding and manipulation into the machine and the other for collection and disposal of machine waste and extracted fibre. The throughput capacity and material capacity of ramie fibre extraction is about 300-350 kg plants/hr and 10-12 kg dry fibre/hr which is about 330-380 kg green leaves/hr and 12-14 kg dry fibre/hr respectively for sisal fibre extraction.

Fig 7.1: CRIJAF ramie and sisal fibre extractor

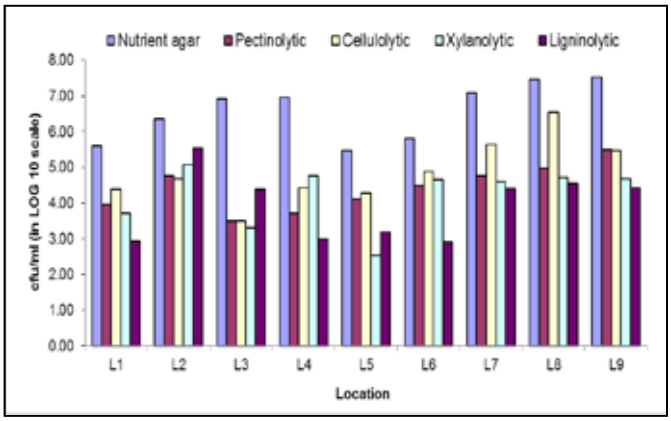
The CRIJAF ramie and sisal fibre extractor produces 55-60 % more fibre than existing 'raspador' decorticator with extraction efficiency of more than 90%. The overall dimension of the machine is 1.00m × 1.00m × 1.12m (L × W × H). The approximate weight of machine with electric motor is about 185 kg. The machine has been commercialized through a MoU between the Institute and the manufacturer **(Source: Exploratory, Contributor: R.K. Naik).**

7.2. Post Harvest Technology

7.2.1. Up scaling and refinement of microbial retting consortium and popularization of microbial formulation mediated retting among farmers

7.2.1.1 Up scaling and refinement of microbial retting consortium

Microbial diversity analysis of retting water samples (28 nos) collected from five districts of West Bengal *viz*., Hoogly, Nadia, Murshidabad, North 24 Parganas & South Dinajpur was carried out by using BIOLOG Eco plate (Fig. 7.2). The active microbial community first attacks the carbon source like D-xylose and D- galacturonic acid, the simplest form of pectin and xylan up to 8 hours for all the samples. After 24 hours of incubation, the second - predominant species was found to degrade some surfactant like tween 40 and tween 80 along with some species that can degrade amino acids like L-serine and L- asparagine. The species in the samples of North 24 Parganas utilized some carbohydrates in simpler and



L1= Goaldah1, 24 Parganas (N), L2= Goaldah2, 24 Parganas (N), L3=Goaldah3, 24 Parganas (N), L4= Goaldah4, 24 Parganas (N), L5= Goaldah5, 24 Parganas (N), L6= Farmania1, 24 Parganas (N), L7= Farmania2, 24 Parganas (N), L8 = Makaltala, 24 Parganas (N), L9 = Kashipur, 24 Parganas (N)

Fig 7.2: Microbial community structure in retting water at the time of fibre extraction in North 24 Parganas district

modified form (D-mannitol, glucose-1-phosphate and D, L-α-glycerol phosphate). About 90% of all the substrates were found to be utilized in all the samples after 72-96 hours of incubation, indicating the fact that the microbial communities were active and able for another round of retting operation.

Lignin degrading bacteria (54 nos.) were isolated from jute retting water by pour-plating on lignin agar using lignin sulphonate as the sole carbon source on the basis of colony morphology and colour pigments. Agar-plate assay of these isolates with 5 different dyes degraded the dyes as evidenced by the decolorisation around the colony but only 5 and 18 strains were found to degrade malachite green (MG) azure B (AzB) respectively. In quantitative assay of 18 strains using AzB @ 25mg/ltr in lignin broth, the most promising strain recorded 92% and complete degradation respectively after 72 hours and 6 days of incubation. Out of 26 pectinolytic strains isolated from retting water, 5 strains were identified using BIOLOG semi-automatic identification system as *Bacillus spp*., all of these isolates were cellulolytic, the most undesirable for jute retting **(Source: TMJ 6.0, Contributors: B. Majumdar, A. R. Saha, S. Sarkar and S. K. Jha).**

7.2.1.2 Promotion of microbial formulation mediated retting among farmers

A total of 650 large scale demonstrations of improved retting with CRIJAF microbial formulation "CRIJAF SONA" were carried out under farmers' field condition in 7 districts of West Bengal, Nagaon district of Assam, Katihar and Purnea districts of Bihar, Srikakulam district of Andhra Pradesh and Bahraich district of Uttar Pradesh (Fig 7.3,7.4,7.5 and 7.6). The retting duration was reduced by at least 6 to 7 days with microbial formulation compared to conventional retting. Fibre strength of treated samples was higher by 2.8 to 4.5 g/tex over the controlled samples. The impact analysis of the farmers' feedback revealed that 85% of the farmers were highly satisfied and 15% were satisfied on this technology ***(*Source: TMJ 6.0, Contributors: B. Majumdar, A. R. Saha, S. Sarkar and S. K. Jha*).***

Fig 7.3: Distribution of CRIJAF microbial formulation to farmer at Gouribati, Hooghly

Fig 7.4: Application of microbial formulation at Goaldah, 24 Parganas (N)

Fig 7.5: Application of microbial formulation at Nagaon, Assam

Fig 7.6: Monitoring of fibre obtained with microbial formulation by scientists at Goaldah, 24 Parganas (N)

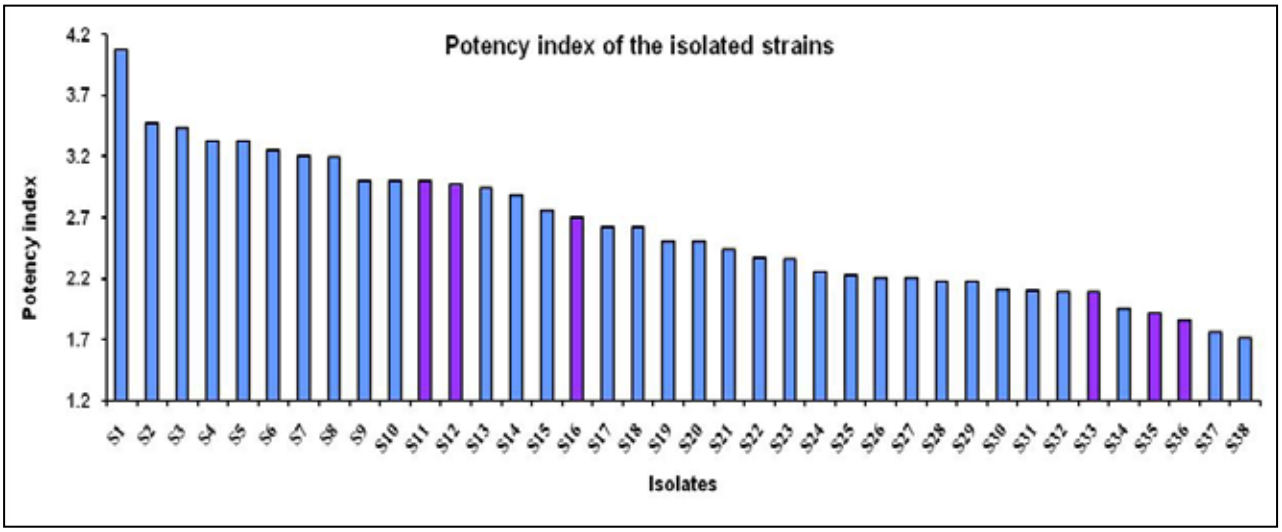


Fig 7.7: Potency index of the pectinolytic strains

7.2.2 Refinement and up scaling of eco-friendly microbial degumming technology in ramie

Thirty seven samples from soils of ramie growing area, agricultural wastes and jute retting water were collected from different districts of West Bengal (Coochbeher, Nadia, Hooghly, Murshidabad, etc.) and Assam to isolate the efficient pectinolytic bacterial microorganisms. Out of 386 colonies isolated, six pectinolytic bacterial strains producing least cellulase activity were selected on the basis of potency index value and it was observed that 6 bacterial strains efficiently degraded both the pectin sources (66-70% esterified citrus pectin and more than 80% esterified apple pectin). Highest polygalacturonase activity (PG activity) was recorded by the isolate S33 in both citrus and apple pectin, respectively. Moreover, four strains showed compatibility with each other whereas other two (S12 & S36) strains showed antagonistic effect with rest of the organisms. A combination of S16 and S11 strains (1:1 v/v) recorded highest polygalacturonase activity followed by S33+SS11 and S33+S16 combinations ***(Source: TMJ 8. Contributors: S. Mitra and A. Singh).***

8. Jute Informatics

JAFexpert is a web-based client-server, three-tier application, introduced by CRIJAF with information related to jute and allied fibre crops. A preliminary version of JAFexpert is available for jute crop (Fig. 8.1). In the next phase up gradation of the expert system (ES) for jute and development of ES for mesta crop has been taken up using ASP.Net as graphical user interface (GUI), C# for programming language and SQL Server at its backend database management tool.

Knowledge was obtained from domain experts, literature, e-resources, farmers and extension workers. Knowledge was then represented in the knowledge base in the form of database with a series of rules and algorithms. To fulfill the set of functional objectives, the conceptual analysis and goal analysis were done to determine the required phases and components of the system.

The system is device-friendly supporting mobile technology having integrated tool for content creation and maintenance. Forum in the ES provides a platform for interaction between users and experts. Within a forum's topic, each new discussion can be replied to multiple users simultaneously.

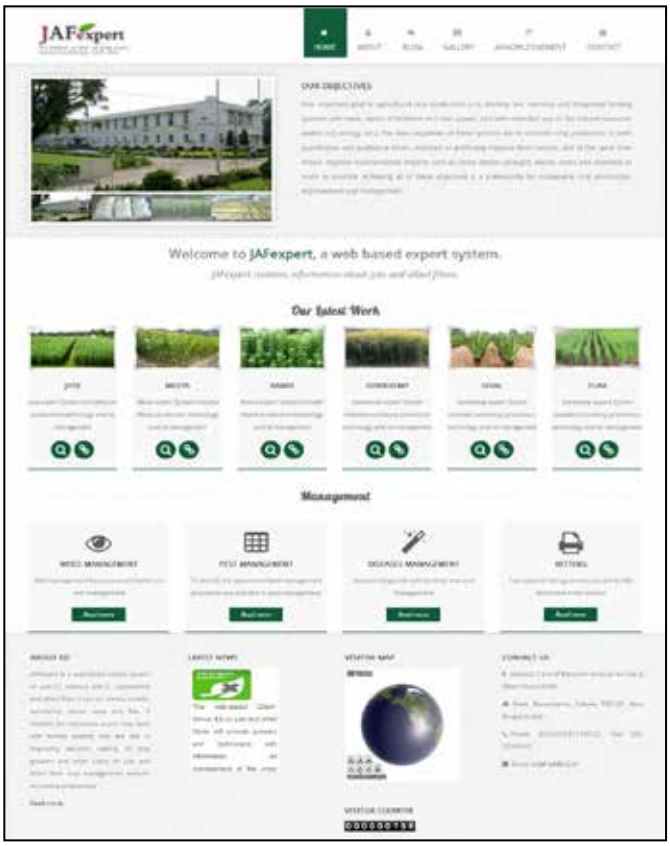


Fig. 8.1: Screen view of JAFepxert system

Development and modification of several parts of the JAFexpert, detailed below, are under process. The interface has been modified to make it device-friendly and accessible through mobile.

Database development and Updation: Database has been updated for forum (Online exchange of information) to exchange information through message board and community web application (profile creation with security and post your own blog) linking users to share their information.

Expert system development on roselle and kenaf: Database structure for roselle and kenaf has been created. Application programming interface (API) for mesta crop and integration of modules is in progress.

Upgradation of ES on jute: Entire database has been migrated to SQL server 2012 version from 2000 and adopted Visual Studio 2012 in place of 2005 version.

Preparation of Content Management System (CMS): CMS prepared for forum module to manage workflow in a collaborative environment to allow publishing, editing and modifying content as well as maintenance from a central interface.

SMS System: Interface has been developed for short message service to farmers. The database of farmers with their addresses and mobile numbers for SMS service has been prepared (Screen 6) and regularly farmers are receiving messages from the system (**Source: TMJ MM 1.8. Contributors: A. K. Chakraborty, C. S. Kar, Shamna A., A. K. Ghorai, R. K. De, D. Barman, K. Selvaraj, M. K. Tripathi, A. K. Sharma and A. K. Jha)**

Fig. 8.2: Screen view ofr JAFexpert Forum

9. Technology Assessment and Transfer of Technology

9.1. Technology assessment and transfer of technology

9.1.1. Frontline demonstration on jute

Frontline demonstration on latest high yielding varieties of jute and other improved production technologies were conducted in villages of Nadia, North 24 Parganas, Malda, Murshidabad and Hooghly districts of West Bengal through the extension centres of the institute in collaboration with Directorate of Jute Development, Ministry of Agriculture an Government of India under Mini Mission-II (MM-II) of Jute Technology Mission Programme. Altogether, 234 demonstrations covering 47.34 ha on jute were conducted in the above districts (Table 9.1).

FLD on jute: Farmers-Scientist interaction

FLD on jute: full grown jute, ready for harvest

Table 9.1 Area covered under each component of frontline demonstration programme

Name of Village	No. of farmers	Improved varieties	Multi row seed drill	Integrated weed management	Drought management	Total
Area in ha						
Gopalpur (Nadia)	43	1.06	3.80	5.00	0.15	10.01
Gouribati (Hoogly)	54	1.00	3.80	5.00	0.15	9.95
Debkundu (Murshidabad)	56	0.66	-	5.13	2.49	8.28
Khairtala (Malda)	40	0.81	1.06	7.30	-	9.17
Goaldah (North 24 Parganas)	41	0.58	2.90	6.30	0.15	9.93
Total	234	4.11	11.56	28.73	2.94	47.34

9.1.1.1. Varietal evaluation

The tossa jute varieties i.e. JRO 204 (Suren), JRO 2407 (Samapti), CO 58 (Sourav), JRO 128 (Surya) and JRO 8432 (Shakti) along with check JRO 524 (Navin) were demonstrated for assessing yield performance in the farmer's field in 4.11 ha area in five districts. Sowing was done under irrigated condition in the month of April-May. All recommended package of practices were followed. The highest fibre yield of jute irrespective of the locations (Table 9.2) was obtained from the variety JRO 204 (30.81 q/ha) followed by JRO 2407 (29.46 q/ha), JRO 128 (29.24 q/ha), JRO 8432 (28.40 q/ha) and CO 58 (28.37 q/ha). Highest net return per hectare was obtained from JRO 204 (Rs. 25, 587/ha) followed by JRO 2407 (Rs. 21,700/ha), JRO 128 (Rs.21, 084/ha), JRO 8432 (Rs.18, 661/ha) and CO 58 (Rs.18,574/ha). Check variety (JRO 524) yielded 28.63 q/ha fibre giving a net return of Rs.19, 711 against Rs.62, 886 cost of cultivation. Regarding benefit-cost ratio, JRO 204 (1.40) gave maximum benefit followed by JRO 2407 (1.34), JRO 128 (1.33), JRO 8432 (1.29) and CO 58 (1.29).

Table 9.2 Economics of cultivation of jute varieties

Variety	Fibre yield (q/ha)	Cost of cultivation (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	B:C ratio
JRO 204 (Suren)	30.81	63, 273	88, 860	25, 587	1.40
JRO 2407 (Samapti)	29.46	63, 273	84, 973	21, 700	1.34
CO 58 (Sourav)	28.37	63, 273	81, 847	18, 574	1.29
JRO 128 (Surya)	29.24	63, 273	84, 357	21, 084	1.33
JRO 8432 (Shakti)	28.40	63, 273	81, 934	18, 661	1.29
JRO 524*(Navin)	28.63	62, 886	82, 597	19, 711	1.31

*Check variety; Price of jute fibre: Rs. 1,900-2,400/q and jute stick: Rs.300-500/q

9.1.1.2. Integrated weed management

In order to reduce cost of weeding and increase profitability of jute cultivation, the demonstrations on pre-emergence herbicide *i.e.* application of pretilachlor @3 ml/l and post-emergence herbicide (butachlor @ 20 kg/ha, quizalofop ethyl @1.5ml/l) and mechanical weeding by nail weeder was laid in the farmer's field in 28.73 ha in 5 districts (Table 9.3). Demonstration on integrated weed management resulted in 0.60-2.94 q/ha more fibre yield over farmer practice (22.86-30.12 q/ha). Maximum gain in fibre yield was from application of quizalofop ethyl (0.72-2.65 q/ha) followed by nail weeder (0.93-2.00 q/ha), butachlor (0.72 q/ha) and pretilachlor (0.60 q/ha). Maximum saving on cost of human labour was from nail weeder (Rs. 4,088-10,948/ha) followed by quizalofop ethyl (Rs. 3,201-9,331/ha), butachlor (Rs. 3,402/ha) and pretilachlor (Rs. 1,658/ha). Across the centres and weed management technologies, maximum net return in absolute term was obtained at Manikchak in case of nail weeder (Rs. 14,820/ha). Application of quizalofop ethyl gave maximum net return in absolute term at Goaldah (Rs. 16,092/ha). It was followed by Gouribati (Rs. 12,014/ha), Gopalpur (Rs. 9,060/ha) and Debkundu (Rs. 4,496/ha) over farmer's practice. The use of butachlor and pretilachlor yielded a net return of Rs. 6,630/ha and Rs. 4,113/ha, respectively over farmer's practice at Devkundu centre. This variation was due to varying rate of labour charges, fibre and stick price.

Table 9.3 Economics of jute cultivation under integrated weed management (Rs./ha)

Location/Particulars	IC	HLC	TCC	FY (q/ha)	GR	NR	B:C ratio
Gopalpur							
Quizalofop ethyl	12,217	49,316	61,533	29.63	77,449	15,896	1.25
FP	10,138	58,570	68,708	26.98	75,544	6,836	1.09
Gauribati							
Quizalofop ethyl	11,970	51,863	63,833	29.87	88,177	24,284	1.38
FP	9,370	58,354	67,724	26.93	80,444	12,720	1.18
Devkundu							
Butachlor	9,685	47,898	57,585	27.75	76,313	18,728	1.32
Quizalofop ethyl	12,060	48,099	60,159	27.91	76,573	16,594	1.27
Pretilachlor	10,130	49,642	59,772	27.63	75,983	16,211	1.27
Nail weeder	9,651	47,212	56,863	28.25	77,688	20,824	1.36
FP	10,935	51,300	62,235	27.03	74,333	12,098	1.19

Manikchak							
Nail weeder	7,947	41,266	49,213	25.56	66,456	17,243	1.42
FP	7,399	52,214	59,613	23.86	62,036	2,423	1.10
Goaldah							
Quizalofop ethyl	8,689	61,085	69,774	32.12	97,163	27,389	1.39
Nail weeder	7,672	61,380	69,052	31.05	98,927	24,875	1.17
FP	9,300	70,416	79,716	30.12	91,013	11,297	1.14

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 – Farmers' practice

9.1.1.3. Line sowing

Demonstrations on manual four row seed drill (MRSD) were conducted in an area of 11.56 ha across the villages (Table 9.4). It helped in increasing the fibre yield by 1.38-2.28 q/ha and also saved the cost of human labour in jute cultivation by Rs. 5,234 - 5,590/ha over farmer's practice. The effect of this intervention was maximum at Gopalpur (Rs. 10,954/ha) followed by Manikchak (Rs. 8,747/ha), Gauribati (Rs. 8,309/ha) and Goaldah (Rs. 6,894/ha).

FLD on jute: line sowing

Jute farmer grown paddy after jute

Table 9.4 Economics of jute cultivation (Rs./ha) under line sowing through multi row seed drill (MRSD)

Location/Particulars	IC	HLC	TCC	FY (q/ha)	GR	NR	B:C
Gopalpur							
MRSD	12,614	52,980	65,594	29.78	83,834	17,790	1.27
FP	10,138	58,570	68,708	26.98	75,544	6,836	1.09
Gauribati							
MRSD	9,265	53,120	62,385	28.31	83,414	21,064	1.33
FP	9,370	58,354	67,724	26.93	80,444	12,720	1.18
Manikchak							
MRSD	8,068	46,906	54,974	25.44	64,144	11,170	1.20
FP	7,399	52,214	59,613	23.86	62,036	2,423	1.10
Goaldah							
MRSD	12,404	64,904	77,308	31.57	95,499	18,191	1.23
FP	9,300	70,416	79,716	30.12	91,031	11,297	1.14

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

9.1.1.4. Drought management practices

Frontline demonstration on 3 drought management practices was laid out in 2.94 ha for jute (Table 9.5). Highest fibre yield enhancement was obtained from application of sulphur @30kg/ha over recommended dose of fertilizer (RDF) i.e. 60:30:30 (3.39-5.39 q/ha) followed by augmented nutrition *i.e.* 80:40:40 (4.10 q/ha) and RDF with single irrigation (1.54 q/ha). In case of sulphur application along with RDF the highest net return in absolute term was achieved at Gopalpur (Rs.12,900/ha) followed by Gouribati (Rs.7,382/ha), Devkundu (Rs. 7,066/ha) over farmer's practice. In case of augmented nutrition *i.e.* 80:40:40 and RDF with single irrigation Rs. 3,508/ha and Rs. 3,285/ha was received respectively.

Table 9.5 Economics of jute cultivation under drought management practices (Rs./ha)

Location/ Particulars	IC	HLC	TCC	FY (q/ha)	GR	NR	B:C
Gopalpur							
RDF + Sulphur	14,318	48,612	62,930	28.46	79,688	16,578	1.18
FP	10,638	50,040	60,878	23.12	64,736	3,858	1.06
Gauribati							
RDF + Sulphur	11,177	48,017	59,194	29.37	80,768	21,574	1.36
FP	9,650	47,400	57,050	24.16	71,242	14,192	1.24
Devkundu							
RDF + single irrigation	10,200	46,775	56,975	25.73	70,758	13,783	1.24
RDF + Sulphur	14,103	44,068	58,171	27.54	75,735	17,564	1.30
Augmented nutrition	14,550	51,469	66,019	29.10	80,025	14,006	1.21
FP	11,085	44,940	56,025	24.19	66,523	10,498	1.18
Goaldah							
RDF + Sulphur	14,305	64,336	78,641	28.71	86,849	8,207	1.10
FP	12,178	53,896	66,074	23.32	70,543	4,469	1.06

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

9.1.1.5. Farmers' feedback

Farmers were satisfied with the performance of technological interventions implemented on their fields. They were convinced with the performance of integrated weed management through mechanical as well as pre and post-emergence herbicides, multi row seed drill and drought management practices. Weed management through herbicide reduced the labour requirement and also saved their time. They were very much satisfied with the performance of nail weeder as it reduced the dependency over chemicals and helped in reducing the effect of composite weeds. Finally, all these methods helped in reducing the cost of cultivation in comparison to their traditional practice. The farmers also responded to application of elemental sulphur in rainfed condition as it was simple and compatible to their production system and profitable too. **(Source: JEXA 4.7; Contributors: S. Kumar, S.K. Jha, S. Sarkar and Shamna A.)**

9.2. Assessment of jute based multiple cropping sequences in farmers' fields of major jute growing districts of West Bengal

In view to demonstrate the advantage of multiple cropping systems for maximization of profit from the same unit of area, various jute based cropping sequences under irrigated condition were assessed. Altogether, 60 demonstrations were conducted at the farmers' field during the year (2013-14). Size of the plots were 400 m^2 for each trial at five extension centres *i.e.* Gopalpur,

Goaldah, Manikchak, Debkundu and Gouribati from Nadia, North 24 Parganas, Malda, Murshidabad, and Hooghly districts of West Bengal, respectively.

The performance of two major jute-based multiple cropping sequences, i.e. Jute – Paddy –Mustard sequences in Goaldah village (North 24 Parganas) and Gouribati village (Hooghly) and Jute – Paddy – Wheat sequences in Debkundu village (Murshidabad), Manikchak village (Malda) and Gopalpur village (Nadia) were evaluated. The demonstrated varieties were jute (cv. JRO 204), paddy (cv. IET 4094), wheat (cv. UP 262) and mustard (cv. B 9). The crop-wise demonstrations were: 60 trials on jute as first crop and 60 trials on kharif paddy as second crop. For the third crops, 24 trials on mustard and 36 trials on wheat. Crop management and protection practices were followed as per the requirement (Table 9.6 & 9.7).

Table 9.6 Location-specific yield and benefit cost analysis of the jute based multiple cropping sequences

Name of the extension centre	Cropping Sequences	Yield (q/ha)	No of demo.	Cost of cultivation (Rs. /ha)	Gross return (Rs. /ha)	Net return (Rs. /ha)	B : C ratio	Rank
Goaldah	Jute	30.60	12	74308	98649	24341	1.33	III
	Paddy	33.33	12	40858	60000	19142	1.50	
	Mustard	15.14	12	33137	52906	19769	1.60	
	Total			148303	211555	63252	1.43	
Gauribati	Jute	29.60	12	62385	80784	18399	1.29	IV
	Paddy	35.00	12	64964	84708	19744	1.30	
	Mustard	10.04	12	36020	40167	4147	1.12	
	Total			163369	205659	42290	1.26	
Gopalpur	Jute	32.00	12	65594	81070	15476	1.24	II
	Paddy	39.87	12	57962	73833	15871	1.27	
	Wheat	45.00	12	50567	100800	50233	1.99	
	Total			174123	255703	81580	1.47	
Debkundu	Jute	27.91	12	60159	85581	25422	1.42	I
	Paddy	40.52	12	55113	76500	21394	1.39	
	Wheat	48.25	12	53845	110492	56647	2.05	
	Total			169117	272573	103463	1.61	
Manikchak	Jute	25.44	12	54974	69960	14986	1.42	NA
	Paddy	00.00	12	10125	000	000	000	
	Wheat	40.33	12	56184	90319	34135	1.61	
	Total			121283	160279	49121	1.32	

Jute – Paddy –Mustard performed better at Goaldah (Swarupnagar), North-24 Parganas than Gouribati(Tarakeswar), Hooghly district. Similarly, the performance of Jute – Paddy –Wheat has been found better at Debkundu (Beldanga), Murshidabad district than Gopalpur (Karimpur), Nadia district and Manikchak (Manikchak) of Malda district.

Table 9.7 Overall evaluation of yield and benefit cost analysis of the jute based crop sequence

Crop Sequences	No. of demo	Yield (q/ha)	Cost of cultivation (Rs. /ha)	Gross return (Rs. /ha)	Net return (Rs. /ha)	B : C ratio	Rank
Jute	24	30.10	68347	89717	21370	1.31	II
Paddy	24	34.17	52911	72354	19443	1.4	
Mustard	24	12.59	34579	46537	11958	1.36	
Total			155837	208608	52771	1.34	
Jute	36	28.45	60242	78870	18628	1.31	I
Paddy	24	26.80	41067	50111	12422	1.22	
Wheat	36	44.53	53532	100537	47005	1.88	
Total			154841	229518	78055	1.48	

Furthermore, overall performance of each cropping sequence irrespective of locations (Table 2), it is revealed that Jute-Paddy-Wheat (1.48) performed better than Jute-Paddy-Mustard (1.34) with higher benefit cost ratio, higher net return and lower cost of cultivation. **(Source: JEXA 4.8; Contributors: S.K. Jha, S. Sarkar, Shamna, A and S. Kumar)**

9.3. Attitude and perception of farmers towards ICT based extension

A study in the non-sample area for pretesting the schedule on farmers' opinion about ICT based extension (Table 9.8) indicated that existing infrastructures of ICTs are not enough to meet the needs of the farming community (80%), ICTs are potential tools to reach the needy farmers (73.33%), ICTs cannot deliver personalised information (70.0%), ICTs provide possible solutions to the present agricultural situation (66.66%), ICT based pest/disease outbreak warning system facilitate farmers to take preventive measures (63.33%), expert advice makes the farmers enterprise/activities productive (63.3%).

Table 9.8 Farmers' opinion about ICT based extension (N=30)

Statements	Respondents	
	Number	% age
ICTs provide possible solutions to the present agricultural situation	20	66.66
ICTs cannot meet location specific needs of the farmers	8	26.66
ICTs are potential tools to reach the needy farmers	22	73.33
Farmers' feedback is fast through ICTs than traditional methods	6	20.00
Illiteracy will not deter farmers in availing ICT services	16	53.33
ICTs cannot deliver personalized information	21	70.00
ICT based extension services assist the farmer in planning and decision making aspects in agriculture	10	33.33
Farmers can get remunerative prices to their produce through ICT based market intelligence	16	53.33
'ICT services' is a distant dream for resource poor farmers	12	40.00
Expert advice makes the farmers enterprise/activities productive	19	63.33
All kinds of information exchange are possible only through ICTs	9	30.00
Existing infrastructure of ICTs is not enough to meet the needs of the farming community	24	80.00
ICT based Pest/disease outbreak warning system facilitate farmers to take preventive measures	19	63.33
Weather forecasting through ICTs assists farmers in timely decisions	12	40.00

An analysis on the farmers' extent of accessibility of ICT tools in the sample area with N=60, revealed that only 8 % of the farmers have access to computer, 2 % have internet access while 92 % farmers have access to television and all the farmers have cell phones. This result indicates that the ICT based extension can make use of television and mobile phones as the quicker medium for message transmission to maximum number of farmers keeping the message intact. **(Source JEXA 5.1, Contributors: Shamna. A and A.K. Chakraborty)**

9.4. Performance of new tossa jute varieties in farmers' field

Experiments were conducted with new tossa jute varieties i.e., JRO 204 (Suren), JRO 2407 (Samapti), CO 58 (Sourav), JRO 128 (Surya) and JRO 8432 (Shakti) at Goaldah (22.82 N, 88.87 E), Swarupnagar, North 24 Parganas; Gouribati (22.88°N, 88.01°E), Tarakeswar, Hooghly; Debkundu (23.93°N, 88.62°E), Beldanga, Murshidabad; Gopalpur (23.97°N, 88.25°E), Karimpur, Nadia and Khairtala (25.08°N, 87.90°E), Manikchak, Malda in farmers' participatory mode to analyse the yield performance as compared to the existing popular variety.

Irrespective of variety, the highest jute productivity was obtained at Tarakeswar, Hooghly (32.2 q/ha) followed by the fibre yield obtained at Beldanga, Murshidabad (30 q/ha), Karimpur, Nadia (29.9 q/ha) and Swarupnagar, North 24 Parganas (29.5 q/ha) (Table 9.10)

Malda (Manikchak) recorded the lowest jute productivity (25.1 q/ha). In this location the crop growth was satisfactory up to 75 DAS (plant height 198-207 cm). But during mid-July (2013), due to heavy downpour and inundation, the jute plant height were restricted as observed in plant height values recorded at 105 DAS and beyond (Table 9.11). The farmers of Malda could not harvest the jute crop at 120 days crop age due to standing water; whereas, they waited until the water recedes to a certain level and the jute was harvested at 134 days crop age. The water stagnation after 75 DAS was the major cause for comparatively lower fibre yield at Malda for all the tossa jute varieties.

Regarding the productivity of newer tossa varieties, it was observed that JRO 204 recorded highest average productivity of 30.87 q/ha followed by CO 58 (28.44 q/ha) and JRO 2407 (28.36 q/ha).

Table 9.9 Plant height (PH) and basal diameter (BD) of tossa jute at harvest

Locations	JRO 2407		CO 58		JRO 128		JRO 8432		JRO 204	
	PH (cm)	BD (cm)	PH (cm)	BD (cm)	PH (cm)	BD (cm)	PH (cm)	BD (cm)	PH (cm)	BD (cm)
North 24 Parganas	343	1.70	346	1.69	337	1.66	338	1.67	-	-
Hooghly	301	1.44	302	1.43	295	1.40	308	1.47	-	-
Nadia	256	1.27	252	1.25	-	-	-	-	274	1.36
Murshidabad	373	1.85	366	1.78	-	-	-	-	375	1.84
Malda	236	1.21	226	1.21	-	-	-	-	261	1.30

For all the intensively jute growing districts of West Bengal, the choice of tossa variety should be JRO 204 (popularly known as *Suren*) as the said variety gave the highest average productivity of fibre (30.87 q/ha) & sticks (72.7 q/ha) and the highest profitability (average B:C ratio of 1.61). **(Source: JEXA 5.2, Contributors: S. Sarkar, S.K. Jha, S. Kumar, Shamna, A, B. Majumdar, C. Biswas and B.S. Gotyal)**

Table 9.10 Comparative performance of different tossa jute varieties at different jute growing districts of West Bengal

Variety	Swarupnagar, North 24 Parganas			Tarakeswar, Hooghly			Karimpur, Nadia			Beldanga, Murshidabad			Manikchak, Malda			Mean fibre yield of variety (q/ha)	Mean Stick yield of variety (q/ha)
	FY	SY	F:S	FY	SY	F:S	FY	SY	F:S	FY	SY	F:S	FY	SY	F:S		
JRO 2407	29.9	70.9	0.4220	31.9	75.5	0.4225	29.3	69.0	0.4246	29.5	69.4	0.4251	21.2	49.9	0.4248	28.36	66.8
CO 58	27.0	63.9	0.4225	32.8	77.6	0.4227	28.9	67.9	0.4256	29.4	68.6	0.4286	24.1	56.5	0.4265	28.44	66.9
JRO 204	-	-	-	-	-	-	31.4	74.0	0.4243	31.1	72.5	0.4290	30.1	70.2	0.4288	30.87	72.2
JRO 128	30.8	73.0	0.4222	31.6	73.9	0.4276	-	-	-	-	-	-	-	-	-	*	*
JRO 8432	30.3	71.9	0.4214	32.6	77.2	0.4223	-	-	-	-	-	-	-	-	-	*	*
LM	29.5	69.9	-	32.2	76.1	-	29.9	70.3	-	30.0	70.2	-	25.1	58.9	-	-	-

* only two centres grew the variety (JRO 128 and JRO 8432)
FY= Fibre yield in q/ha; SY= Stick yield in q/ha, and F:S= Fibre: stick ratio; LM = mean yield over location

Table 9.11 Changes in jute plant height and basal diameter at Manikchak, Malda over the growth stages

Variety	40 DAS		75 DAS		105 DAS		134 DAS	
	PH (cm)	BD (cm)	PH (cm)	BD (cm)	PH (cm)	BD (cm)	PH (cm)	BD (cm)
JRO 204	55.8	0.32	206.9	1.16	225.5	1.21	261.0	1.30
CO 58	53.6	0.30	197.7	1.10	219.5	1.18	226.2	1.21
JRO 2407	51.2	0.29	201.2	1.12	222.2	1.19	235.3	1.21

DAS: days after sowing

Krishi Vasant: CRIJAF participated in the Krishi Vasant (National Agricultural Show) on 9-13th February, 2013 at CICR, Nagpur. The Institute conducted live demonstration of improved varieties of jute (4), roselle (1), kenaf (1), flax (2), sunnhemp (2) and ramie (2) for awareness of the farmers from different states about the bast fibre crops. CRIJAF as the nodal Institute for the state of West Bengal reviewed, shortlisted and forwarded the videos and other printed extension materials in the regional language and Hindi for documentation. Besides, the Institute showcased the frontier technologies for improved cultivation of jute and allied fibre crops through the exhibition and also participated in the farmers-scientist interaction in the occasion of Krishi Vasant.

Dr. S. Ayyappan, Hon'ble DG, ICAR visiting CRIJAF stall at Krishi Vasant, 2014, Nagpur

Farmers visiting crop cafetaria of CRIJAF at Krishi Vasant, Nagpur

Dr. N. Gopalakrishnan, ADG (CC), ICAR and Dr P.K. Chakrabarty, ADG (PP & Biosafety), ICAR visiting CRIJAF stall at Krishi Vasant, 2014, Nagpur

Farmers' Field School at Swarupnagar, North 24 Pgs

Farmers' Field School at Manikchak, Malda

Dr. S. Satpathy delivering lecture in National training on improved production technology of jute and allied fibres

Dr. P.G. Karmakar addressing the trainees of National training on improved retting methods of jute

10. Tribal Sub Plan (TSP)

The TSP activities were carried out on jute, ramie and sisal with an objective to bring more area under these fibre crops in tribal dominated areas with improved technological intervention to enhance livelihood security of the tribal people. The TSP activities on jute was mainly piloted in North 24 Parganas, Nadia and Dakshin Dinajpur districts of West Bengal. Activities pertaining to sisal were concentrated in Jharsuguda and Sambalpur districts of western Odisha and also been initiated in Ranchi district of Jharkhand in collaboration with Ramakrishna Mission Ashram, Ranchi. TSP activities on ramie were at Barpeta and Chirang district of Assam, West Siang district of Arunachal Pradesh, Tura district of Meghalaya and Jharnapani of Nagaland. Through TSP emphasis was given on generation and distribution of quality planting materials, expansion of area under the fibre crops, transfer of technology and human resource development for economic upliftment and enhancement of livelihood security of tribal farmers.

10.1. TSP to enhance the livelihood security of tribal farmers of North 24 Parganas

With an objective to enhance the livelihood security of tribal farmers, the tribal sub plan is being implemented at Makaltala and Farmania villages of Habra-1 block of North 24 Parganas district from July-August 2013. A detailed focussed group interview and survey revealed that there are 110 tribal families at Makaltala village and 30 tribal families at Farmania. Majority of these tribal families are dependent on agriculture and allied activities as source of their income. To increase the income from agriculture and allied activities, interventions were planned to be implemented at Makaltala and Farmania villages of North 24 Parganas Distt.

10.1.1. Microbial retting

For getting quality fibre by retting jute in a stagnant water source for 2-3 times, powder based microbial formulation (CRIJAF Sona) developed by CRIJAF showed promise in varied agro-climatic conditions. On farm trainings and demonstrations on use of microbial retting formulations were conducted in both the villages during July, 2013 among the tribal farmers (Fig. 10.1 & 10.2). In the training cum demonstration, 40 tribal farmers participated. The packets of retting formulations were distributed. In this method retting duration was reduced by 6-7 days and farmers got better quality fibre which fetch higher price for them. Tribal farmers responded well to this retting technology and were eager to adopt the microbial retting formulation during the coming year also. **(Source: B. Majumdar, S. Sarkar, S.K. Jha, and Shamna, A)**

Fig. 10.1 Training on improved jute retting technology

Fig. 10.2 Demonstration of improved microbial jute retting

10.2. TSP on jute at Dakshin Dinajpur

10.2.1. Dissemination of improved microbial jute retting technology

Survey and interaction was conducted to identify 30 tribal farmers from 6 villages of Tapan block for implementation of the programme. In the initial year of the programme, training and demonstration on improved microbial retting of jute was organized for 2 days during 16-17 July, 2013 (Fig. 10.5) at Hazrabari unit of Dakshin Chakbhabani Rural Awareness Society (DCRAS). Microbial jute retting formulation packets

were distributed among all the 50 tribal farmers. Later, interaction with the beneficiary farmers for feedback of the improved microbial retting technology revealed that farmers are satisfied with the technology and they earned at least Rs. 200-400 more per q of jute fibre obtained in this method as compared to the conventional retting **(Source: S. Sarkar and B. Majumdar).**

Fig. 10.3 Training for tribal women at Makaltala

Fig. 10.4 Training of tribal farm women at CRIJAF

Fig 10.5 Training and demonstration of improved retting technology for the tribal farmers of Tapan block of Dakshin Dinajpur

10.3. TSP on sisal in Odisha

10.3.1. Area expansion of sisal

Area expansion programme for sisal was undertaken under TSP in 6 tribal villages of Jharsuguda and Sambalpur districts of Odisha. In the programme, 31 tribal farmers have been identified and benefitted through expansion of sisal plantation in 17.11 ha area (Fig 10.6 - 10.9). Among the tribal farmers, 61% have land area of <0.50 ha, 16% have land area of 0.5 – 1.0 ha and 23% of them have >1.0 ha land area **(Source: A.K. Jha and D.K. Kundu).**

Fig. 10.6 Tribal farmer with his sisal plantation

Fig. 10.7 Sisal intercropped with pulse in tribal farmers' fields

Fig. 10.8 Training of tribal farmers of Odisha on improved sisal production technology

Fig. 10.9 Farmers awareness camp about sisal for the tribal farmers of Ranchi

10.4. TSP on ramie in NE states

10.4.1. Generation and distribution of planting materials

Quality planting material is the key for establishment of ramie plantation. Ramie Research Station (RRS), Sorbhog had taken special initiative to produce sufficient quantity of quality planting materials for 20 ha of ramie plantation in Arunachal Pradesh and 5 ha in Chirang district of Assam under TSP. Director General, ICAR and Vice Chancellor, Central Agricultural University, Imphal distributed ramie planting materials among the tribal farmers (Fig. 10.10 & Fig. 10.11) on 26 March, 2014 at KVK, Tura, Meghalaya ***(Source: A.K. Sharma and S. Satpathy).***

Fig. 10.10 Hon'ble DG, ICAR distributing ramie planting materials among the tribal farmers

Fig. 10.11 Demonstration of ramie planting to the tribal farmers

10.5. TSP on Soil Test Crop Response (STCR)

10.5.1. FLD on pulses

FLD on lentil was undertaken in 15.07 ha area of 90 tribal farmers' fields in Bankura and 3.33 ha area of 11 farmers in Nadia district of West Bengal **(Source: A.R.Saha).**

10.6. TSP under AINP on JAF

Field demonstrations on improved microbial retting of jute and seed production of *olitorius* jute had been conducted under AINPJAF at RARS, Nagaon (Assam) and UBKV, Coochbehar(West Bengal) centres, respectively.

At Nagaon, the microbial retting programme had been conducted with *tossa* jute variety Tarun at Benganaati and Ouguri villages of Nagaon and the demonstrations were taken up in 10 ha land involving 50 tribal farmers of these villages. The retting was conducted in natural water bodies and the duration in conventional method ranged between 21 to 24 days whereas in microbial retting, the duration varied 14 to 16 days, thereby indicating a reduction in retting duration by 7 to 8 days in natural in both the locations. Moreover, the general

Table. 10.1. HRD for tribal farmers conducted under TSP

Event	Date	Place	No. of trainees	Remark
Training programme on '*Improved production technology of sisal*'	13-15th June, 2013	SRS, Bamra	25	Institute TSP
Training programme on '*Improved microbial retting technology*'	16-17 th July, 2013	CRIJAF, Barrackpore	50	Institute TSP
Training and demonstration on *improved microbial jute retting technology*	27 th July, 2013	TSP Village of Makaltala	40	Institute TSP
Training on '*Jute seed production*'	12 th Sept, 2013	UBKV, Pundibari	100	AINP-JAF
Training programme on '*Entrepreneurship development through diversified use of jute fibre and fabrics*'	21-24 th Sept, 2013	CRIJAF, Barrackpore	30	Institute TSP
Training programme on '*Improved production technology of ramie*'	23-25 th Oct, 2013	RRS, Sorbhog	11	Institute TSP
Exposure visit-cum-training	11 th Nov, 2013	SRS, Bamra	11	Institute TSP
Training programme on '*Fertilizer recommendation based on soil test and target yield approach for improved crop productivity*'	18-20 th Nov, 2013	CRIJAF, Barrackpore	26	STCR
Training programme on '*Improved jute seed production technology*'	25 th Nov, 2013	KVK, Dakshin Dinajpur	28	Institute TSP
Training programme on '*Jute handicrafts*'	26-30 th Nov, 2013	KVK, Dakshin Dinajpur	30	Institute TSP
Training on *making of decorative and fancy jute bags*	4-10 th March, 2014	TSP village of Makaltala	25	Institute TSP
Training programme on '*Improved production technology of sisal*'	13-15 th Mar, 2014	SRS, Bamra	25	Institute TSP
Training programme on '*Prescription based fertilizer application on soil test and target yield basis for improved crop productivity*'	26 th Mar, 2014	CRIJAF, Barrackpore	51	STCR
Training programme on '*Improved production and post-harvest technologies of jute for tribal farmers*'	28-29 th Mar, 2014	CRIJAF, Barrackpore	25	AINP-JAF
Training programme on '*Soil test and target yield basis fertilizer application for higher returns*'	31 th Mar, 2014	CRIJAF, Barrackpore	40	STCR

observation of the farmers was that separation of fibre from the bark was relatively easier in the consortium treated plants and the attack of aquatic insects was less in microbial treated plants as compared to the conventionally retted ones. The farmers involved in this programme were satisfied with the fibre colour and lesser retting duration.

At Coochbehar, the seed production of *tossa* jute variety S 19 was taken up in 25 ha farmers' field at Tufanganj (Coochbehar ditrict) and Kumargram (Jalpaiguri district) involving 100 tribal farmers. The demonstrations were conducted on the high lands belonging to the tribals which included their newly planted orchards and other unused lands in the forest areas. The sowing was initiated in August 2013 and it extended upto September 2013. The late sowing in Mid-August to late September, encouraged profuse branching in the seed crop and did not require any de-topping. As the forest areas of the tribal farmers at Kumargram were inaccessible, the TSP programme was initiated there in collaboration with a local NGO named "Tufanganj Anwesha Welfare Society (TAWS)" which was already operating in those areas. The entire seed production was taken up under certification programme by the state seed certification agency with prior permission and registration. The entire lot of the certified *olitorius* (variety S 19) jute seed was bought by the NGO TAWS @ Rs 60.00 per Kg. The same seed had been sorted and packed under the supervision of scientists of AINP unit of UBKV for subsequent use in the jute fibre production programme under TSP in 2014.

One leaflet on jute seed production technology titled "*Uttarbange pater beej utpadan: kichu proyojoniyo tathya*" in Bengali had been published and distributed to the tribal farmers for creating awareness among the farmers. **(Source: S. Mitra)**

10.7. HRD programmes under TSP

Human resource development programmes taken up under the TSP primarily aimed to impart the knowledge of improved technologies to the tribal farmers to ease the adoption process. The training programmes conducted in this aspect are as follows (Table 10.1, Fig. 10.3 & Fig. 10.4).

11. AINP on Jute and Allied Fibres

All India Network Project on Jute & Allied Fibres functions through 9 SAUs and 4 ICAR institute-based centres with its Head Quarter at CRIJAF, Barrackpore. During the year 2013-14, total 53 projects comprising of 225 trials were conducted on jute (*C. capsularis* and *C. olitorius*), mesta (*Hibiscus cannabinus* and *Hibiscus sabdariffa*), sunnhemp (*Crotalaria juncea*), flax (*Linnum usitatissimum*), ramie (*Boehmeria nivea*) and sisal (*Agave* sp.) under crop improvement, crop production and crop protection programmes.

11.1. Crop Improvement

During the year 2013-14, a total of 22 projects comprising of 123 trials were evaluated on jute and allied fibre crops at various centres under crop improvement programme. Ten projects for jute, seven for mesta, three for sunnhemp and one each for flax and ramie were evaluated which includes germplasm evaluation, national hybridization programme, IETs, AVT-Is, AVT-IIs and adaptive trials at different centres.

11.1.1. Varieties identified for release

Three varieties *viz*. JRC-9057 (Ishani) of white jute, JRKM 9-1 (Satyen) of kenaf and R-1411 (Hazarika) of ramie have been identified for release during the 27th Annual Workshop held at CRIJAF, Barrackpore. The release proposal of these varieties has already been furnished to the Central Sub-Committee on Crop Standards, Notification and Release of Varieties (CSCSNRV) vide letter no. F.No.4 (38)/13-14/926, dated 16.09.2013.

Beside, one variety each in *tossa* jute (JROG-1), kenaf (JBMG-4), sunnhemp (JRJ-610), flax (JRF-2) and two varieties of roselle (CRIJAFR-2 and CRIJAFR-8) have been identified for release during the 11th Annual Group Meeting held during February, 28th to 1st March, 2014 at UBKV, Pundibari, Coochbehar.

11.1.2. Germplasm Evaluation

Seventy-five accessions each in *tossa* (*C. olitorius*) and white (*C. capsularis*) jute, 160 accessions in roselle (*H. sabdariffa*) and 75 germplasm lines in kenaf (*H. cannabinus*) were evaluated with their 2 respective checks at different locations during the last crop season.

***C. capsularis*:** Average fibre yield (g/plant) over four locations was recorded to be 9.11±1.38 g/plant with a range of 5.80 (CIN-103) to 13.17 (CEX-69) g/plant. None of the germplasm lines outperformed the best check variety JRC 517 (14.54 g/plant) for fibre yield.

***C. olitorius*:** Average fibre yield over the three locations was recorded to be 11.77±1.59 g/plant with a range of 7.82 (OIN-116) to 15.88 (OIJ-296) g/plant. Out of 75 accessions, 32 lines outperformed the best check JRO 204 (12.13 g/plant).

***H. sabdariffa*:** Out of 160 accessions evaluated at two locations, 28 genotypes surpassed the yield of best check HS 4288 (11.5 g/plant). R-72 was recorded as best performer, producing 16.87 grams of fibre per plant followed by R-77 and R-326.

***H. cannabinus*:** Average plant height of 75 accessions evaluated at Aduthurai centre ranged from 134 to 226 cm with a mean of 177.6±25.3 cm. Basal diameter varied from 0.80 cm to 1.64 cm with a mean of 1.16±0.20 cm.

11.1.3. National Hybridization Programme

***C. capsularis*:** 29, 32 and 25 F_3 progenies were evaluated at Kalyani, Bahraich and Katihar centres, respectively. Progenies from cross combination CIN-149 × JRC 321 (13.8 g/plant) at Kalyani and CIN-117 x CIJ-100 (13.79 g/plant) at Katihar outperformed the best check for fibre yield. Fibre yield in general, was found too low at Bahraich centre.

Twenty five F_9 populations were evaluated at Kalyani centre. Progenies from cross combination Padma × CIN - 312 performed best for fibre yield (12.4 g/plant), followed by CIN - 149× UPC - 94 (12.2 g/plant)

***C. olitorius*:** A set of 37 F_2 populations evaluated at Kalyani, Coochbehar and Rahuri centres. Progenies of cross combination OIJ-015 × OIN–574 (12.2 g/plant) at Kalyani and OIJ 015 × OIJ 267 (40.27 g/plant) at Coochbehar centre exhibited higher fibre yield than checks. The populations accumulated low biomass (172.39±32.78 g/plant) and exhibited low fibre yield (5.29±1.06 g/plant) at Rahuri centre.

Another set of twenty three populations of F_8 generation evaluated at Kalyani. Progenies of cross combination TJ-40 ×O1J-100/TAN/NY/018C (12.2 g/plant) outperformed best check JRO 8432 (11.6 g/plant).

Crossing superior germplasm: Six superior germplasm of *C. olitorius* each at Coochbehar (OEX-33, OEX-34, OEX-

35, OEX-36, OEX-37 and JRO-8432) and Kalyani (OIN-714, OIN-515, OIJ-214, OIJ-216, OIN-791 & OIN-581) centres were crossed in half diallel and line x tester fashion, respectively. Few single crosses have been attempted in Katihar centre.

11.1.4. Yield Evaluation trials

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

IET: NJ-7010 turned to be the best performing entry with 37.90 q/ha fibre yield followed by NJ-7005 (34.68 q/ha) national check JRO 204 (33.70q/ha) and BCCO-8 (32.23q/ha).

AVT I: Test entry KRO-4 was found to be the best performer with 28.38 q/ha fibre yield followed by check JRO 8432 (27.28q/ha), and test entry KRO-5 (26.10 q/ha) and JROK-10 (25.99 q/ha).

Adaptive Trial: Test entry JROG-1 (29.65 q/ha) outyielded the best check variety JRO 524 by 7.82% based on 11 locations in Odisha, West Bengal, Bihar and Assam.

11.1.4.2. White jute (*C. capsularis*)

IET: Test entry BCCC-3 turned to be the best performing with fibre yield of 31.87 q/ha followed by check variety JRC 517 (31.00 q/ha), NDJC-2013 (30.63 q/ha) and JRC 698 (30.25 q/ha).

AVT I: Test entry NCJ-28-14 performed best with 25.37 q/ha fibre yield followed by check JRC 698 (23.75 q/ha), BCCC-2 (25.11 q/ha) and JRCJ-3 (24.59 q/ha).

AVT II: Based on pool analysis over location and year mean (grand mean), test entry NCJ 28-10 (26.39 q/ha) was the best performer followed by BCCC-1 (25.50 q/ha), NDJC-2011 (25.31 q/ha) and JRCJ-2 (25.11 q/ha).

11.1.4.3. Kenaf (*H. cannabinus*)

IET: Check variety AMC 108 (30.78 q/ha) was found to be the best performer which is very close to the test entry JRK-2011-1 (30.77 q/ha). Almost all test entries outperformed the other check variety MT 150 (27.78 q/ha) for fibre yield.

AVT II: Test entry JBMP-2 (26.61 q/ha) was found to be the best performing followed by JBMP-1 (25.34 q/ha) and JBMP-3 (25.12 q/ha) which outyielded better check variety AMC 108 (25.03 q/ha).

Adaptive Trial: Two entries *viz.* JBMG-4 and JBMG-5 evaluated at five locations in four states. Test entry JBMG-4 (22.26 q/ha) out yielded the best check AMC 108 (19.50 q/ha) by 14.17%.

11.1.4.4. Roselle (*H. sabdariffa*)

IET: Test entries JRR-2012-1 (36.03 q/ha) and AHS-249 (33.54 q/ha) identified as the better performing entries over both the check varieties AMV 5 (32.37 q/ha) and HS 4288 (26.15 q/ha).

AVT I: AHS-230 was found to be the best performer with 30.80 q/ha fibre yield followed by test entry AHS-233 (26.48) and JRR-2011-1 (25.95 q/ha).

AVT II: Test entry JBRP-01 was the best performer with 28.29 q/ha fibre yield followed by AHS-216 (27.57 q/ha) and best check variety HS 4288 (26.12 q/ha).

Adaptive Trial: Out of three test entries evaluated in Odisha and Andhra Pradesh, CRIJAF R-8 (23.67 q/ha) outyielded the best national check variety AMV 5 (21.13 q/ha) by 12.02%.

11.1.4.5. Sunnhemp (*C. juncea*)

IET: Test entries Sanai-9 (12.41 q/ha), Sanai-6 (12.26 q/ha) and Sanai-10 (12.20 q/ha) identified as the better performing entries over both the check varieties SUIN 053 (12.08 q/ha) and SH 4 (11.79 q/ha).

AVT I: All test entries *viz*. SUIN-5 (8.93 q/ha), SUIN-3 (8.51 q/ha), SUIN-4 (8.38 q/ha), SUIN-1 (8.35 q/ha) and SUIN-2 (7.82 q/ha) performed better than both the check varieties SH 4 (7.73 q/ha) and K 12 Yellow (7.64 q/ha).

AVT II: Test entry SUIN-62 (8.77 q/ha) performed marginally better than the best check SUIN 053 (8.69 q/ha) followed by test entry SUIN-63 (8.67 q/ha).

Adaptive Trial: Test entry JRJ-610 with an average yield of 10.83 q/ha outyielded the best check SUIN 053 (9.21 q/ha) with 17.60% yield superiority in state of Uttar Pradesh.

11.1.4.6. Ramie (*B. nivea*)

IET: Test entry R 1415 exhibited maximum dry fibre yield (24.13 q/ha/yr) owing to the highest dry fibre recovery (3.12%) followed by R 1414 (21.94 q/ha/yr), and R 52 (20.71 q/ha/yr).

11.1.4.7. Flax (*L. usitatissimum*)

AVT II: Test entry JRF-5 (21.27 q/ha) marginally out yielded the check variety JRF-2 (20.91 q/ha) but difference was not significant.

Adaptive Trial: On the basis of evaluation at four locations in Uttar Pradesh and one location in West Bengal test entry JRF-2 recorded raw fibre yield 16.59 q/ha at farmer's field.

11.2. Crop Production

In the year 2013-14, total 17 research projects comprising of 60 trials were conducted on jute and allied fibre crops at different AINP centres under crop production programme. The new *C. olitorius* genotype JROG-1 recorded significantly higher fibre yield over check varieties at Kalyani, Coochbehar and Kendrapara and maximum fibre yield was obtained with fertilizer dose of 100 kg N: 21.8 kg P: 41.7 kg K/ha. However, none of the new kenaf genotypes (JBMG-4 and JBMG-5) under adaptive trial recorded any significant increase in fibre yield over the check variety HC 583 at both Kendrapara and Amadalavalasa centres. Fibre yield of kenaf genotypes increased significantly upto 60 kg N + 13.2 kg P + 25 kg K/ha level at Amadalavalasa centre only. Among the three roselle genotypes under adaptive trial, CRIJAF R-5 and CRIJAF R-8 recorded significantly higher fibre yield over the check variety AMV 5 at Amadalavalasa centre only and the fibre yield of roselle genotypes increased significantly up to fertilizer dose of NPK @ 60 : 13.2 : 25 kg/ha level. Fibre yield of new sunnhemp entry JRJ 610 was significantly higher (9.04 q/ha) over the check varieties SH 4 and SUIN 053 at Pratapgarh centre only and the fibre yield increased significantly upto 20:40:40 kg NPK/ha only.

Targeted yield (3.5 t/ha) of jute fibre was achieved with ST-TY based fertilizer application at Kalyani only. However, the integration of FYM with ST-TY based fertilizer application could achieve the targeted yield at Bahraich and Katihar. Integration of FYM along with ST-TY based fertilizer application could achieve the higher target (4t/ha) at Kalyani only. Targeted yield (5.5 t/ha) of rice was achieved with ST-TY based fertilizer application at Bahraich only. Higher yield target of 6.5 t/ha was achieved at Kalyani centre when FYM was applied in combination with ST-TY based fertilizer application.

Application of fertilizer on soil test and targeted yield basis along with lime achieved the targeted jute fibre yield (3.5 t/ha) at Coochbehar only. In corporation of FYM along with ST-TY based fertilizer application achieved the targeted jute fibre yield at Kendrapara. Targeted grain yield (5 t/ha) of rice with ST-TY based fertilizer application was achieved at Coochbehar only. Targeted yield of mesta was not achieved either at Aduthurai or at Amadalavalasa.

The results of weed control trials revealed that quizalofop ethyl 5 % EC @ 60g with one hand weeding and use of nail weeder twice (1st at 5 DAE and 2nd at 10 DAE) followed by one hand weeding within the row at 15 DAE recorded the comparable fibre yield with two hand weeding (15-20 DAE and 35-40 DAE) treatment at Kalyani, Kendrapara, Katihar and Bahraich centres. The highest net return was recorded with two hand weeding treatment but the highest benefit-cost ratio was recorded with post emergence application of quizalofop ethyl @ 60 g/ha at 15 DAE with one hand weeding at 15-20 days after herbicide application at Bahraich and Katihar centres. In mesta, the highest fibre yield was obtained when weeds were controlled by application of pretilachlor 50 EC @ 900 ml/ha followed by one hand weeding at Amadalavasa, whereas, two hand weeding treatment and application of quizalofop ethyl @ 60 g/ha at 15 DAE + one hand weeding at 15-20 days after herbicide application were comparable and recorded comparatively higher fibre yield of mesta at Aduthurai.

At Coochbehar, maximum seed yield of *capsularis* jute was recorded when the crop was sown on 1st week of July with a spacing of 60 cm x 15 cm spacing while at Nagaon, the highest seed yield was observed with crop sown on 6th July with 45 cm x 10 cm spacing (6.09 q/ha) and topping at 45 days after sowing. At Bahraich, sowing of *capsularis* jute on 15th June with a spacing of 60 cm x 15 cm and topping at 45 DAS recorded maximum seed yield of the crop. Maximum seed yield of *olitorius* jute was recorded at Rahuri when crop was sown on 31st July with a spacing of 45 cm x 30 cm and topping was done.

Under the drought condition the highest fibre yield recorded when jute was sown on 30th March to 3rd week of April with one irrigation and application of 80 kg N + 18 kg P + 33 kg K/ha along with bunding all around the field and it was comparable when crop was shown on the same date with three irrigations and application of 60 kg N +13 kg P +25 kg K/ha at Kalyani and Kendrapara. At Amadalavalasa, the highest fibre yield of mesta was recorded when crop was sown with onset of monsoon with application of 60 kg N + 13 kg P + 25 kg K/ha +30 kg S/ha, and the fibre yield was almost similar when mesta was sown on same date in open furrow with 60 kg N + 13 kg P + 25 kg K/ha.

CRIJAF microbial formulation used for retting performed very well in various AINP centers located at different agro-climatic region. Jute retting was completed in 9 to 15 days in most of the centers with microbial formulation compared to 15 -22 days required in control, while Coochbehar centre recorded same duration (20

days) with treated and untreated one. Nagaon centre recorded 20.9 days with microbial formulation compared to 29.8 days in control. In case of mesta, the retting was completed in 8 to 9.2 days with formulation compared to 14-18 days in control. The treated fibre of jute recorded fibre strength of 25.4 to 29.4 g/tex compared to 18.9 to 28.5 g/tex in untreated fibre.

The results of jute-pulse strip cropping at Kalyani and Kendrapara indicated that higher system productivity recorded with jute-pulse strip crop and sole crop of jute, whereas, higher net return and benefit-cost ratio was recorded with sole crop of green gram (cv. Pant Mung 5). The sole jute cropping recorded the highest system productivity and net return at Bahraich and Katihar but the highest benefit-cost ratio obtained in jute and green gram strip cropping.

The maximum green biomass of mesta was recorded with variety MT 150 (415.86 q/ha) at Bamra, Odisha while both at Amadalavalasa and Aduthurai centres, varieties MT 150 and JBM 2004-D recorded significantly higher biomass of the crop as compared to AMV 5. The green biomass of mesta variety increased upto 160 kg N/ha level at Bamra and Aduthurai centres while the increase was significant upto 80 kg N/ha only.

The sowing of mesta seed crop on 15th May with spacing of 45 cm x 10 cm and topping at 45 DAS was found suitable for seed production of mesta at Aduthurai. Sowing on 6th August with a spacing of 45 cm x 10 cm recorded significantly higher seed yield of mesta at Amadalavalasa. At Kendrapara, maximum seed yield of mesta (7.35 q/ha) was recorded with 45 cm x 10 cm though no significant variation was observed in seed yield between the two topping dates.

Maximum seed yield of sunnhemp was achieved with a spacing of 30 cm x 10 cm at Rahuri (12.75 q/ha) while the effect of spacing on seed yield was found non-significant at Aduthurai. At both the centres, variation in the dose of N, P and K did not bring significant variation in seed yield of the crop. At Amadalavalasa, maximum seed yield (18.56 q/ha) and yield attributes were recorded with spacing of 60 cm x 15 cm (16.45 q/ha) and with a fertilizer dose of 20:60:60 (NPK, kg/ha).

Fibre yield of ramie (17.64 – 17.79 q/ha) recorded with integrated nutrient management treatments (125% N from inorganic + 50% N from FYM/ramie compost) was statistically at par with yield observed (18.45 q/ha) in 150% recommended fertilizer dose at Barrackpore and may be recommended for south Bengal conditions. Similarly in sisal, combined application of NPK @ 90:30:60 kg/ha + sisal waste @ 20 t/ha recorded maximum dry fibre yield (16.3 q/ha) of the crop at Bamra, Odisha.

The suitable sowing time for fibre flax was found to be early December (9th) for Kalimpong and end of December (25th) for Wellington centres and end of October (30th) for Pratapgarh as the crop recorded maximum biomass and fibre yield when sown during these periods, respectively. Row spacing of 15 cm was found suitable for flax cop in all the three centres as it gave maximum value of biomass and yield with this spacing.

11.3. Crop Protection

Pest and disease scenario in jute and mesta crops was monitored during the active growing season. The experiment was conducted at seven centres (23 locations). Yellow mite, Bihar hairy caterpillar (BHC), semilooper, stem weevil were the most common insect pests in jute while in mesta aphid, leafhopper, whitefly, mealybug and semilooper were prevalent. At Barrackpore, yellow mite was severe (122 mites/cm^2) during 2nd week of May and BHC became serious during 3rd week of July. Yellow mite was major pest at Katihar, Kendrapara, Bahraich and Coochbehar. Semilooper and BHC were prevalent at Nagaon and indigo caterpillar was specific to this location.

Stem rot and root-rot were most severe at Barrackpore, Coochbehar, Katihar and Kendrapara. Mosaic and anthracnose were prominent at Katihar, Bahraich, Kendrapara and Nagaon. Seedling blight was specific to Nagaon. Stem-rot appeared at later stage (85–105 DAS) of crop growth. Anthracnose disease was recorded at Nagaon (34.05%), Baharich (18.70%) and Katihar (3.56%) during 60-105 DAS. Mosaic incidence was maximum at Bahraich (68.80%), Kendrapara (33.33%) and Katihar (11.48%). Seedling blight incidence was high at Nagaon (1.80%) at 35 DAS.

Fifty *tossa* jute (*C. olitorius*) lines were screened at four locations against root knot nematode under pot culture conditions. At Coochbehar, Nagaon and Kendrapara all the entries were rated as either susceptible or highly susceptible. At Bahraich, 5 germplasm (OIJ-040, OIJ-223, OIN-701, OIN-911 and OEX-33) were found to be highly resistant while 16 entries were resistant against the root knot nematode.

Under natural field conditions at Katihar, 6 accessions of *tossa* jute (OIN-06, OIN-09, OIN-69, OIN-71, OIN-83,

OIN-508) were free from stem weevil infestation. KTC-1 recorded least infestation by semilooper. OIN-09 and OEX-05 recorded least Bihar hairy caterpillar infestation. Among the white jute (*C. capsularis*) germplasm CIN-02, CIN-06, CIN-09 were free from yellow mite while CIN-10, CIN-50 were free from stem weevil. At Kendrapara, *tossa* jute lines OIN-48, OIN-130, OIN-508 recorded least yellow mite infestation. Accessions OIN-76, OIN-1123 were free from stem and root rot disease. *Capsularis* germplasm CIN-11, CIN-64, CIN-116, CIN-367 and CEX-25 recorded relatively less yellow mite infestation. CIN-13, CIN-101, CIN-105, CIN-139 and CIN-523 recorded least stem weevil infestation and accessions CIN-65, CIN-364 were free from stem and root rot disease. At Nagaon *olitorius* accessions OIN-06, OIN-68, OIN-104 and OIN-130 recorded least yellow mite infestation (6.1 no./cm^2). Accessions OIN-150, OIN-62, OIN-104, OIN-112 and OEX-13 showed least susceptibility to stem weevil while OIJ-88 recorded relatively less BHC infestation. *Capsularis* accessions CIN-10, CIN-7 and CIN-53 showed relatively less incidence of stem weevil. Yellow mite infestation was less in CIN-1, CIN-26, CIN-93, CIN-116, CIN-117, CIN-138, CIN-179, CIN-210 and CIN-259 while BHC infestation was less in CIN-26 and CIN-130. Among *olitorius* jute germplasm at Coochbehar accessions OIN-15, OIN-30, OIN-59, OIN-490, OIN-138 and OIN-104 recorded relatively less yellow mite infestation. Semilooper damage was least in OIN-09, OIN-25 and accession OEX-9 was free from root rot incidence. Among the *capsularis* accessions CIN-48, CIN-43, CIN-20 and CIN-06 were least infested with semilooper.

At Amadalavalsa, 41 mesta accessions were screened for insect pests and disease resistance under natural epiphytotic conditions. Among these, three (AS-80-9, AS-80-19, AR-80) were least susceptible to aphids. R-271 was resistant against white flies, R-40 against semiloooper, R-347 against leaf hoppers and R-128 against mealybug. Only one accession (R-79) was identified as highly resistant to foot and stem rot disease.

For management of stem rot under integrated crop management system early sowing (15th March) was effective in reducing stem rot incidence at Coochbehar, Bahraich and Kendrapara while late sowing (30th March), was effective in reducing stem rot incidence at Barrackpore and Katihar. Disease severity increased with the higher nutritional dose (N:P:K-80:40:40) at Barrackpore, Coochbehar and Kendrapara while reverse trend was observed at Bahraich and Katihar. Seed treatment with *Trichoderma viride* @ 10g/kg + Butachlor 50 EC @ 2kg a.i./ha as pre-mergence + spraying of carbendazim 50 WP @ 0.1% + spraying of endosulfan 35 EC @ 0.15% at 15 days interval significantly reduced disease incidence at Coochbehar, Bahraich and Katihar though at Barrackpore and Kendrapara the treatment failed to produce such effects.

In a seed crop at Bahraich, spraying of carbendazim @ 0.1% at pod setting stage also reduced seed infection (2.37%) and seed discolouration however, seed yield was maximum when sown at June end (3.52 q/ha).

Early sowing (15thApril) resulted higher yellow mite infestation in jute at Barrackpore. Hence, application of abamectin 1.8 EC @ 0.0015% in late sown (15thMay) crop at 45 and 60 DAS resulted significantly the least mite population. Similar trend was observed at Katihar. However, at Bahraich, Coochbehar and Kendrapara, other spray schedules consisting of dicofol 18.5 EC (0.045%), quinalphos 25 EC (0.04%), fenazaquin 10 EC (0.015%), profenophos 50 EC (0.10%) produced similar results.

For semilooper and BHC, application of fenazaquin 10 EC @ 0.015% at 45 and 60 DAS followed by profenophos 50 EC @ 0.10% at 70 and 80 DAS was most effective at all the centres.

In eco-friendly management of insect pests and diseases in jute, the integrated organic module consisting of FYM (5 t/ha), *Azotobacter* (5 g/kg seed), *PSB* (5 g/kg seed), *Trichoderma viride* (5 g/kg seed) and soil application of *T. viride* (2 kg/ha), *Pseudomonas fluorescens* (0.2% foliar spray) and neem oil (0.03%) was most effective against jute stem rot.

Among the five fungicides tested at Barrackpore and Amadalavalasa against foot rot disease of mesta caused by *Phytopthora parasitica var. sabdariffae,* seed treatment with metalaxyl MZ 8% WP @ 2g/kg followed by 0.2% foliar spray at 30 and 45 DAS was found most effective.

In biorational management of yellow mite in jute, treatment application of azadirachtin (10000 ppm), *Lecanicillium lecanii* ($2x10^8$ CFU/g), spiromesifen 240 EC (0.7 ml/l) individually or in combinations significantly reduced pest population. These treatments were equally effective against this pest at Barrackpore. At Coochbehar, Katihar and Nagaon, application of spiromesifen 240 EC (0.7 ml/l) at 35 and 50 DAS caused the maximum reduction in mite population at 7 DAS.

Six *tossa* jute lines from advanced varietal trial (AVT-I) along with check were screened for resistance against

major diseases and insects at Barrackpore. However, no significant difference could be observed among them.

Similarly entries of white jute in (AVT-I) were screened along with the checks. All the lines were susceptible to BHC, semilooper, yellow mite and stem rot. However, all the test lines were less susceptible to stem weevil at 60 DAS compared to the check. In another trial in AVT-II, entries of white jute were screened along with check.

Among the five advanced lines of *H. sabdariffa* tested (AVT-I) at Barrackpore for resistance against stem rot disease, AHS-233 was least infected. In AVT-II, JBRP-02 recorded least incidence (9.32%) of foot and stem rot whereas in JBRP-01 the extent of disease incidence was 14.05%.

Appearance of stem rot, wilt, leaf spot and pod borer was recorded on six lines of sunnhemp along with a check at Barrackpore. However, no significant difference could be observed in any of the lines for any disease or pest. Similarly eight sunnhemp lines were tested under AVT-II. The lines were non-significant in terms of their resistance status.

At Amadalavalasa, in AVT-I for screening of roselle, entry ASH-230 was resistant to aphids, leafhoppers, white flies, mealybug and semilooper. In AVT-II for screening of roselle, entry JBRP-01 was resistant to all the major insect pests.

Fig. 11.1: Honb'le DDG (Crop Science) ICAR, Prof. S. K. Datta inaugurating the 11th Annual Group Meeting of AINP on J&AF at UBKV, Coochbehar, West Bengal

Fig. 11.2: Honb'le ADG (CC), Dr. N. Gopalakrishnan inaugurating the 11th Annual Group Meeting of AINP on J&AF at UBKV, Coochbehar, West Bengal

Fig. 11.3: Dr. S. Satpathy Director (Acting), CRIJAF, Barrackpore inaugurating the 11th Annual Group Meeting of AINP on J&AF at UBKV, Coochbehar, West Bengal

Fig. 11 3: Inaugural address by Honb'le DDG (CS), ICAR

12. Krishi Vigyan Kendra

During 2013-14, Krishi Vigyan Kendra (KVK), Burdwan designed and implemented various programmes for farmers, farm women and rural youths which includes On Farm Testing/Trial (OFT) of various technologies, Frontline Demonstrations (FLD) of established technologies, training for farmers, farm women, rural youths and extension workers etc. besides conducting other extension activities like exposure visits, field day, method demonstration and similar other activities.

12.1. On Farm Trials

Seven OFTs were conducted by the KVK to popularize different recommended technologies among the farmers and by the farmers in different villages of Burdwan. The salient findings of these OFTs are depicted below:

- Evaluating the performance of *olitorius* jute varieties namely JRO 204, CO 58 and JRO 128 under rainfed and medium upland situation of Burdwan district indicated that CO 58 and JRO 204 produced significantly more fibre and were at par followed by JRO 128.
- In paddy along with recommended doses of fertilizers' applications of 6 kg Zn and 20 kg S in medium upland situation of Burdwan district resulted in significantly higher productivity over any technology options. There were significant differences in yield attributes like EBT and 1000 grain weight.
- In chilli along with recommended doses of fertilizers, application of NAA, triacontanol and boron enhanced the flower retention, fruit numbers and yield. Plant vigour also increased with the treatment of triacontanol leading to higher yield.
- Performance of pig breed indicated that there was significantly higher body weight at selling (at the age of 7 month) in white Yorkshire breed but litter size at birth was significantly higher in Ghungroo pig under low input system. It was also observed that survivality of piglets at weaning were also more in Ghungroo pig.
- Supplementation of organic source of S and Vit E improved egg production in *deshi* duck under backyard management practices compared to inorganic source of Se and Vit E.
- Evaluation of different extension teaching methods used by KVK indicated that there was higher gain and retention of knowledge in the teaching method using lecture and demonstration.
- Cauliflower pickle consisting of spices, salt with adequate amount of mustard oil, acetic acid (@ 20 ml/kg and sodium benzoate @ 0.5 mg/kg) increased the shelf life of pickle as well as profitability, as evident from organoleptic test, in comparison to others.

Fig. 12.1 FLD on jute

Fig. 12.2 OFT on pig breed

12.2. Front Line Demonstrations

A total of 220 Front Line Demonstrations (FLDs) were conducted on jute, paddy, mustard, lentil, tomato, banana, rice bean (as fodder), oat (as fodder), maize and vegetables in agriculture and horticulture. In animal sciences, FLD s were on cow, poultry and piggery. The salient findings of the FLDs are given below in Table No 12.1.

Table 12.1.: Details of FLDs conducted at KVK, Burdwan

Crop / Livestock demonstration (No.)	Technology demonstrated	Remarks
Jute (35)	Improved cultivar (cv. JRO 204) Local Check JRO 524	61% change in yield was obtained through use of JRO 204 (30.5 q/hq) over local variety (26.3 q/ha)
Paddy (15)	System of Rice Intensification (SRI)	On an average, the practice of SRI yielded (68.4 q/ha) much above the conventional practice (55.8 q/ha) with an increase of 22.6 %
Paddy (7)	Management of yellow stem borer of rice through pheromone traps	15.38 % increase in yield of paddy was obtained through management of yellow stem borer using pheromone trap.
Mustard (15)	Sulfur nutrition	There was 7.6 % increase in yield through sulfur nutrition in mustard
Lentil (15)	Improved cultivar (cv. WBL 81) Local Check B 256	Yield of lentil increased from 10.4 q/ha to 12.5 q/ha which is 20.2 % more
Tomato (15)	Tomato (cv. Abhilash)	The yield increased by 25.8 % by using Abhilash (340 q/ha) over local variety (270 q/ha)
Banana (9)	Grand Naine	22.5 % increase in yield was obtained by using TCB
Banana (7)	IIHR-Banana-micronutrient formulation	Yield of banana increased to 770.40q/ha using micronutrient over local check (700.10q/ha)
Rice bean (fodder) (5)	Improved variety and fertilizer application Var. Bidhan-2	39.6% increase in yield was obtained in improved practice (284 q/ha) over local check (203 q/ha)
Oat (fodder) (5)	Improved variety and method of sowing Var. Kent	14.87 % increase in yield was obtained in improved practice (417 q/ha) over local check (363 q/ha)
Maize (50)	Shelling maize from dehusked cob using tubular maize sheller	Mean heart rate was 89 beats/min as compared to check (103 beats/min), also mean work pulse (beats/min) decreased from 41 to 17 using maize sheller
Diversified vegetable (cucurbits, brinjal, chilli, tomato, okra, bean and GLV)(7)	Diversified vegetable (cucurbits, brinjal, chilli, tomato, okra, bean and GLV) + manuring+ fertilizers	Yield increased to 104.2 q/ ha from 94.2q/ha
Deshi Cow (10)	Region specific mineral supplementation to *deshi* cow	38.4% increase in milk yield was obtained
Deshi Cow (10)	Home made feed supplementation to *deshi* cow	62.9 % increase in milk yield was obtained in improved practice (558.5 kg/lactation) over local check (342.8 kg/lactation)
Poultry (RIR) (10)	Improved rural poultry breed rearing	Egg production increased to 75/hen/4 month from 32/hen/4month
Piggery (5)	Improved prolific breed	1/ unit

12.3. Trainings

Various training programmes on diversified topics (Table 12.2) in agriculture, horticulture, animal and fishery sciences, plant protection, agricultural extension and home sciences were conducted by the KVK to effectively disseminate various improved technologies.

Fig. 12.3 Exposure visit of ATMA, Katihar

Fig. 12.4 Training on nutritional security of farm women

Fig. 12.5 Sensitization workshop on PPV&FRA

Table 12.2.: Details of training programmes conducted by KVK, Burdwan

Target group	No. of Trainings	No. of Participants						
		General			SC/ST			Trainee day
		Male	Female	Total	Male	Female	Total	
Farmers & Farm women	97	1380	270	1650	660	120	780	2430
Rural youth	26 (3 days each)	445	0	445	160	0	160	605
Extension functionaries	6	70	5	75	15	0	15	90
Vocational training	15 (7 days each)	115	90	205	35	80	115	320
Total	144							3445

12.4. Production of seed materials at KVK farm and distribution to the farmers

- Certified paddy seed (MTU 7029) : 240 q
- Tomato and brinjal seedlings: 15000 nos.
- 100 bundles of banana (Grand Naine)
- 375 kg cowpea beans
- In "Seed Village" Programme, 1500 q paddy seed production (MTU 7029) in 36 ha in different villages of Burdwan district in participatory mode.

12.5. Other Extension Activities

- Field Days for horizontal dissemination of the technologies on crops viz. jute, paddy, mustard, livestock, rice bean, oat, nutritional garden, horticulture, etc.
- Animal Health Camp for mass vaccination against PPR etc. diseases of livestock
- 4 Farmers' Exposure visit in different places/ organizations
- Film show exhibition to the farmers
- Self-help group and Mahila Mandal convener meeting were done by KVK.
- Farm Science Club Conveners meet were organized
- Conducting seminar/workshop on World Food Day, World Veterinary Day etc.

Fig. 12.6 SAC meeting, 2013

Fig. 12.7 Technology week

Fig. 12.8 Vaccination camp during World Veterinary Day

12.6. Technology Week and Krishi Mela

Technology Week (24th February–1st March, 2014) was conducted at KVK in PPP mode in collaboration with NABARD and two private firms, namely CLAAS and UPL. Nearly 600 farmers from nearby and adopted villages participated. The technologies demonstrated in the Krishi Mela to the farmers during the Technology week were:

Integrated farming system, Chandra hatchery, Low cost seedling raising techniques for vegetables, Vermicomposting technology, SRI technology, Backyard poultry, Goatary, Women empowerment, Improved technologies on jute and Poly house for nursery vegetables.

12.7. Sensitization Programme on Protection of Plant Varieties and Farmers Right Act (2001)

An awareness programme on Protection of Plant Varieties and Farmers Right Act (PPV&FRA), sponsored by PPV&FR Authority, New Delhi was organized by KVK Burdwan on 24th February, 2014. Selected progressive farmers from 22 blocks of Burdwan district, Asstt. Directors of Agriculture of different blocks, representatives of Farmers' clubs and NGOs participated in this programme. A total of 170 participants were sensitized by Dr. Dilip Kr. Dey, Ex-Prof., BCKV and other distinguished scientists and officials on need for protection of traditional and extant plant varieties. Applications for registering seven traditional rice varieties under PPV & FRA were filled and submitted for further process to the authority.

12.8. Special programme on Food and Nutrition

The National Nutrition Week was celebrated from 1-7 September, 2013 in collaboration with ICDS, Galsi-I, Burdwan for addressing the problem of malnutrition or under nutrition among children and women especially in rural areas. The 7 days awareness programme was held at different Anganwadi centres, tribal villages of Galsi–I. where Supervisors, Anganwadi workers, ASHA (Accredited Social Health Activists) workers, panchayat members, teachers, village women, pregnant and lactating women, adolescents' girls and school students participated. Different programme and related to nutrition, video shows, trainings, quiz competition, awareness camp, demonstration on cheap recipes of making nutritional weaning food etc. were also organized. Around 300 farm women benefited from it.

Fig. 12.9 Anganwadi workers attending the programme during Nutrition Week

12.9. Literatures released/published:

Research paper: 3 nos; Technical bulletin on SRI (in Bengali); Extension leaflets: 4; Media coverage: News papers like *Dainik Jagran* and *ICAR Reporter* and two success stories documented on broiler farming and pig farming at tribal area and innovative hatchery **(Source: D. Ghorai, PC, KVK, Burdwan)**.

13. Human Resource Developement

13.1. Meetings/Events

CRIJAF, Barrackpore

- The Institute Research Council (IRC) meeting was organized 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 9-10th April, 2013.
- Review meeting on "jute seed production plan for 2013-14" under Mini Mission-II of Jute Technology Mission (JTM) and Rastriya Krishi Vikas Yojana (RKVY) was held on 14th June, 2013 to plan the seed production during 2013-14.
- Training-cum-Awareness Programme on "PPV&FRA" was organized on 20th June, 2013 under the aegis of the Protection of Plant Varieties & Farmers' Rights Authority (PPV&FRA).
- The Advisory Committee Meeting on "NFBSFARA projects" was held on 22th June, 2013 to review the progress and salient achievements made during 2012-13.
- "Farmers' Day-2013" was organized on 27th June, 2013 for promotion of latest improved in technologies to make the stakeholders aware of the recent developments for enhancing production and productivity of jute and allied fibre crops.
- Under the RKVY project, "Orientation-cum-Training Programmes" were organized on 3-5th July 2013 at Simlapal, Onda and Hirband blocks of Bankura, attended by 341 farmers.
- "Hindi Workshop" was organized on 23rd August 2013 to motivate the staffs of the institute to work more in Hindi.
- The 30th Institute Management Committee (IMC) meeting was held on 27th August 2013.
- The "Hindi Pakhwara" was organized during 13-27th September 2013 to encourage scientists and staff members of the institute to use Hindi more in day to day office works.
- "Vigilance Awareness Week" was observed at CRIJAF, Barrackpore, Kolkata, along with its four regional stations and the KVK during 28th October - 2nd November 2013.
- "Agriculture Education Day" was organized on 11th November, 2013 with an objective to create awareness among the school students regarding the importance of agricultural sciences. The theme of the programme was "Agriculture Sciences and Food Security".
- "Seed Day" under RKVY was organized at CRIJAF, Barrackpore on 16th January, 2014.
- "Institute Foundation Day" was celebrated on 10th February, 2014.
- "Sensitization Workshop of FMS/MIS" was organized at CRIJAF, Barrackpore on 13th February 2014 to make awarness about the programme among the staffs.
- 11th Annual group meeting of AINP on Jute and Allied Fibres was organized at UBKV, Coochbehar on February 28- 1st March, 2014.
- Review meeting on "Hybrid varieties development under quality seed production under RKVY and inauguration of laboratories and other facilities under RKVY" was organized at CRIJAF, Barrackpore on 5th March 2014.
- "International Women's Day" was organized at CRIJAF, Barrackpore on 10th March 2014 with the theme "Role of Agricultural Sciences in Food Security".
- Research Advisory Committee (RAC) meeting was held at Central Research Institute for Jute and Allied Fibres, Barrackpore on 19-20th March, 2014.

Sh.RS, Pratapgarh

- "Field day" was organized on 30th January, 2014 at Suriyawa village of Pratapgarh (U.P.) to create awareness among the farmers regarding flax fibre crop. Fifty farmers from nearby villages participated in the programme.
- "Hindi Pakhwara" was celebrated from 13-27th September, 2013 to create awareness among staff members regarding the use of Hindi in official work.

CSRSJAF, Budbud

- "Seed Day" under "ICAR Seed Project" was organized on 21th November, 2013 to create awareness regarding the need of quality seeds as primary input for increasing agricultural production and productivity.

13.2 Training organized by CRIJAF

Programme	Venue and Date	No. of participants
Training programme on "Entrepreneurship Development on Value Addition of Jute Fibre"	CRIJAF, Barrackpore 16-18th May, 2013	18
National training on "Advances in Improved Production Technology and Fibre Quality Assessment of Jute and Allied Fibre Crops"	CRIJAF, Barrackpore 24-29th June, 2013	22
Farmers training on "Improved Production Technology of Sunnhemp and Flax"	ShRS, Pratapgarh 11-13th July 2013	25
Training on "Improved Retting of Jute"	Purnea, Bihar 9-10th July, 2013	25
Training on "Improved Retting Methods of Jute and Allied Fibres with Special Reference to Quality Assessment"	CRIJAF, Barrackpore 5-12th August, 2013	24
Training on "Improved Production Technologies of Jute and Allied Fibre Crops"	CRIJAF, Barrackpore 30 Sept-4th Oct, 2013	22
Training programme on "Jute Seed Production"	CRIJAF, Barrackpore 27th November, 2013	30

Dignitaries distributing prizes to the students during Agriculture Education Day

Mr. G. Bhattacharya, CVO (GSI, Kolkata) delivering lectures during Vigilance Awarness Week

Review meeting on seed production under RKVY

Farmers are awarded with CRIJAF- Nail Weeder by dignitaries during Farmers Day 2013.

Training on enterpreneurship development by making fancy jute bags.

Trainees getting acquinted about fermenter usedfor mass production of retting consortia

Participants in SAS training session

Demonstration of mechanical fibre extractor to the trainees

13.3. Seminar/Symposium/Conference/Workshop attended by the scientists

Programme	Institute and Date	Name of Participant/s
Brainstorming Session on "Improving Research in Agricultural Extension: Issues and Way Forward"	NBSS&LUP Regional Station, Salt Lake, 26th April, 2013	Dr. Shailesh Kumar Dr. Shamna, A
International Conference on "Impact of Technological Tools on Food Security under Global Warming Scenario"	Shobhit University, Meerut 11-12th May, 2013	Dr. S.K. Pandey
User Acceptance Training (UAT) programme for digitization of office records in MIS/FMS project under NAIP	IASRI, New Delhi 8-10th May, 2013	Dr. A. K. Chakraborty
Training Programme on "Effects of Polymer Application on Leaching of Nitrogen in Sandy Loam and Sandy Clay Loam Soils"	CRIDA, Hyderabad 20th May- 20th August, 2013	M. Ramesh Naik
Sensitization workshop of "National Fund for Basic, Strategic and Frontier Areas of Research in Agriculture"	AAU, Jorhat 8-9th July, 2013	Dr. D. Sarkar Dr. P. Satya

Annual Review Workshop of "National Fund for Basic, Strategic and Frontier Areas of Research in Agriculture"	New Delhi 22-23rd July, 2013	Dr. D. Sarkar Dr. P. Satya
Sensitization workshop on "National Fund for Basic, Strategic and Frontier Areas of Research in Agriculture"	NIRJAFT, Kolkata 23-24th August, 2013	Dr. B. S. Gotyal Dr. K. Selvaraj Dr. S.B. Chowdhury Dr. H.K. Sharma
National seminar on "Developments in Soil Science-201 & "78th Annual Convention of Indian Society of Soil Science	CAZRI, Jodhpur 23-26th October, 2013	Dr. B. Majumdar Dr. A. R. Saha
National Symposium on "Crop Pathosystem Interactions Under Aberrant Weather and Perspectives for Crop Health Management"	CRRI, Hazaribag 24-25th October, 2013	Dr. C. Biswas Dr. A.N. Tripathi
Sensitization workshop on "Office Record Digitization In MIS/FMS Project" under NAIP	IINRG, Ranchi 31st October, 2013	Dr. A. K. Chakraborty
Workshop on "Scientific Report Writing and Presentation"	NAARM, Hyderabad 26-30th November, 2013	Dr. P. Satya
International Conference on "Extension Education Strategies for Sustainable Agricultural Development- A Global Perspective"	UAS, Bangalore 5-8th December, 2013	Dr. S.K. Jha Dr. Shamna. A
National symposium on "Managing Natural Resources for Enhancing Agricultural & Allied Productivity in Coastal Region Under Changing Climate"	CSRI, Gujarat 11-14th December, 2013	Dr. M.S. Behera
National Seminar on " Krishi ki adhunik praudyigiki ki uplabdhyian evam chunautiyan"	CIFE, Mumbai 14-16th December, 2013	Dr. Shailesh Kumar
CAFT programme on "Computational and Statistical Advances in Bioinformatics for Omics Data"	IASRI, New Delhi 21 January-10th February, 2014	Dr. A. K. Chakraborty
International Conference on "Bioresource, Biodiversity and Biotechnology"	Association for the Advancement of Biodiversity Science (AABS) at Mysore, Karnataka 30- 31st January, 2014	Dr. P. Satya Dr. Amit Bera Dr. S.B. Choudhary Dr. H.K. Sharma Dr. A. Anil Kumar Mr. Lalit Kharbikar Mr. M. Ramesh Naik
Biennial Conference of Indian Society of Weed Science on "Weed threat to Agriculture, Biodiversity and Environment"	DWSR, Jabalpur 15-17th February, 2014	Dr. Mukesh Kumar
National Conference on "Emerging Problems and Recent Advances in Applied Sciences: Basic to Molecular Approaches"	CCSU, Meerut 8-9th February, 2014	Dr. S.K. Pandey
World Congress on "Agroforestry"	ICRAF, New Delhi 10-14th February, 2014	Dr. S.B. Choudhary Dr. H.K. Sharma

Sensitization workshop on "Office Record Digitization in MIS/FMS Project" under NAIP	CRIJAF, Barrackpore 13th February, 2014	Dr. A. K. Chakraborty
International Symposium on "Integrated Water Resources Management (IWRM)"	CWRDM, Kozhikode 19–21st February, 2014	Dr. M.S.Behera
48th ISAE Annual Convention and Symposium	CTE, MPUAT, Udaipur 21-23rd February, 2014	Er. Ranjan Kumar Naik
11th Annual Group Meeting of AINP on Jute and Allied Fibres	UBKV, Coochbehar 28 February- 1st March, 2014	31 Scientists of CRIJAF

13.4. Training undergone by the scientist and staff members during the period

Programme	Institute and Date	Participant/s
Training on "Recent Advances in Statistical Modelling Techniques"	IASRI, New Delhi 31st May - 20th June 2013	Dr. Mukesh Kumar
Training programme on "Advances in Improved Production Technology and Fibre Quality Assessment of Jute and Allied Fibre Crops"	CRIJAF, Barrackpore 24-29th June, 2013	Dr. A.N. Tripathi, Dr. V. Ramesh Babu
ICAR summer school on "Information Communication Technology, Initiatives for Inclusive Agricultural Development"	TNAU, Coimbatore 3-23rd July, 2013	Dr. Shamna. A
Training programme on "Data Analysis Using SAS"	CRIJAF, Barrackpore 1-6th July, 2013	Dr. S. K. Pandey Dr. C.S. Kar Dr. S.B. Choudhury Dr. A. Anil Kumar Dr. M.S. Behera Dr. K. Selvaraj Dr. S.P. Mazumdar Dr. S.P. Gawande Dr. R.K. De Dr. S. Mitra Dr. H.K. Sharma
Training programme on "Agricultural Research Management"	NAARM, Hyderabad 15-27th July, 2013	Dr. S. K. Pandey Dr. Babita Chaudhary
Training on "Improved Retting Methods of Jute and Allied Fibres with Special Reference to Quality Assessment"	CRIJAF, Barrackpore 5-12th August, 2013	Dr. M. S. Behera Dr. S. Biswas
SAS installation-cum-training for NAIP consortium for SSCNARS	DWM, Bhubaneswar 5-6th September, 2013	Dr. A. K. Chakraborty
Training on "Understanding of Mechanism of Host-Pathogen Bioagent Interaction and Sustainable Bio-Management Strategy for Threatening Crop Diseases "	IARI, New Delhi 24 September- 14th October, 2013	Dr. S.P. Gawande
Pest Surveillance	NIPHM, Hyderabad 3-10th October, 2013	Dr. V. Ramesh Babu

Short course on "Recent Approaches for Breeding Climate Resilient Sugarcane Varieties"	SBI, Coimbatore 8-17th October, 2013	Dr. A. K. Sharma
Training programme on "Agro-Ecosystem Analysis and Ecological Engineering for Pest Management"	NIPHM, Hyderabad 04-24th December, 2013	Dr. K. Selvaraj
Internal auditing of the quality management system	CRIJAF, Barrackpore 22-23rd January, 2014	Dr. B S. Gotyal Dr. J. Mitra Dr. C.S. Kar Dr. P. Satya Dr. S.B. Choudhary Dr. S.K. Pandey Dr. Mukesh Kumar Dr. S. P. Mazumdar

13.5. Radio Talk/ TV Show

Programme	Topic	Speaker
Krishi Darshan (Live Programme)	"Improved Jute Retting Methods" Door Darshan Kendra, Kolkata, 20.08.13	Dr. B. Majumdar
Ajker Chasbas	"Improved Technology for Jute Retting" Akashvani (All India Radio), Kolkata, 04.08.13	Dr. D.K. Kundu
Krishi Kothar Asor	"Entrepreneurship Development in Value Addition to Jute Fibre by Making Shopping Bags" Akashvani (All India Radio), Kolkata, 26.09.13	Dr. D.K. Kundu

14. Awards/ Rewards/ Recognition

- Dr. D. K. Kundu, Principal Scientist (Soil Science) and Head, Crop Production Division and M.S. Behera, Senior Scientist (Agronomy) were awarded with **Dr. J. S. P. Yadav Best Paper Award** of Indian Society of Coastal Agricultural Research for the years 2010-2012 conferred during 10th National Symposium of the Society on 11-14th December, 2013 at CSSRI-RRS, Bharuch, Gujarat.
- Dr. Babita Chaudhary, Senior Scientist (Plant Breeding) was awarded with **Scientist of the Year Award** in the National Symposium on "Innovative and Modern Technologies for Sustainable Agriculture & Rural Development" organized by Society of Biological Sciences and Rural Development, 19-20th September, 2013 at Allahabad.
- Dr. Babita Chaudhary, Senior Scientist (Plant Breeding) was awarded with **Young Scientist Associate Award-2014** during the 16th Indian Agricultural Scientists and Farmers' Congress on "Nanobiotechnological Approaches for Sustainable Agriculture & Rural Development", 22-23rd February, 2014, at Integral University, Lucknow.
- Dr. Babita Chaudhary, Senior Scientist (Plant Breeding) was awarded with **Young Scientist award** for outstanding contribution in the field of plant breeding by the Society for Scientific Development in Agriculture and Technology on the occasion of Annual General Body Meeting, 23rd June, 2013 at Meerut (UP).
- Dr. M. K. Tripathi, Senior Scientist (Agronomy) was awarded with **Kunwar Saxena Bahadur SRDA Award** by the society for recent development in agriculture for valuable contribution in the area of agricultural science on the occasion of International Conference on "Impact of Technological Tools on Food Security under Global Warming Scenario (ITTFS-2012)" during 11-12th May, 2013 at Shobhit University, Meerut, India.
- Dr. M. K. Tripathi, Senior Scientist (Agronomy) was awarded with **Bharat Jyoti Award** by the India International Friendship Society during the conference on "Economic growth and national integration" on 23rd December, 2013 at India International Centre, New Delhi.
- Dr. S.K. Pandey, Senior Scientist (Plant Breeding) was awarded the **Young Scientist 2014** by the Society for Scientific Development in Agriculture and Technology in a National Conference on "Emerging Problems and Recent Advances in Applied Sciences: Basic to Molecular Approaches" 8th February, 2014 at CCSU, Meerut.
- A.N. Tripathi, Scientist (Plant Pathology) was awarded the **Best Poster** in the National symposium on "Crop Pathosystem Interactions Under Aberrant Weather and Perspectives for Crop Health Management & 26th AGM of Indian Phytopathological Society (Eastern Zone) organized by Central Rainfed Upland Rice Research Station, (CRRI, ICAR), 24-25th October, 2013, Hazaribag, Jharkhand.
- Dr. Amarpreet Singh, Scientist (Agronomy) awarded with **IARI Gold Medal** during 52nd Convocation of IARI for outstanding performance during Ph.D. (Agronomy) degree programme on 21st February, 2014 at IARI, New Delhi.

15. Research Projects

Table 15.1. In-house research projects

Project no.	Project title and investigator(s)	Duration	Results cited in the page No.
Crop Improvement			
JB 1.1	Introduction, maintenance, characterization and conservation of jute, mesta and flax germplasm *P. G. Karmakar (w.e.f. Dec. 2010), S. B. Choudhury (w.e.f. Feb. 2011), H. K. Sharma (w.e.f. April 2012) and Anil Kumar (w.e.f. 22.11.2012)*	1997-Long term	
JB 8.4	Breeding for higher fibre yield and quality in *Corchorus capsularis* *Jiban Mitra and C. S. Kar*	2009-14	
JB 8.5	Development of improved genotypes of mesta resistant to biotic stress with enhanced fibre yield and quality *S.K. Pandey, Pratik Satya, H.K. Sharma, S. Satpathy and R.K. De*	2010-15	
JB 8.9	Induction and utilization of mutation in *tossa* jute(*Corchorus olitorius*) *S.B. Choudhary, C.S. Kar and H.K. Sharma*	2010-14	
JB 9.0	Identification of good general combiners for fibre yield and quality in roselle (*Hibiscus sabdariffa* L.) *H.K. Sharma, S.K. Pandey and Pratik Satya*	2010-14	
JB 9.1	Improvement of fibre yield in tossa jute through heterosis breeding *Anil Kumar, C. S. Kar and J. Mitra*	2011-15	
JBT 4.1	Biotechnology for Jute and Allied Fibres Improvement *D. Sarkar and P. Satya*	2010-15	
JB 9.3	Towards development of jute transgenics (*C. olitorius and C. capsularis*) tolerant to biotic and abiotic stress tolerance for enhanced production at sustainable scale *A. B. Mandal and Kanti Meena*	2012-17	
JB 9.2	QTL mapping for fibre quality in tossa jute *S. B. Choudhary, P. G. Karmakar, D. Sarkar, H. K. Sharma, Kanti Meena, Amit Bera* and *H. Bhandari*	2012-15	
JAFSP 2.3	Investigation on breeding behavior and mechanism of self-incompatibility in sunnhemp *H. Bhandari (upto 01.01.2014) and Maruti, T. (w.e.f 02.01.2014 as PI), S.K.Pandey, Babita Chaudhary and S.K. Sarkar*	2013-16	
JBT 4.2	*In vitro* culture to develop productive doubled haploid lines in *capsularis* jute with premium quality to attain farm prosperity *Kanti Meena, A. B. Mandal and R.K. De*	2013-16	
JST 6.0	Estimation of competition effects in jute-mungbean intercropping system *A.K. Chakraborty and A. K. Ghorai*	2013-15	

Crop Protection			
JE 1.1	Integrated management of kenaf pests with special reference to mealybug *S. Satpathy and B.S. Gotyal (w.e.f. April, 2012)*	2009-14	
JM 8.0	Management of stem rot disease of jute *R. K. De, Chinmay Biswas and S. K. Sarkar*	2009-14	
JE 1.2	Identifying the sources and mechanism of resistance against major pests of jute *B. S. Gotyal and S. Satpathy*	2010-14	
JE 1.3	Ecology and management of jute hairy caterpillar *Spilosoma obliqua* Walker *K. Selvaraj, (w.e.f. April, 2012) S. Satpathy and B. S. Gotyal*	2011-14	
JE 1.4	Determination of single and multiple pests economic injury levels in jute *K. Selvaraj and B.S. Gotyal*	2012-15	
JM 8.1	Studies on *Beauveria bassiana* for managing jute pests and diseases *Chinmay Biswas, S. Satpathy and B. S. Gotyal*	2010-14	
JM 8.4:	Exploitation of potential bio-agents and PGPR for biomanagement of stem rot and growth promotion of jute *A. N. Tripathi, R. K. De and S. K. Sarkar*	2012-16	
JE 1.5	Identification of *Bacillus thuringiensis* (Berliner) isolates for management of major lepidopteran pests of jute *V. Ramesh Babu, B. S. Gotyal, K. Selvaraj and S. P. Gawande*	2012-16	
JM 8.3	Studies on variability of *Macrophomina phaseolina* infecting jute and mesta *R. K. De, A. N. Tripathi and C. S. Kar*	2012-17	
JM: 8.5	Basic studies to understand process of stem rot disease development in jute *Kunal Mandal, Chinmay Biswas and C. S. Kar*	2013-15	
Crop Production			
JA 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*	2012-16	
JA 5.6	Assessment of productivity and nutrient management for selected jute based cropping system *Mukesh Kumar, A.K. Ghorai, S. Mitra and S. R. Singh*	2011-16	
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, B. Majumdar, Sunanda Biswas* and *Sonali Paul Majumdar (w.e.f. 22.08.2013)*	2010-14	
SLC 1.3	Use of micro-irrigation method and micro-nutrients to improve fibre yield and water use efficiency of sisal *D. K. Kundu, S. Sarkar, A. R. Saha, A.K.Jha*	2011-15	

JA 6.5	Water productivity evaluation of jute genotypes under changing climatic scenario *D. Barman, D. K. Kundu, A. K. Ghorai and S. Mitra*	2012-15	
JA 6.6	Effect of sulphur and potassium application on yield and quality of jute seed *Amarpreet Singh, Mukesh Kumar, Sonali P. Majumdar, S. R. Singh, Amit Bera and D. K. Kundu*	2013-16	
JC 6.4	Phosphorus distribution and availability in an inceptisol under intensive cultivation of jute-rice-wheat cropping system *Sonali Paul Mazumdar, A.R. Saha and D.K. Kundu*	2013-16	
Agricultural Extension			
JEXA 4.7	Frontline demonstrations on jute under Mini Mission-II of Jute Technology Mission *Shailesh Kumar, Shamna A., Sitangshu Sarkar (w.e.f. 1.12.2012) and S.K. Jha (w.e.f. 16.01.2013)*	2007-14	
JEXA 4.8	Assessment of jute based multiple cropping sequences in farmers' fields of major jute growing districts of West Bengal *S.K. Jha, Shamna, A., S. Kumar and Sitangshu Sarkar (w.e.f. 1.12.12)*	2009-14	
JEXA 5.2:	Studies on performance of newer olitorius jute varieties in farmers' fields of five districts of West Bengal *Sitangshu Sarkar, S.K. Jha, S. Kumar, Shamna, A, B. Majumdar, C. Biswas and B.S. Gotyal*	April 2013 to December 2014	
JEXA 5.1:	Attitude and perception of farmers towards ICT based extension *Shamna A and A.K. Chakraborty*	2013-15	
Sunnhemp Research Station, Pratapgarh, Uttar Pradesh			
SNHA 1.6	Residual effect of sunnhemp on wheat in rice-wheat cropping system *M. K. Tripathi and S.R. Singh*	2010-14	
SNHB 1.8	Breeding of flax (*Linum usitatissimum*) for high yield and superior fibre quality *B. Chaudhary, H. R. Bhandari and M. K. Tripathi*	2011-16	
SNHB 1.9	Population improvement of sunnhemp for fibre yield *B. Chaudhary, S. K. Pandey and M. K. Tripathi*	2011-16	
SNHA 2.0	Effect of NPK on growth and yield of flax (*Linum usitatissimum* L.) *M. K. Tripathi, S. R. Singh and Babita Chaudhary*	2010-14	
Sisal Research Station, Bamra, Odisha			
SLC 1.4	Feasibility of growing annual intercrops in sisal plantation in plateau region of India *Sitangshu Sarkar, D. K. Kundu, A. R. Saha, B. Majumdar and A.K. Jha*	2011-14	
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, Sitangshu Sarkar and R.K. De*	2012-14	

Ramie Research Station, Sorbhog, Assam			
RB 1.0	Collection, maintenance and evaluation of ramie germplasm *A.K. Sharma and S. P. Gawande*	Long term	
RB 2.4	Development of high yielding genotypes with enhanced fibre quality through hybridization *A.K. Sharma, P. Satya, K. Salvaraj and S.P. Gawande*	Long term	
RBM 2.5	Indexing and identification of diseases and insect pests of ramie and development of IPM module *S.P. Gawande, B.S. Gotyal, A. N. Tripathi and A. K. Sharma*	2013-16	
Central Seed Research Station for **Jute** and **Allied Fibres, Budbud, West Bengal**			
BSP 1.0	Breeder seed production of jute, mesta and sunnhemp *C. S. Kar, A. Bera and H. R. Bhandari*	Long term	

Table 15.2. Externally funded research projects

Project No.	Project Title & Principal Investigator	Duration	Results cited in the page No.
MSP	Seed production in agricultural crops and fisheries *C. S. Kar (PI)*	2006 (continuing)	
DAC	Protection of jute varieties and DUS testing *J. Mitra (PI)*	Long term	
NFBSFARA	Genomics for augmenting fibre quality improvement in jute *D. Sarkar (PI)*	2011-16	
NFBSFARA	Understanding biosynthesis and genetics of gum content in ramie (*Boehmeria nivea*) for developing low gum genotypes *P. Satya (PI)*	2012-16	
DBT	Genetic analysis of resistance to stem rot in jute *P. Satya (PI)*	2012-15	
RKVY	Component I: Hybrid jute technology development for higher productivity (*P. Satya*) Component II: Production of quality jute seed (*C.S. Kar*)	2012-14	
MM-II (JTM)	Adaptive research on jute seed production in West Bengal C. S. Kar (PI)	2011-14	
DST (WB)	Jute seed production in West Bengal: Exploring a new horizon *Amit Bera*	2010-14	
JC 5.2	To study changes in soil quality, crop productivity and sustainability under jute-rice-wheat cropping system (LTFE) [formerly JC 8.0 initiated in April 1971] *D.K. Kundu (w.e.f. 29.01.2013, A.R. Saha, A.K. Ghorai, B. Majumdar and Sonali Paul Majumdar*	Long term	
JC 5.6	Soil test and resource based integrated plant nutrient supply system for sustainable agriculture (AICRP) *A.R. Saha,, B. Majumdar, Sunanda Biswas* and *Sonali Paul Majundar (w.e.f. 22.08.2013)*	Long term	

TMJ-1	Development of high yielding and better quality jute genotypes by integrating conventional and advanced strategies *P. Satya (PI)*	2013-17	
TMJ-2	Genetic enhancement of jute and mesta for drought response and fibre quality *J. Mitra (PI)*	2013-17	
TMJ-3	Development of Jute and Allied Fibres Informatics A.K. Chakrabarty (PI)	2013-17	
TMJ-4	Development of low cost eco-friendly technologies for weed management in jute and mesta *A.K. Ghorai (PI)*	2013-17	
TMJ-5	Improving water productivity of jute and mesta and its retting under low volume water *A.K. Ghorai (PI)*	2013-17	
TMJ-6	Up scaling and refinement of microbial retting consortium and popularization of microbial formulation mediated retting among farmers *B. Majumdar (PI)*	2013-17	
TMJ-7	Management of stem rot disease and major insect pests of jute *C. Biswas (PI)*	2013-17	
TMJ-8	Refinement and up scaling of eco-friendly microbial degumming technology in ramie *S. Mitra (PI)*	2013-17	
TMJ-9	Improvement of nitrogen use efficiency (NUE) in jute in relation to bast fibre yield *S. Mitra (PI)*	2013-17	
TMJ-10	Seed quality enhancement for mitigating biotic and abiotic stresses in jute (*Corchorus olitorius*) *Amit Bera (PI)*	2013-17	

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17. 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 agro-biodiversity especially on jute and other fibre crops such as sisal, ramie, flax, sunnhemp, mesta, etc. 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 10,000 books and 11,720 bound volume of journals.

Fig. 17.1 View of CRIJAF library reading hall

CRIJAF publications were provided to over 350 different organizations in India and abroad. It subscribed 57 numbers of journals including Indian and foreign journals. The institute annual report, AINPJAF annual report, JAF newsletter and other institute publications were distributed to different institutes, stakeholders of jute and allied fibres and visitors. 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 Service (DDS) system by Consortium for e-Resources in Agriculture (CeRA) to access different journals online. Under the DDS system the library has sent copies of publications as per request to researchers in different institutes **(Source: J. Mitra, SIC, Library)**.

18. AKMU, ITMU and PME Cell

18.1 Agricultural Knowledge Management Unit (AKMU)

The local area network provides connectivity to all categories of staffs including, scientific, administrative, technical officers and research scholars. There are more than 100 desktop systems connected through LAN to access internet facilities, mail system etc.

The internet facility with OFC backbone has been extended to the institute guest house in addition to Wi-Fi system. Recently, NKN (National Knowledge Network) with bandwidth 2 Gbps in addition to the existing ERNET Internet service of 2 Mbps has been established and started functioning from this year. Besides, a BSNL BB type line is also maintained as an alternate option.

Gateway level security "Kaspersky Endpoint Security 10 version 10.2.1.23" for 70 computers of the institute attached to LAN was implemented and deployed. Licensing through KMS (Key Management Service) for protection of sensitive data of Institute from cyber threat was obtained. Through ICT based IT application under NAIP Component-I computers, servers, networking equipment, UPS, printers were procured to improve the IT infrastructure of the Institute.

Besides, this unit extends its support to all the multimedia facilities needed for all types of meetings, seminars, symposiums, workshops, video conferencing and support for MIS-FMS laboratory for conducting training during the year. Moreover, online web applications *viz.*, Personnel Management Information System Network (PERMISNET), Project Implementation Management System of ICAR (PIMS-ICAR), Half Yearly Progress Monitoring System (HYPM), Central Public Procurement Portal (CPPP) is being managed out by this cell. AKMU of the institute also updates the contents and maintains the institute website.

18.2 Institute Technology Management Unit (ITMU)

ITMU deals with intellectual property (IP) protection, maintenance and technology commercialization related matters at the Institute level. ITMU and ITMC (Institute Technology Management Committee) chaired by the Director is the apex decision making body of the institute. This unit is also actively involved in reviewing the previous research works on jute and allied fibres thoroughly and identifying the specific areas in which there is possibility to develop new technology. Preparation of "jute bibliography" is under process with collection of published research work on crop improvement. "Indian Jute' a bulletin of National Jute Board, vol. XXIV, no. 2, Dec' 2012 issue was digitalized during the period under report.

Filing of application for patents and follow up

- The First Examination Report on the Patent Application No. 1367/KOL/2006 (An improved seed sowing machine) was received from the Assistant Controller and the concerned Scientist is preparing response to the queries.
- Application for 4 more patent applications *viz*. "An improved process of large scale degumming of ramie fibre" (Application no. 1036/KOL/2008), "An improved herbicide applicator" (Application no. 319/KOL/2010), "Nail Weeder" (Application no. 386/KOL/2010) and "A microbial consortium used in faster retting of jute and mesta" (Application no. 418/KOL/2011) filed earlier were pursued.

Commercialization of technologies and Trade Mark registration

- An ITMC meeting was held on 05.02.2014 to discuss various issues related to commercialization of technologies developed by the institute and also an application for registration of trademark for the CRIJAF microbial formulation for faster, eco-friendly and quality retting of jute and mesta. ITMC decided to register a new Trade Mark "CRIJAF Sona' for the said microbial formulation.

Participation in Technology Dissemination Programmes / Annual Workshop

During the year ITMU participated in

- **'Agribusiness Camp'** at NRC on Orchid, Sikkim on June 24, 2013 organized by ZTM&BPD Unit, NIRJAFT, Kolkata in collaboration with NRC on Orchid

- **'Agribusiness Camp'** at CARI, Andaman and Nicobar Islands on 27 July, 2013 organized by ZTM&BPD Unit, NIRJAFT, Kolkata in collaboration with CARI.
- **'Annual Workshop of ZITMC' (East zone) and 'Agri-Investors' Meet'** held at NIRJAFT, Kolkata on 26 - 27 September, 2013, respectively.
- **'Foundation Day of AgrInnovate India Ltd. (AgIn)'** organized at NASC Complex, New Delhi on 19 October, 2013 and presented the technologies developed by the Institute.

18.3 Prioritization, Monitoring & Evaluation (PME) Cell

The PME cell of CRIJAF was established as per guideline of the Council. It comprises of a group of two scientists headed by a Principal Scientist and one 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, publications etc. Important activities performed by the cell are conducting Institute Research Council (IRC) and Project Monitoring Committee (PMC) meetings, maintaining Research Project Files (RPFs), coordinating online submission of Half Yearly Progress Monitoring (HYPM) report of all the Scientists of the institute, updating online programme - PERMISNET and PIMS-ICAR, formulating Results Framework Documents (RFD) of the institute, preparing Monthly Progress Report (MPR), Quarterly Progress Report (QPR), Half-Yearly Performance Review (HYPM), Annual plan, DARE report, ATR of Directors' Meet & 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.

19. Women's Cell

The institute Women Cell addresses the issues related to grievances of women employees in the Headquarters and different regional research stations. During 2013-14, the Women Cell did not receive any grievance from the staffs. Besides, the cell proactively organized events to encourage not only the women employees but also women farmers.

To create awareness among the tribal farm women, the women cell of CRIJAF organized the celebration of International Women's Day at CRIJAF on 10th March 2014. The theme for the program was "Inspiring Change among Tribal Farm Women". In this event, 70 farm women participated including 50 tribal farm women from Makaltala and Farmania villages of North 24-Parganas district and women entrepreneurs of jute based products. In the occasion of international women's Day, the successful women from different fields i.e. entertainment, scientific research, teacher and police service graced the occasion, shared their experiences and expressed views about role and importance of the women in making the society and nation.

A 7-day training programme on "Making of Decorative and Fancy Jute Bags" was organized for entrepreneurship development among tribal farm women during 4-10th March, 2014.

The women cell took initiative in facilitating the women staffs for greater motivation. In this context, Mrs. M. Deb Chowdhury (AAO) was awarded as best women employee of CRIJAF for the year 2013-14. Mrs. Gita Das (T-3) was also felicitated for her achievement in ICAR sports. Both of them were felicitated by the guest in the occasion of International Women's Day.

Nine women entrepreneurs were rewarded on the occasion of Women's Day with the amount obtained from sale of jute-based artefacts prepared by them through CRIJAF sale counter in melas and exhibitions **(Source: Shamna A and S.P. Mazumdar, Women's Cell of CRIJAF).**

Dr. (Mrs.) K. Datta, Prof., Calcutta University addressing in the occasion of Women's Day

Women employees are felicited by the guest

20. Official Language Cell

केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान के लक्ष्य, कार्यक्षेत्र तथा राजभाषा गतिशीलता

केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान एक प्रमुख राष्ट्रीय संस्थान है जिसे पटसन एवं समवर्गीय रेशा फसलों के उत्पादन में वृद्धि हेतु आवश्यक अनुसंधान तथा उसे किसानों तक पहुँचाने का दायित्व सौंपा गया है। इस संस्थान की स्थापना वर्तमान स्थान नीलगंज, बैरकपुर, कोलकाता में सन् 1953 के दौरान हुई जिसका कुल क्षेत्रफल 62.8 है0 है।

संस्थान के अनुसंधान कार्य को तीन प्रभागों नामतः फसल उन्नतिकरण (Crop Improvement), फसल उत्पादन (Crop Production) और फसल सुरक्षा (Crop Protection) तथा पाँच अनुभागों जैसे – जैव प्रोद्योगिकी, कृषि सांख्यिकी, फार्म मशीनरी एवं पॉवर, कृषि विस्तार तथा कृषि मौसम विज्ञान, के अंतर्गत व्यवस्थित किया गया है। इन अनुसंधान प्रभागों एवं अनुभागों की सहायता हेतु फार्म, वर्कशाप, पुस्तकालय, प्राथमिकता अनुवीक्षण एवं मूल्यांकन कक्ष, संस्थान प्रौद्योगिकी प्रबन्धन एकक, कृषि ज्ञान प्रबंधन एकक, प्रशासन अनुभाग, वित्त व लेखा अनुभाग भी कार्यरत हैं। संस्थान में मौलिक, सामरिक तथा क्षेत्र अनुकूल अनुसंधान कार्य हेतु आवश्यक प्रयोगशालाएँ व क्षेत्रीय सुविधाऐं उपलब्ध हैं।

संस्थान ने पटसन एवं समवर्गीय रेशा तथा बीजों से संबंधित अनुसंधान कार्य हेतु देश के विभिन्न भागों में 4 अनुसंधान केन्द्रों की स्थापना की हैं, जो निम्नवत है :–

1. रेमी अनुसंधान केन्द्र, सरभोग, असम (वर्ष 1959 में स्थापित), कुल क्षेत्र 60 हेक्टेयर ।
2. सीसल अनुसंधान केन्द्र, बामरा, ओडिशा (वर्ष 1962 में स्थापित), कुल क्षेत्र 106.4 हेक्टेयर ।
3. सनई अनुसंधान केन्द्र, प्रतापगढ़, उत्तर प्रदेश (वर्ष 1963 में स्थापित), कुल क्षेत्र 12.4 हेक्टेयर ।
4. केन्द्रीय पटसन एवं समवर्गीय रेशा बीज अनुसंधान केन्द्र, बुदबुद, वर्दवान, पश्चिम बंगाल (वर्ष 1956 में स्थापित), कुल क्षेत्र 86.1 हेक्टेयर ।
5. संस्थान के मुख्यालय, बैरकपुर परिसर का कुल क्षेत्रफल 62.8 हेक्टेयर है ।

इन केन्द्रों के अलावा बहु–स्थानीय परीक्षण तथा तकनीकी प्रणालियों की पुनः स्थापना हेतु अखिल भारतीय पटसन एवं समवर्गीय रेशा नेटवर्क परियोजना के तहत विभिन्न राज्य कृषि विश्वविद्यालयों में 9 तथा भारतीय कृषि अनुसंधान परिषद से सम्बध संस्थान में एक केन्द्र स्थापित हैं तथा इन केन्द्रों का नोडल एकक बैरकपुर मुख्यालय है।

यह संस्थान नवम्बर 2006 में प्रारम्भ किया गया एम.एम–प (टेकनोलॉजी मिशन ऑन जूट) का नोडल केन्द्र भी है। इसके तहत पूरे देश में 8 विभिन्न परियोजनाओं के परिचालन हेतु 15 सहयोगिक केन्द्र हैं । सभी परियोजनाओं के लक्ष्य प्राप्ति का समय सीमा मार्च, 2013 निर्धारित की गई थी जिसके अन्तर्गत इन परियोजनाओं के प्राप्त परिणामों से उत्साहित होकर, परिषद ने इसके पुनः पांच वर्षों के लिए कुल 10 नवीन परियोजनाओं की स्वीकृति प्रदान की है।

राजभाषा गतिविधियाँः

केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान में भारत सरकार की राजभाषा नीति का अनुपालन सुनिश्चित करने के लिए संस्थान में एक राजभाषा कक्ष है, इसमें एक वरिष्ठ वैज्ञानिक हिन्दी प्रभारी के रूप में तथा एक सहायक कार्यरत हैं।

इस संस्थान के वैज्ञानिकों द्वारा कृषकों के उनके जीवनयापन में गुणात्मक सुधार हेतु पटसन एवं समवर्गीय रेशे वाली फसलों के महत्वपूर्ण कृषि तकनीकों से अवगत कराया जाता है। कृषि के क्षेत्र में इस संस्थान की सकारात्मक 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। हमारा कर्तव्य बनता है कि हिन्दी की अस्मिता को बनाए रखने और इसकी गरिमा को बढ़ाने के लिए पूरी निष्ठा से कार्यालयीन दैनिक क्रिया कलापों में हिन्दी का अधिकाधिक प्रयोग करें।

संस्थान के राजभाषा अनुभाग ने हिन्दी पदों के अभाव के बावजूद भी संस्थान में कार्यरत वैज्ञानिकों/ अधिकारियों के बलबूते पर राजभाषा के प्रचार–प्रसार हेतु अनेक उल्लेखनीय कार्य किए है। के.प.स.रे.अ.सं. में हुई इन उपलब्धियों का संक्षिप्त विवरण प्रस्तुत हैंः–

प्रशासनिक उपलब्धियाँः–

संस्थान ने प्रशासन के क्षेत्र में भी काफी महत्पूर्ण उपलब्धियाँ प्राप्त की हैंः–

» 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 रबड 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 की चर्चायें सिर्फ राजभाषा में ही होती हैं।

» अन्य भाषा–भाषी लोगों के 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 कम्प्यूटरों में द्विभाषी रूप में काम करने की सुविधा उपलब्ध है।

» 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 अनुभाग में प्रविष्टियाँ, टिप्पणी, मसौदा लेखन व अन्य कार्य हिन्दी में होते 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, शब्दकोश, 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 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 के क्रिया कलापों में हिन्दी के अधिकाधिक प्रयोग सुनिश्चित करने के उद्देश्य से संस्थान के वेबसाइट पर हिन्दी–अंग्रेजी वाक्याशों को अपलोड़ किया गया है।

संस्थान व इसके उपकेन्द्रों में "हिन्दी पखवाड़ा /सप्ताह" का आयोजन

संस्थान के अधिकारियों/कर्मचारियों को कार्यालयीन काम–काज में राजभाषा हिंदी के प्रति अभिरुचि जागृत करने तथा उन्हें प्रेरित एवं प्रोत्साहित करने के उद्देश्य से दिनांक 13 से 27 सितम्बर, 2013 के दौरान हिन्दी पखवाड़ा का आयोजन किया गया। हिन्दी पखवाड़ा का उद्घाटन समारोह दिनांक 13.09.2013 को संस्थान के सभागार में बड़े घूम–धाम से मनाया गया। जिसकी अध्यक्षता संस्थान के निदेशक, डा. एस. सत्पथी जी के द्वारा किया गया तथा मुख्य अतिथि/वक्ता के रूप में श्री बी.पी. साह, प्राचार्य, केन्द्रीय विद्यालय (थल सेना), बैरकपुर, कोलकाता एवं डा. एन. सिंह, पूर्व प्राचार्य, केन्द्रीय विद्यालय, काशीपुर, कोलकाता को आमंत्रित किया गया था। उद्घाटन समारोह में संस्थान के सभी अधिकारियों/कर्मचारियों ने उत्साहपूर्वक भाग लिया। निदेशक महोदय ने अपने अध्यक्षीय संबोधन में संस्थान के सभी अधिकारियों/कर्मचारियों से अपने दैनिक काम–काज में हिन्दी का अधिकाधिक प्रयोग करने पर बल किया। तथा उन्होंने सभी अधिकारियों/कर्मचारियों से आग्रह किया कि वे हिंदी में कार्य करते समय सरल तथा सुबोध शब्दों का प्रयोग करें।उन्होंने संस्थान के सभी अधिकारियों/कर्मचारियों से यह भी आग्रह किया कि अब प्रत्येक सोमवार को कार्यालयीन कार्य हिंदी में करें, जिसकी शुरूआत दिनांक 16.09.2013 अर्थात् हिन्दी पखवाड़ा के प्रथम सोमवार से किया जाए।

डा. एस. सत्पथी, निदेशक (कार्यकारी), हिन्दी पखवाड़ा के उद्घाटन समारोह में अधिकारियों एवं कर्मचारियों को संबोधित करते हुए।

हिंदी में कार्य करने संबंधी परिपत्र पहले ही जारी किया जा चुका है। उन्होंने यह भी बताया कि संसदीय समिति समय–समय पर सरकारी कार्यालयों में हिंदी से संबंधित क्रिया–कलापों का निरीक्षण करती है, जिसमें यह देखा जाता है कि राजभाषा अधिनियम की धारा 3(3) का अनुपालन पूर्णतः किया जा रहा है या नहीं। उन्होंने सभी प्रभाग/अनुभाग के प्रधानों/प्रभारियों से आग्रह किया कि वे अधिकाधिक पत्राचार हिंदी में ही करें। मुख्य अतिथि के रूप में श्री बी.पी. साह, प्राचार्य, केन्द्रीय विद्यालय (थल सेना), बैरकपुर, कोलकाता ने अपने भाषण में कहा कि राजभाषा हिंदी ही एक मात्र ऐसी भाषा है जो विविधताओं से परिपूर्ण भारत के एक राज्य को दूसरे राज्यों से जोड़ती है। उन्होंने कहा कि संविधान में हिंदी को पूर्ण रूप से राजभाषा का दर्जा प्राप्त है एवं हमें निष्ठा भाव से इसे मजबूत करना चाहिए एवं राष्ट्रभाषा होने के कारण उसे सम्मान करना चाहिए। उन्होंने यह भी कहा कि भारत की सभी भाषाएं एक दूसरे की परिपूरक हैं अतएव हम भारत के किसी भी कोने में जाएं तो हमें सभी भाषाओं में सामंजस्य नजर आती है। उन्होंने कहा कि विदेशी कम्पनियों ने भी अपने व्यापार क्षेत्र को बढ़ाने के लिए विज्ञापन में हिन्दी भाषा का सहारा लिया। मुख्य वक्ता के रुप में आमंत्रित डा. एन. सिंह, पूर्व प्राचार्य, केन्द्रीय विद्यालय, काशीपुर, कोलकाता का संबोधन अत्यंत विनम्र, तार्किक एवं सरस होने के कारण सभागार में उपस्थित सभी अधिकारियों/कर्मचारियों की गंभीरता दर्शनीय थी। उन्होंने राजभाषा हिंदी के गतमान, वर्तमान एवं सक्षम भविष्य की चर्चा अत्यंत रोचक ढंग से की। उन्होंने कहा कि हिंदी आज सरकारी कामकाज की भाषा ही नहीं देश के कोने–कोने के जनमानस की अभिव्यक्ति की भाषा बन गई है। अतएव देश की शासकीय भाषा के साथ–साथ राष्ट्रीय एवं अंतर्राष्ट्रीय स्तर पर जन संपर्क की भाषा के रूप में आज हिंदी की पहचान सर्वविदित है। डा. दिलीप कुमार कुण्डु, प्रभागाध्यक्ष, फसल उत्पादन प्रभाग ने अपने भाषण में कहा कि भारत वर्ष में अनेक प्रांत हैं और अनेकों भाषाएं बोली जाती हैं। हिंदी एक सरल भाषा है, ज्यादातर भारतवासी इस भाषा को आसानी से समझते हैं। उन्होंने संस्थान के सभी अधिकारियों एवं कर्मचारियों से यह अनुरोध भी किया कि निदेशक महोदय द्वारा प्रत्येक सोमवार को हिन्दी में कार्य करने संबंधी जारी परिपत्र का अक्षरसः पालन करें तथा राजभाषा हिन्दी में काम–काज करने का हरसंभव प्रयास करें। डा. पी.जी. कर्मकार, प्रभागाध्यक्ष, फसल सुधार प्रभाग ने अपने वक्तव्य में बताया कि प्रत्येक व्यक्ति स्वेच्छा से हिंदी को सीखने का संकल्प लें जिससे हिंदी न केवल जन–साधारण की भाषा बने बल्कि कार्यालयीन काम–काज में उसका निर्विघ्न प्रयोग हो।

डा. पी.जी. कर्मकार, प्रभागाध्यक्ष, फसल सुधार, अधिकारियों एवं कर्मचारियों को संबोधित करते हुए।

उन्होंने आगे हिन्दी भाषी वैज्ञानिकों से आग्रह किया कि वे एक वैज्ञानिक शब्दावली तैयार करने का प्रयास करें। श्री के.पी. नाथ, वरिष्ठ वित्त एवं लेखा अधिकारी ने अपने भाषण में कहा कि हम सभी का दायित्व है कि कार्यालयीन कार्य हिंदी में करने का प्रयत्न करें ताकि हमारा राजभाषा के प्रति लगाव बना रहे। श्री एन.सी. दे, प्रशासनिक अधिकारी ने अपने वक्तव्य में बताया कि हमारे देश में विभिन्न भाषाएं बोली जाती हैं जिनमें हिंदी संपर्क भाषा की भूमिका निभा रही है साथ ही यह हमारी राजभाषा भी है। हम सभी को यथासंभव कार्यालयीन कार्य हिंदी में ही करना चाहिए। कार्यक्रम का संचालन करते हुए डा. सुरेन्द्र कुमार पाण्ड़ेय, वरिष्ठ वैज्ञानिक एवं प्रभारी, हिन्दी कक्ष ने मुख्य अतिथिओं/वक्ताओं, मंचासीन सदस्यों तथा उपस्थित अधिकारियों एवं कर्मचारियों को संस्थान की राजभाषा कार्यान्वयन समिति की ओर से हार्दिक स्वागत करते हुए उन्हें हिन्दी पखवाडा के अतंर्गत आयोजित किए जाने वाली विभिन्न हिन्दी प्रतियोगिताओं की जानकारी देते हुए यह आग्रह किया कि वे विभिन्न हिन्दी प्रतियोगिताओं में अधिकाधिक संख्या में भाग लेकर इस आयोजन को सफल बनाएं।

हिन्दी पखवाड़ा के दौरान संस्थान के हिन्दीत्तर भाषी तथा हिन्दी भाषी अधिकारियों/कर्मचारियों को हिन्दी कार्य के प्रति प्रोत्साहित किए जाने के उद्देश्य से विभिन्न प्रतियोगितायें आयोजित की गईं जो इस प्रकार हैं:–हिन्दी कविता–पाठ/तत्कालिक भाषण (एक्सटेम्पोर) (हिन्दीत्तर तथा हिन्दी भाषियों के लिए), "हिन्दी श्रुतलेखन एवं पठन" (हिन्दीत्तर भाषियों के लिए), हिन्दी निबंध लेखन (हिन्दीत्तर भाषियों के लिए), वाद–विवाद (हिन्दीत्तर तथा हिंदी भाषियों के लिए), शब्द पर्याय, वाक्यांश लेखन तथा अनुवाद (हिन्दीत्तर भाषियों के लिए), हिन्दी टंकण (टाइपिंग) (हिन्दीत्तर तथा हिंदी भाषियों के लिए), हिन्दी टिप्पण, मसौदा लेखन तथा पत्र लेखन (हिन्दीत्तर भाषियों के लिए), हिन्दी अनुलेखन एवं पठन प्रतियोगिता (कुशल सपोर्ट स्टाफ के लिएद्ध।

संस्थान में हिन्दी पखवाड़ा समारोह के अवसर पर हिन्दी प्रतियोगिताओं में भाग ले रहे प्रतिभागीगण।

इस प्रकार कुल 10 हिंदी प्रतियोगिताएं आयोजित की गईं जिसमें संस्थान के अधिकारियों/कर्मचारियों ने बढ़–चढ़कर भाग लिया। दिनांक 26.09.2013 को वैज्ञानिक विचार गोष्ठी भी आयोजित की गई जिसमें संस्थान से वैज्ञानिक लेख पुस्तिका एवं हिंदी पत्रिका प्रकाशित करने हेतु कई महत्वपूर्ण सुझाव दिये गये।

अंत में डा. सुनीति कुमार झा, वरिष्ठ वैज्ञानिक ने मुख्य अतिथियों/वक्ताओं सहित मंचासीन सभी गण्मान्य वयक्तियों और सभागार में उपस्थित अधिकारियों एवं कर्मचारियों को धन्यवाद ज्ञापित किया।

केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान, बैरकपुर, कोलकाता में दिनांक 27 सितम्बर, 2013 को बड़े ही उत्साह पूर्ण वातावरण में "हिन्दी पखवाड़ा समापन समारोह" का अयोजन किया गया।

विभिन्न हिन्दी प्रतियोगिताओं में सफल प्रतिभागियों को पुरष्कृत करते हुए मुख्य अतिथि, डा. आर.एस. पाण्डेय।

इस अवसर पर डा. आर.एस. पाण्ड़ेय, वैज्ञानिक अधिकारी एवं विभागीय अध्यक्ष, अनुसंधान विकास एवं प्रशिक्षण प्रभाग, एम.ए.टी.एम.ओ., सी. जो.ओ. काम्पलेक्स, साल्ट लेक, कोलकाता संस्थान की ओर से मुख्य अतिथि के रूप में सादर आमंत्रित थे । इस कार्यक्रम की अध्यक्षता संस्थान के निदेशक, डा. एस. सत्पथी ने की। इस अवसर पर मुख्य अतिथि, डा. आर.एस. पाण्ड़ेय, वैज्ञानिक अधिकारी एवं विभागीय अध्यक्ष, अनुसंधान विकास एवं प्रशिक्षण प्रभाग, कोलकाता ने अपने व्याख्यान में कहा कि सरकारी कार्य राजभाषा हिन्दी में करना हम सब का कर्तव्य है। हमारे संविधान में हिंदी को राजभाषा के रूप में मान्यता दी गई है। इसलिए हिंदी का प्रचार–प्रसार करना हम सबका संवैधानिक दायित्व है। उन्होंने सभागार में उपस्थित सभी अधिकारियों/कर्मचारियों को स्वरचित कविता–पाठ भी सुनाया।

अपने अध्यक्षीय संबोधन में निदेशक, डा. एस. सत्पथी ने कहा कि राजभाषा हिंदी में काम–काज करना कठिन नहीं है। हिंदी भारत के अधिकांश लोगों के द्वारा बोली जाने व समझी जानी वाली भाषा है। उन्होंने आगे कहा कि हिन्दी भाषा जनसाधारण तथा किसान भाइयों के साथ संपर्क बनाने का बेहतर व प्रभावी माध्यम है क्योंकि इस भाषा को लगभग हर भारतीय समझता या बोलता है । उन्होंने संस्थान में हिन्दी पखवाड़ा के सफल आयोजन हेतु हिन्दी कक्ष से जुड़े अधिकारियों/कर्मचारियों तथा अन्य प्रत्यक्ष/अप्रत्यक्ष रूप से जुड़े अधिकारियों/कर्मचारियों, प्रतियोगिताओं में परीक्षक/निरीक्षक (इनविजीलेटर) के रूप में कार्य करने वाले अधिकारियों/कर्मचारियों, वरि. वित्त एवं लेखा अधिकारी, प्रशासनिक अधिकारी तथा सभागार में उपस्थित अन्य सभी अधिकारियों/कर्मचारियों को धन्यवाद दिया। सभी विजेता प्रतियोगियों को (क्रमशः प्रथम, द्वितीय एवं तृतीय) संस्थान के निदेशक, डा. एस. सत्पथी, मुख्य अतिथि, डा. आर.एस. पाण्ड़ेय तथा श्री एन.सी.दे, प्रशासनिक अधिकारी के कर कमलों द्वारा पुरस्कार प्रदान किए गए।

अंत में निदेशक महोदय ने संस्थान में हिन्दी पखवाड़ा तथा इस दौरान आयोजित विभिन्न हिन्दी प्रतियोगिताओं के सफल आयोजन पर अपनी खुशी जाहिर करते हुए आशा व्यक्त की कि इस संस्थान में हिन्दी के प्रयोग में उत्तरोत्तर प्रगति होगी । हिन्दी पखवाड़ा समापन सत्र का संचालन डा. सुरेन्द्र कुमार पाण्ड़ेय, वरिष्ठ वैज्ञानिक एवं प्रभारी, हिन्दी कक्ष ने श्री मनोज कुमार राय, सहायक के सहयोग से किया। कार्यक्रम का समापन डॉ. सुनीति कुमार झा, वरिष्ठ वैज्ञानिक के धन्यवाद ज्ञापन के साथ सम्पन्न हुआ ।

सनई अनुसंधान केन्द्र, प्रतापगढ़, उत्तर प्रदेश में "हिन्दी पखवाड़ा" का आयोजन

सरकारी काम–काज में राजभाषा के रुप में हिन्दी के प्रति जागरूकता पैदा करने तथा उसके प्रभावों में गति लाने के लिए सनई अनुसंधान केन्द्र में भी हिन्दी पखवाड़ा का आयोजन दिनांक 13 से

27 सितम्बर, 2013 के दौरान किया गया, जिसका उद्घाटन केन्द्र के प्रभारी वैज्ञानिक, डा. मनोज कुमार त्रिपाठी ने किया तथा डा. बबिता चौधरी, वरिष्ठ वैज्ञानिक की देख–रेख में हिंदी पखवाड़ा आयोजित किया गया। पखवाड़ा के दौरान निबंध लेखन, वाद–विवाद, अंग्रेजी से हिन्दी अनुवाद आदि प्रतियोगिताएं आयोजित की गईं जिसमें केन्द्र के कर्मचारियों ने बढ़–चढ़कर हिस्सा लिया। सभी विजेता प्रतियोगियों को पुरस्कार भी प्रदान किए गए ।

हिन्दी पखवाड़ा समापन समारोह" का आयोजन दिनांक 27 सितम्बर, 2013 को किया गया। इस अवसर पर मुख्य अतिथि के रूप में डा. अखिलेश पाण्ड़ेय, प्रोफेसर, एम.डी.पी.जी. कॉलेज, प्रतापगढ़ तथा विशिष्ट अतिथि के रूप में श्रीमती अराधना पाण्ड़ेय, अध्यापिका, आदर्श बालिका विद्यालय, प्रतापगढ़ आमंत्रित थे। प्रो0 अखिलेश पाण्ड़ेय ने अपने संबोधन में हिन्दी के विकास तथा इसे देश के विभिन्न हिस्सों में लोकप्रिय बनाने हेतु विस्तार से चर्चा किया। उन्होंने कहा कि समस्त सरकारी कार्य हिन्दी में होने चाहिए जिससे देश का सामान्य जनमानस उसे सहजता से समझ सके। विशिष्ट अतिथि के रूप में श्रीमती अराधना पाण्ड़ेय ने हिन्दी की वर्तमान स्थिति से असंतोष व्यक्त किया तथा उन्होंने कहा कि बिना हिन्दी भाषा के विकास से देश का समग्र विकास संभव नहीं है। कार्यक्रम की अध्यक्षता कर रहे वैज्ञानिक प्रभारी, डा. मनोज कुमार त्रिपाठी ने अपने संबोधन में शोध कार्य एवं शोध पत्रों को हिन्दी में प्रकाशित करने पर बल दिया तथा उन्होंने केन्द्र के अधिकारियों/कर्मचारियों से दैनिक कार्यालयीन कार्य हिन्दी में करने पर बल दिया। डा. बबिता चौधरी, वरिष्ठ वैज्ञानिक के धन्यवाद ज्ञापन के साथ हिन्दी पखवाड़ा का समापन हुआ।

सीसल अनुसंधान केन्द्र, बामरा, ओडिशा में "हिन्दी पखवाड़ा" का आयोजन

सीसल अनुसंधान केन्द्र के अधिकारियों/कर्मचारियों में राजभाषा हिंदी के प्रति अभिरुचि जागृत करने तथा उन्हें प्रेरित एवं प्रोत्साहित करने के उद्देश्य से हिंदी पखवाड़ा दिनांक 16.09.2013 से 30.09.2013 तक बड़े हर्षोल्लास के साथ मनाया गया। जिसका उद्घाटन केन्द्र के वैज्ञानिक प्रभारी, डा. ए.के. झा ने किया। उन्होंने अपने अधीनस्थ कार्यरत अधिकारियों/कर्मचारियों से अपना कार्यालयीन कार्य यथा संभव हिन्दी में करने पर बल दिया। हिन्दी पखवाड़ा के दौरान विभिन्न प्रतियोगिताओं का आयोजन किया गया। इन प्रतियोगिताओं में विजेता अधिकारियों/कर्मचारियों को पुरस्कार भी वितरित किए गए।

रेमी अनुसंधान केन्द्र, सरभोग, बरपेट्टा, असम में "हिन्दी सप्ताह" का आयोजन

रेमी अनुसंधान केन्द्र में हिंदी सप्ताह बड़ी उत्साह और उल्लास के साथ मनाया गया जिसका उद्घाटन दिनांक 14.09.2013 को किया गया। केन्द्र के वैज्ञानिक प्रभारी, डा. अमित कुमार शर्मा ने हिंदी सप्ताह का उद्घाटन किया। अपने संबोधन में उन्होंने केन्द्र के अधिकारियों एवं कर्मचारियों से कहा कि हिंदी के प्रयोग में हमारा संकोच ही सबसे बड़ी बाधा है, यदि हम संकोच को दरकिनार कर कार्यालय के रोजमर्रा कार्य हिन्दी में करें तो हिन्दी में काम करने में कोई कठिनाई नहीं आएगी। यद्यपि हमारे देश में विभिन्न भाषाएं बोली जाती हैं किन्तु हिन्दी संपर्क भाषा का कार्य निभा रही है साथ ही हमारी राजभाषा भी है। उन्होंने केन्द्र के अधिकारियों/कर्मचारियों से आग्रह किया कि अपना कार्यालयीन कार्य हिंदी में ही करें । इस हिंदी सप्ताह के दौरान हिंदी में विभिन्न प्रतियोगिताएं आयोजित की गईं जिसमें केन्द्र के अधिकारियों/कर्मचारियों ने उत्साहपूर्वक भाग लिया। हिन्दी सप्ताह के दौरान दिनांक 17.09.2013 को हिंदी भाषण एवं कृषि सामान्य ज्ञान प्रतियोगिताओं का आयोजन किया गया। इस अवसर पर सी.आर.पी.एफ. के कम्पनी प्रभारी, श्री ललन यादव कार्यक्रम में मुख्य अतिथि के रूप आमंत्रित थे। मुख्य अतिथि के द्वारा सफल प्रतिभागियों को पुरस्कार प्रदान किए गए।

हिन्दी सप्ताह का समापन समारोह दिनांक 20.09.2013 को आयोजित किया गया। इस दौरान डा. ए.के. शर्मा, प्रभारी वैज्ञानिक, डा. एस. पी. गवांडे, वैज्ञानिक, श्री एन.एल. दास, तकनीकी अधिकारी तथा श्री डी. बोरो, सहायक प्रशासनिक अधिकारी आदि ने कार्यक्रम में अपने–अपने विचार रखे।

अंत में श्री पंकज दास, सहायक के धन्यवाद ज्ञापन के साथ हिन्दी सप्ताह समारोह का समापन हुआ।

केन्द्रीय पटसन एवं समवर्गीय रेषा अनुसंधान संस्थान, बैरकपुर, कोलकाता में एक दिवसीय हिन्दी कार्यषाला का आयोजन

केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान, बैरकपुर, कोलकाता की राजभाषा कार्यान्वयन समिति के तत्वावधान में दिनांक 23, अगस्त 2013 को संस्थान के अधिकारियों/ कर्मचारियों की हिन्दी में कार्य करने की झिझक दूर करने के उद्देश्य से एक दिवसीय हिन्दी कार्यशाला का आयोजन किया गया। कार्यशाला की अध्यक्षता संस्थान के निदेशक, डा. एस. सत्पथी ने की। डा. उमाकान्त दुबे, रजिस्ट्रार, पी.पी.वी.एफ.आर.ए., नई दिल्ली मुख्य अतिथि ने अपने भाषण में कहा कि हमारे संविधान में हिंदी को राजभाषा का दर्जा दिया गया है और हम सभी का कर्तव्य है कि हिंदी में काम–काज करने का हर सम्भव प्रयास करें। उन्होंने सभी प्रतिभागियों से अनुरोध किया कि अपने दैनिक कार्यालयीन कार्यों में हिंदी का अधिक से अधिक प्रयोग करें तथा कार्यशाला में प्रस्तुत किए गए पारिभाषिक पद–बंदों का रोजमर्रा के कार्यालयीन कामकाज में इस्तेमाल करने

का भी आग्रह किया। डा. डी.के. दे, पूर्व प्रभागाध्यक्ष, पादप प्रजनन विभाग, वी.सी.के.वी., कल्याणी, नदिया ने अपने विचार व्यक्त करते हुए कहा कि कार्यशाला में बहुत कुछ सीखने तथा हिंदी में कार्य करने की जानकारी मिलती है। डा. डी.के. कुण्डु, प्रभागाध्यक्ष, फसल उत्पादन ने कार्यशाला में सभी अधिकारियों/कर्मचारियों को हिन्दी में कार्य करने की अपील करते हुए सभी से आग्रह किया कि कार्यशाला से भरपूर लाभ उठाया जाना चाहिए, जिससे कि कार्यालयीन काम–काज में हिंदी के प्रयोग में सार्थक सुधार हो सके। डा. पी.जी. कर्मकार, प्रभागाध्यक्ष, फसल सुधार ने कहा कि हिन्दी सरल और सहज भाषा है जिसके माध्यम से हम अपने विचारों को सहजता से व्यक्त कर सकते हैं।

संस्थान के निदेशक डा. एस. सत्पथी ने अपने अध्यक्षीय संबोधन में सभी अधिकारियों/कर्मचारियों का स्वागत करते हुए कहा कि हम सभी का दायित्व है कि कार्यालय का अधिकाधिक कार्य हिन्दी में करने का प्रयास करें।

डा. पी.जी. कर्मकार, प्रभागाध्यक्ष, फसल सुधार, अधिकारियों एवं कर्मचारियों को संबोधित करते हुए।

उन्होंने आगे कहा कि हिन्दी में काम करने से बिल्कुल न झिझकें। कार्यालयीन कामकाज में सरल और सहज हिंदी के प्रयोग पर बल देते हुए यह विचार व्यक्त किया कि राजभाषा का प्रयोग एवं उसका उचित प्रचार–प्रसार हमारा संवैधानिक उत्तरदायित्व है। प्रत्येक अधिकारी/कर्मचारी अपने अन्य कार्यालयीन कर्तव्यों के समान ही इस कर्तव्य को भी पूरी निष्ठा से करें। अंत में उन्होंने संस्थान के सभी अधिकारियों/कर्मचारियों से अपील किया कि सप्ताह के प्रथम दिन अर्थात प्रत्येक सोमवार को कार्यालयीन कार्य हिन्दी में करने का प्रयास करें।

इस कार्यशाला में श्री राम नारायण सरोज, उप निदेशक (पूर्व), हिंदी शिक्षण योजना, राजभाषा विभाग, गृह मंत्रालय, भारत सरकार, निजाम पैलेस, कोलकाता ने संघ की राजभाषा नीति, नियम, राजभाषा का महत्व, हिन्दी प्रोत्साहन योजना, राजभाषा अधिनियम/नियम, टिप्पण एवं मसौदा लेखन आदि विषयों पर व्याख्यान दिए तथा अधिकारियों/कर्मचारियों के शंकाओं का समाधान किया। श्री राम नारायण सरोज, उप निदेशक (पूर्व), हि.शि.यो., कोलकाता ने प्रशिक्षणार्थियों को हिन्दी में टिप्पण/आलेखन के सरल प्रयोग को बताते हुए अभ्यास करवाया।

मुख्य वक्ता श्री राम नारायण सरोज हिन्दी कार्यशाला में प्रशिक्षणार्थियों को संबोधित करते हुए।

उन्होंने राजभाषा के सरल सहज अनुप्रयोग के साथ–साथ कार्यालय प्रयोजनार्थ संक्षिप्त तथा शुद्ध हिंदी लिखने के कौशल से संबंधित विषयों पर व्याख्यान भी दिया। इसके साथ, इन विषयों का अभ्यास भी कराया गया। डा. सुरेन्द्र कुमार पाण्ड़ेय, वरिष्ठ वैज्ञानिक एवं प्रभारी, हिन्दी कक्ष ने संस्थान के सभी अधिकारियों/कर्मचारियों से अनुरोध किया कि वे इस कार्यशाला से सर्वाधिक लाभ उठाएं तथा हिंदी को कार्यालयीन तौर पर प्रयोग करने की विधियों पर अपने आप को अद्यतन करें।

हिन्दी कार्यशाला का संचालन डा. सुरेन्द्र कुमार पाण्ड़ेय, वरिष्ठ वैज्ञानिक एवं प्रभारी, हिन्दी कक्ष ने श्री मनोज कुमार राय, सहायक के सहयोग से किया।

डा. सुनीति कुमार झा, वरिष्ठ वैज्ञानिक के धन्यवाद ज्ञापन के साथ कार्यशाला का समापन हुआ।

केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान (भारतीय कृषि अनुसंधान परिषद), बैरकपुर, कोलकाता में एक दिवसीय हिन्दी कार्यशाला का आयोजन

केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान, बैरकपुर, कोलकाता की राजभाषा कार्यान्वयन समिति के तत्वावधान में संस्थान में दिनांक 25 जनवरी, 2014 को राजभाषा कार्य से जुड़े एवं हिन्दी का कार्यसाधक ज्ञान रखने वाले अधिकारियों/कर्मचारियों की हिन्दी में काम करने की झिझक को दूर करने के उद्देश्य से एक दिवसीय हिन्दी कार्यशाला का आयोजन किया गया। इस कार्यशाला की

उद्घाटन सत्र की अध्यक्षता संस्थान के निदेशक, माननीय डा. एस. सतपथी ने की।

डा. एस. सत्पथी, निदेषक (कार्यकारी), हिन्दी कार्यषाला में अधिकारियों एवं कर्मचारियों को संबोधित करते हुए।

उन्होंने संस्थान के कर्मचारियों/अधिकारियों को संबोधित करते हुए उद्गार व्यक्त किया कि हिंदी हमारी राष्ट्रीय अस्मिता का प्रतीक है। यह एक सरल और सहज भाषा है जिसके माध्यम से हम अपने विचारों को सहजता से व्यक्त कर सकते हैं। उन्होंने आगे यह भी कहा कि हमें अपने कार्यालयीन कार्यों में राजभाषा हिंदी का अधिकाधिक प्रयोग कर संवैघानिक अपेक्षाओं की पूर्ति के लिए सदैव तत्पर रहना चाहिए। उन्होंने कार्यालयीन काम–काज में सरल और सहज हिंदी के प्रयोग पर भी बल दिया। डा. दिलीप कुमार कुण्डु, प्रधान वैज्ञानिक एवं प्रभागाध्यक्ष, फसल उत्पादन ने अधिकारियों/कर्मचारियों से आह्वान किया कि कार्यालय द्वारा आयोजित कार्यशाला से भरपूर लाभ उठाया जाना चाहिए, जिससे कि कार्यालयीन काम–काज में हिंदी के प्रयोग में सार्थक वृद्धि हो सके। डा. पी.जी. कर्मकार, प्रधान वैज्ञानिक एवं प्रभागाध्यक्ष, फसल सुधार प्रभाग ने राजभाषा के सरल एवं सहज अनुप्रयोग के साथ–साथ कार्यालय प्रयोजनार्थ हिंदी पत्राचार पर बल दिया।

डा. पी.जी. कर्मकार, प्रभागाध्यक्ष, फसल सुधार, हिन्दी कार्यशाला में अधिकारियों एवं कर्मचारियों को संबोधित करते हुए।

श्री एन. सी. दे, प्रशासनिक अधिकारी ने अपने भाषण में संस्थान के अधिकारियों एवं कर्मचारियों को दैनंदिन कार्यालयीन काम में राजभाषा हिंदी के प्रयोग पर बल दिया। इस कार्यशाला का संचालन डा. सुरेन्द्र कुमार पाण्डेय, वरिष्ठ वैज्ञानिक एवं प्रभारी, हिंदी कक्ष ने श्री मनोज कुमार राय, सहायक के सहयोग से किया। उन्होंने राजभाषा हिंदी में हो रहे प्रगति पर विस्तार से संस्थान के अधिकारियों एवं कर्मचारियों को अवगत कराया।

इस कार्यशाला में व्याख्यान हेतु श्री आर.डी. शर्मा, राष्ट्रीय पटसन एवं समवर्गी रेशा प्रौद्योगिकी अनुसंधान संस्थान, कोलकाता एवं श्रीमती पूनम दीक्षित, सहायक निदेशक (राजभाषा), हिंदी शिक्षण योजना, राजभाषा विभाग, गृह मंत्रालय, भारत सरकार, निजाम पैलेस, कोलकाता को आमंत्रित किया गया था। श्री शर्मा ने कम्प्यूटर पर हिंदी से यूनिकोड पद्धति द्वारा कार्य करने संबंधी विषय पर पावर प्वांइट प्रस्तुतिकरण किया। श्रीमती पूनम दीक्षित, सहायक निदेशक (राजभाषा), हिंदी शिक्षण योजना, राजभाषा विभाग, गृह मंत्रालय, भारत सरकार, निजाम पैलेस, कोलकाता ने विभिन्न प्रकार के पत्राचार तथा राजभाषा कार्यान्वयन में आने वाली समस्याओं के विषय पर बहुत ही रोचक व्याख्यान के माध्यम से सविस्तार एवं सोदाहरण सहित समझाया।

मुख्य वक्ता, श्रीमती पूनम दीक्षित, हिन्दी कार्यशाला में अधिकारियों एवं कर्मचारियों को प्रशिक्षण प्रदान करती हुईं।

उन्होंने प्रतिभागियों को व्याकरण, वर्तनी की अशुद्धियां, लिंग आदि विषयों पर ऐसे उदाहरण प्रस्तुत किए जो कि प्रतिभागियों के जेहन में अक्षरसः समा गए। उन्होंने प्रतिभागियों को राजभाषा संबंधी अड़चनों से अवगत कराते हुए उनकी व्याकरणिक कमियों को दूर करने के गुर भी सिखाया। सभी प्रतिभागियों ने पूरे सत्र में शांतिपूर्ण ढंग से उत्साहपूर्वक ज्ञानार्जन किया।

अंत में डा. सुरेन्द्र कुमार पाण्डेय, वरिष्ठ वैज्ञानिक एवं प्रभारी, हिंदी कक्ष द्वारा प्रस्तुत धन्यवाद ज्ञापन के साथ हिंदी कार्यशाला का समापन हुआ।

21. Committees

21.1. Research Advisory Committee (RAC)

The Research Advisory Committee (RAC) meeting of the institute was held during 19-20th March, 2014 under chairmanship of Prof. S. K. Sanyal, Former Vice Chancellor, BCKV, West Bengal. Dr. R. Singh, Principal Scientist & Head, Division of Agricultural Physics, IARI, Dr. K. Ramaraju, Director, Centre for Plant Protection Studies, TNAU and Dr. M. A. A. Baig, Professor and Director, Comprehensive Scheme, OUAT, attended the meeting as members. Dr. D.K. Kundu Head, Crop Production Division acted as the Member Secretary. The Chairman and Members of the RAC appreciated the efforts of the Director and all the scientists of CRIJAF for their excellent research work for development and identification of new improved varieties and development of technologies to bring economic prosperity to the farmers engaged in production of jute and allied fibre crops. The committee made following recommendations after thorough interaction with the scientists on the ongoing research programmes at CRIJAF and its Regional Research Stations for further strengthening of the research activities of the institute.

- Collection and evaluation of germplasms with special reference to fibre quality (fineness), tolerance to biotic stress (stem rot) and abiotic stresses (water stress, soil acidity and salinity) and other attributes like nutritive value of jute and roselle and for effective utilization of the identified species.
- Construction of high saturated linkage map of jute and molecular tagging of useful genes influencing quality and tolerance to different kinds of stress along with quantitative traits.
- Identification of quality parameters for jute fibres required for making diversified products and screening techniques in collaboration with NIRJAFT.
- Collection/introduction of flax germplasms from foot hills of the Himalayas and their evaluation for fibre productivity. Standardization of production technology for flax as a fibre crop.
- Evaluation of wild species of *Crotolaria* for agro-morphological traits and their possible applications. Assess the effects of micronutrient application on growth & fibre productivity of sunnhemp.
- Collection of ramie germplasms and their evaluation at molecular level for yield and fibre quality.
- Identification of the bottlenecks for quality jute seed production in West Bengal and development of production technology in farmers' participatory mode to overcome the field constraints.
- Determination of soil characteristics in jute growing tracts of India and study on salinity tolerance in jute.
- Study the fibre production potential of sisal crop grown primarily for soil conservation.
- Development of multi-crop seeder suitable for jute- and sisal-based cropping systems and study feasibility of fitting medicinal & aromatic plants in jute- and sisal-based cropping systems.
- Identification of new efficient microbes and development of low-cost, improved technology for retting of jute under humid and moderate temperature conditions.
- Documentation and molecular diagnosis of newly emerging pests and diseases in jute and allied fibres, and studies on ecology of insect pests under changing climate as well as exploitation of the pheromones for behavioural studies.
- Supplement the HPR study on resistance of jute to yellow mite and Bihar hairy caterpillar by initiating collaborative programme with other institutions/ organizations for ascertaining the volatiles imparting the mechanism of resistance.
- Place emphasis on biological control of diseases and pests through endophytes with diverse strains, PGPR–antagonistic consortia and indigenous strains.
- Analyze residues of the recommended pesticides in edible parts of jute and roselle plants.
- Study the variability of *Macrophomina phaseolina* for virulence and identify resistant sources against virulent strain.

- Assess and refine newly developed technologies in farmers' fields and study impact of different technologies. In addition to Front Line Demonstration, emphasis will be given on technology transfer through farmers' producer groups and SHG.
- Enhancement of livelihood security for farmers through dissemination of improved technologies and development of entrepreneurship among rural youth and farm women in diversified uses of jute and allied fibres.

Research Advisory Committee (RAC) meeting is in progress

RAC members releasing publications during inagural session

21.2. Institute Management Committee (IMC)

The 30th Institute Management Committee (IMC) meeting of CRIJAF was held on 27th August, 2013 under the chairmanship of Dr. S. Satpathy, Director (Acting), CRIJAF. Other members present in the meeting were Dr. Satyanand Sushil, Plant Protection Advisor, Government of India, Dr. M. Singh, Head, Crop Improvement Division, IIVR, Varanasi and Dr. (Mrs.) Mayabini Jena, Pr. Scientist, CRRI, Cuttack. Mr. N.C. Dey AO, CRIJAF as member

Institute Management Committee (IMC) meeting is in progress

secretary, organized the meeting. Heads of the Divisions/ Section, Scientists in-charge, AINP on JAF, Scientists in-charge of Regional Stations, Programme Coordinator, KVK, Budbud, scientists in-charge, PME Cell and the Sr. FAO, CRIJAF, were also present in the meeting as co-opted members. The achievements made in research and development during 2012-13 was presented and other various related agendas were discussed. The IMC expressed satisfaction over the progress made by the institute over last one year.

21.3. Institute Research Council (IRC)

The Institute Research Council (IRC) meeting was organized under the chairmanship of Prof. B.S. Mahapatra, Director, CRIJAF to review the on-going in-house, externally funded research projects during 9-10th

Institute Research Council (IRC) meeting is in progress

April, 2013 and the new research proposals submitted by the Scientists. All the HoDs, Scientists from the Regional Station, Programme Coordinator, KVK, Budbud and

Dr. A.K. Jana, Ex-Principal Scientist and PMC member were also present in the IRC meeting. The progress of ongoing research projects were reviewed further 11 new research project proposals were discussed and necessary modifications were recommended. After completion of due time, 12 research projects were concluded with specific recommendations.

21.4. Project Monitoring Committee (PMC)

The project monitoring committee meating was held on 1st February, 2014 under the chairmanship of Director and external members to evaluate the 12 concluded projects. During, 2012-13, out of 12 projects 2 were graded as excellent, 8 were very satisfactory and one was satisfactory.

21.5. Results Framework Document (RFD) Committee

Results Framework Document (RFD) Committee has been constituted as per the guidelines of the ICAR. The committee meets periodically to discuss and finalize the

Project Monitoring Committee (PMC) meeting is in progress

success indicators of the monthly RFD, midterm and annual RFD performance report before sending to ICAR. The institute set **"EXCELLENT"** performance standard and achieved a total composite score of 97.5% in the annual (1st April, 2013 to 31st March, 2014) performance evaluation report.

22. Distinguished Visitors

Name of the visitor	Affiliation	Date
Dr. Atanu Purkayastha, IAS	Joint Secretary, DAC, Ministry of Agriculture, GoI	14.06.2013 27.11.2013
Dr. Anupam Barik	Additional Commissioner (Crops), Ministry of Agriculture, GoI	14.06.2013 27.11.2013
Padmashree Prof. E.A. Siddiq	Former, DDG (CS), ICAR, New Delhi	22.06.2013 29.10.2013
Dr. A. Bandyopadhyay	National Coordinator, NFBSFARA, ICAR	22.06.2013
Dr. S.K. Chattopadhyay	Director, CIRCOT, Mumbai	22.06.2013 29.10.2013
Dr. N.K. Singh	National Professor, BP Pal Chair & Co-ordinator, ICAR-NPTC, New Delhi	22.06.2013
Prof. S.K. Datta	DDG (Crop Science), ICAR, New Delhi	22.06.2013 27.06.2013 20.07.2013
Sri Moloy Ghatak	Hon'ble Minister-in-Charge for Agriculture, Govt. of West Bengal	27.06.2013
Sri Arup Roy	Hon'ble Minister-in-Charge for Agriculture Marketing, Govt. of West Bengal	27.06.2013
Sri Pradip Majumdar	Advisor (Agriculture) to Chief Minister of West Bengal	27.06.2013
Dr. Satyanand Sushil	Plant Protection Advisor, Government of India	27.08.2013
Dr. K.S. Varaprasad	Project Director, DOR, Hyderabad	04.09.2013
Dr. J.C. Bhatt	Director, VPKAS, Almora	04.09.2013
Dr. C. Chattopadhyay	Director, NCIPM, New Delhi	04.09.2013
Sri. Sujit Mitra	Director (CS), ICAR, New Delhi	04.09.2013 06.11.2013
Dr. Michael Deyholos	Professor, University of Alberta, Canada	04.10.2013
Dr. H.S. Gupta	Director, IARI, New Delhi	29.10.2013
Dr. K. Manoharan	Director, DJD, Kolkata	20.07.2013
Dr. S. Rajendra Prasad	Project Director, DSR, Mau	30.12.2013
Prof. S.K. Sanyal	Former Vice-Chancellor, BCKV, Kalyani	10.02.2014 19.03.2014
Dr. N. Gopalakrishnan	ADG (Commercial Crops), ICAR, New Delhi	19.03.2014
Dr. K. Ramaraju	Director, CPPS, TNAU, Coimbatore	19.03.2014
Dr. R. Singh	Head, Division of Agricultural Physics, IARI, New Delhi	19.03.2014
Dr. M.A.A. Baig	Director, Comprehensive Scheme, OUAT, Bhubaneswar	19.03.2014

Prof. S. K. Sanyal, Former Vice-Chancellor, BCKV, Kalyani & Chairman, RAC delivering the Foundation Day lecture

Padmashree Prof. E.A. Siddiq Former, DDG (CS), ICAR, New Delhi and Prof. S. K. Datta DDG (Crop Science), ICAR, New Delhi during the advisory committee meeting of NFBSFARA

Dr. N. Gopalakrishnan, ADG (Commercial Crops), ICAR, New Delhi during RAC meeting

Dr. H.S. Gupta, Director, IARI, New Delhi interacting with Director

Dr. A. Purkayastha, IAS, Joint Secretary, DAC, Ministry of Agricuture, GoI being welcomed during his visit

Dr. Michael Deyholos, Professor, University of Alberta, Canada interacting with the Scientists

Prof. S. K. Datta, DDG (CS), ICAR interacting with scientists and farmers during the review meeting on jute seed production under RKVY

Dr. A. Bandyopadhyay, National Coordinator, NFBSFARA, ICAR visits ramie experimental field

Prof. S. K. Datta, DDG (CS), ICAR and Dr. A. Purkayastha, IAS, (Joint Secy.) inaugurating the "Seed Quality Lab"

Sri Moloy Ghatak, Hon'ble Minister-in-Charge for Agriculture, GoWB, addressing the farmers during Farmers' Day.

23. Staff Position

Table 22.1: Staff position of CRIJAF and with its four research-stations as on 31.03.2014

Grade	Sanctioned strength	Men in position					
		CRIJAF (HQ)	CSRSJAF	RRS	SRS	SH.RS	Total
Scientist	74+1	42+1	02	02	01	02	49+1
Technical	108	41	11	05	06	05	68
Administration	62	28	01	03	02	02	36
Skilled supporting staff	92	30	03	01	03	03	40

Table 22.2: Staff position at Krishi Vigyan Kendra, Budbud, Burdwan as on 31.03.2014

Designation	Sanctioned strength	Men in position
Programme Coordinator	01	00
Subject Matter Specialist	06	06
Farm Manager	01	01
Programme Assistant (Computer)	01	01
Programme Assistant	01	01
Office Superintendent-cum-Accountant	01	01
Stenographer	01	01
Driver	02	02
Supporting Staff	02	02
Total	16	15

24. Personnel

Name	Designation	E-Mail ID
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Ganesh Kundu	Technical Officer (T5)	--
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S. Chakraborty	Technical Officer (T5)	--
S. K. Phirose	Technical Officer (T5)	--
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25. Revenue Generation and Financial Statement

The financial statement of the institute, AINP on JAF, TMJ and KVK. The statement of revenue generation at CRIJAF HQ, Barrackpore, CSRSJAF, Budbud; Ramie Research Station, Sorbhog; Sisal Research Station, Bamra and Sunnhemp Research Station, Pratapgarh are presented in the table 25.1, 25.2, 25.3 and 25.4.

Table 25.1. Financial statement of CRIJAF for the year 2013-14

(Rs. in Lakhs)

Sub-Head	Non Plan R.E. 2013-14	Non Plan Expenditure up to 31-03-2014	Plan R.E. 2013-14	Plan Expenditure up to 31-03-2014
Establishment Charges	1300.00	1268.07	0.00	0.00
Wages	370.00	369.88	0.00	0.00
Retirement Benefit	320.00	319.15	0.00	0.00
O.TA.	0.40	0.26	0.00	0.00
T.A.	8.00	8.00	13.00	12.99
Other Charges	186.35	153.20	210.00	209.32
Works-Maintenance				
a) Residential	25.00	24.70	0.00	0.00
b) Non Residential	30.00	29.96	0.00	0.00
c) Equipment & others	10.00	9.98	0.00	0.00
d) Minor Works	11.00	10.90	0.00	0.00
Major Works	0.00	0.00	0.00	0.00
H.R.D	0.00	0.00	7.00	6.77
Equipment	8.00	7.96	36.00	35.93
Information Technology	0.00	0.00	3.53	3.53
Furniture	3.00	2.98	0.83	0.83
Library Books & Journals	0.00	0.00	4.64	3.65
Total	**2271.75**	**2205.04**	**275.00**	**273.02**

Table 25.2. Financial statement for AICRP on Jute & Allied Fibres, Technology Mission on Jute (MM-I)) and KVK for the year 2013-14

(Rs. in Lakhs)

Head	Target	Achievement (Upto 31-03-2014)
A.I.C.R.P on J & AF	400.00	399.33
T.M.J. (MM I)	60.00	59.98
K.V.K.	100.00	99.81

Table 25.3. Actual realization of revenue receipts 2013-14

(Rs. in Lakhs)

Target	Achievement (Upto 31-03-2014)
41.50	48.42

Table 25.4. Classification of revenue generated at CRIJAF and its sub-stations

(Rs. in Lakhs)

Institute / Sub-stations	Total Revenue
CRIJAF (HQ), Barrackpore	28.63
CRSRJAF, Budbud, Burdwan	7.46
Ramie Research Station, Sorbhog, Barpeta	4.64
Sisal Research Station, Bamra, Sambalpur	5.56
Sunnhemp Research Station, Pratapgarh	2.13
TOTAL	48.42

26. Agricultural Meteorology

The meteorological data of CRIJAF (HQ), Barrackpore; Sunnhemp Research Station, Pratapgarh, Uttar Pradesh; Ramie Research Station, Sorbhog, Assam and Sisal Research Station, Odisha are presented in tables 26.1, 26.2, 26.3 and 26.4 respectively.

Table 26.1: Meteorological data of CRIJAF, Barrackpore, West Bengal

Month	Temperature (°c)		R.H. (%)		Rainfall (mm)	Rainy Days	Bright Sunshine hour (Hrs.)	Evaporation (mm)	Wind Speed (km/hr)	Soil Temperature (°c)					
										Morning			Noon		
	Max.	Min.	Morning	Noon						5 cm	15 cm	30 cm	5 cm	15 cm	30 cm
Apr-13	35.96	24.01	88.53	48.13	77.2	02	8.07	5.58	4.11	28.23	29.68	31.40	40.98	36.86	31.73
May-13	34.34	25.59	88.29	69.19	128.0	09	5.12	4.48	6.40	29.76	30.65	31.83	36.73	35.01	32.06
Jun-13	33.10	26.20	91.93	76.30	406.1	17	5.07	3.48	2.95	28.46	29.05	29.97	34.05	32.40	31.35
Jul-13	31.94	26.58	93.67	81.87	203.0	19	3.95	3.02	2.37	28.12	28.72	29.79	32.74	31.52	30.01
Aug-13	32.21	25.86	95.19	81.03	444.6	16	3.55	3.05	1.03	27.82	28.26	29.55	32.67	31.07	29.52
Sep-13	32.87	26.18	95.00	67.66	127.4	06	4.40	2.85	0.80	27.53	28.42	29.67	33.90	32.06	29.99
Oct-13	29.88	24.02	96.30	80.06	388.0	15	3.51	1.95	1.00	25.77	26.76	28.06	31.18	29.69	28.24
Nov-13	28.78	16.95	93.70	52.90	000.0	00	7.51	2.22	0.93	19.14	21.47	23.30	27.71	25.29	23.62
Dec-13	26.08	13.07	97.87	54.16	00.0	00	6.65	1.66	1.06	15.59	17.34	19.55	24.20	21.95	19.85
Jan-14	23.41	11.33	98.25	57.58	00.0	00	5.86	1.61	1.77	14.64	16.27	18.09	21.97	19.63	18.19
Feb-14	27.23	14.45	94.78	47.21	22.2	02	7.15	2.62	1.88	17.85	19.66	21.61	28.01	24.73	21.77
Mar-14	32.84	19.61	90.29	40.64	14.0	02	7.27	4.36	2.20	23.80	25.36	27.20	36.69	31.69	28.45

Table 26.2: Meteorological data of Sunnhemp Research Station, Pratapgarh, Uttar Pradesh

Month	Temperature (°C)		R.H (%)		Rainfall (mm)	No. of rainy days
	Max.	Min.	Morning	Afternoon		
Apr-13	37.67	21.15	69.73	31.30	1.6	1.0
May-13	41.39	26.09	70.13	30.74	0.0	0.0
Jun-13	33.88	26.28	86.57	72.00	492.8	12.0
Jul-13	33.40	26.48	88.74	74.70	191.2	16.0
Aug-13	32.36	25.32	91.48	76.77	273.9	18.0
Sep-13	33.33	25.38	89.46	71.16	108.0	7.0
Oct-13	30.04	20.99	89.84	71.88	142.6	11.0
Nov-13	27.90	11.68	89.27	65.43	0.0	0.0
Dec-13	24.16	9.06	90.12	66.64	0.0	0.0
Jan-14	18.48	10.20	96.41	75.96	72.1	6.0
Feb-14	23.00	10.88	92.57	68.03	21.6	7.0
Mar-14	30.44	15.79	79.35	61.77	53.0	1.0

Table 26.3: Meteorological data of Ramie Research Station, Sorbhog, Assam

Month	Temperature (°C)		Rainfall (mm)	No. of Rainy days	No. of Cloudy days	Soil Temperature at different depths		Soil Temperature at different depths		Relative Humidity (%)
	Max.	Min.				5 cm	15 cm	5 cm	15 cm	
Apr-13	29.66	19.55	148.40	16	27	23.29	24.69	33.52	29.66	79.00
May-13	30.13	22.14	403.10	23	24	25.80	26.80	34.22	30.38	87.00
Jun-13	33.45	25.39	337.30	14	22	28.33	29.69	37.77	33.50	87.00
Jul-13	32.12	25.35	528.60	20	21	28.16	29.34	36.28	32.97	90.00
Aug-13	32.38	25.70	166.80	08	10	28.09	29.38	36.57	32.82	86.00
Sep-13	32.14	24.99	503.60	13	14	26.86	28.49	36.67	32.76	88.00
Oct-13	30.55	22.20	150.40	08	17	23.49	25.57	33.75	30.34	85.00
Nov-13	29.47	13.22	28.20	01	04	17.11	18.86	30.33	25.74	76.00
Dec-13	25.80	10.59	00.20	01	15	14.24	16.06	25.53	21.89	81.00
Jan-14	25.19	12.12	00.00	00	01	13.10	14.86	25.48	20.80	83.00
Feb-14	24.53	11.04	31.20	03	05	14.11	15.97	27.08	21.91	80.00
Mar-14	29.57	15.23	12.00	04	06	19.04	20.42	32.21	27.17	62.00

Table 26.4: Meteorological data of Sisal Research Station, Bamra, Odisha

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)	No. of Rainy days	Evaporation (mm)	Soil Temperature (°C)			
						1st hrs.		2nd hrs.			
	Max.	Min.	1st hrs	2nd hrs				5 cm	15 cm	5 cm	15 cm
April-13	37.7	19.8	65.3	29.7	60.4	05	4.92	25.4	27.2	43.5	35.3
May-13	42.3	24.6	66.2	23.6	10.2	02	5.77	30.7	31.3	51.0	37.7
June-13	34.8	24.3	82.4	59.3	154.6	14	4.10	28.0	29.4	39.7	33.1
July-13	31.7	23.3	89.8	75.4	482.0	21	3.85	27.2	28.1	34.2	32.4
Aug-13	31.1	22.8	91.2	73.5	355.2	17	2.60	26.4	26.5	33.7	30.5
Sept-13	32.1	22.5	91.0	69.7	195.4	12	2.40	26.2	26.8	34.7	31.1
Oct-13	30.2	20.9	90.3	70.5	106.0	05	2.20	24.7	25.1	32.9	29.7
Nov-13	29.1	13.0	86.2	45.3	000.0	00	2.30	18.0	20.2	32.2	28.5
Dec-13	27.6	9.8	79.7	47.8	000.0	00	2.40	14.9	16.7	33.3	26.9
Jan-14	27.5	10.0	82.3	39.6	003.2	01	2.10	15.6	16.9	32.8	28.4
Feb-14	30.0	11.4	78.8	32.2	046.6	05	3.10	14.9	17.1	36.3	28.6
Mar-14	32.5	15.3	79.1	40.4	025.8	04	2.80	20.2	21.9	41.5	31.9

Note