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ANNUAL REPORT
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Central Research Institute for Jute and Allied Fibres
(Indian Council of Agricultural Research)
Barrackpore, Kolkata - 700120, West Bengal
www.crijaf.org.in

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Front cover: From left to right: Braconid parasitoid on Bihar hairy caterpillar, Fermenter and Jute fibre
Back cover: From left to right: CRIJAF nail weeder, Jute intercropping with moong and 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 mandated to develop technologies to improve yield and quality of jute and allied fibres. It remains vigilant and responsive to changing scenario through development of novel technologies and by promoting problem-solving knowledge products. Jute varieties and production technologies developed by CRIJAF have contributed a lot to achieve the landmark production of raw jute over 110 lakh bales/annum. Currently, jute is cultivated in an area of approximately 8.5 lakh ha in the country with an average productivity of 25.3 q/ha, while mesta (kenaf and roselle) is cultivated in an area of about 1.5 lakh ha and the average national productivity of the crop is around 11 q/ha. Beyond the traditional uses, jute has gained importance in production of diversified value added products which earn more than Rs 2400 crores per annum and the trend is increasing. Recently, couple of varieties of finer fibre quality (fineness less than 2.5 tex) have been developed in tossa jute, which can cater to the need of the industry for producing value added diversified products. Product diversification and multiple uses of jute and allied fibre crops for paper pulp, particle board, pharmaceuticals, food additive and preservative should be the prime objective to sustain this sector.

Incorporation of diversified collection in the genepool is the pre-requisite to strengthern the breeding programme. Fresh emphasis has been focussed on exploration of diverse areas of southern-peninsular region and north-eastern region to enrich the genepool of jute and allied fibre crops. In this year, four new varieties viz., JROM 1 (Pradip) of *tossa* jute, JRCM 2 (Partho) of white jute, JBM 81 (Shakti) of kenaf and SUIN 037 (Ankur) of sunnhemp were released and notified for commercial cultivation in the country which are expected to boost the fibre productivity further. CRIJAF's efforts on biotechnological researches have revealed high genetic diversity in bast fibre germplasm, established new markers and have led to annotation of transcriptome of jute.

The problem of jute retting in stagnant water has been well addressed by developing new talc-based dry formulation of pectinolytic bacteria with enhanced shelf-life and easy transportability. This technology has been widely promoted in the farmers field.

In recent years, the adversity of climate during the initial growth phase of jute and the later part of the growing season not only encouraged the pre-mature flowering and subsequent problem of retting but also surfaced with greater intensity of existing insect pests and occurrence of new species including the mealybug of jute and red admiral caterpillar of ramie. In the context of emerging pest status, ecological studies of insect pests have been given due impetus. Besides, through multiple damage functions the economic injury level (EIL) for yellow mite and lepidopteran pests have been established as the guide to pest management decision making in jute. The mechanism of resistance in wild germplasm against the Bihar hairy caterpillar has been enumerated and the biochemical basis of resistance has been determined. The success of utilizing endophytic *B. bassiana* for stem weevil management in jute is vary encouraging. In this direction, further four pairs of EST primers *viz.,* CBB1F/R, CBB2F/R (coffee berry borer gene specific), HST1 F/R, HST2 F/R (heat stress tolerant gene specific) were designed and synthesized for specific detection of the fungal entomopathogen, *B. bassiana.*

Farmer's participatory, massive seed production programme in Bankura and Purulia district of West Bengal has given a big thrust in popularization of CRIJAF-bred

varieties through seed replacement in larger area with associated productivity enhancement. *JAFexpert,* a web-based client-server application has been developed by CRIJAF with knowledge related to problem diagnosis and management of jute crop.

New plantations of ramie and sisal, demonstration of jute seed production and microbial retting technology, capacity building on improved jute, sisal and ramie cultivation have been taken up through TSP programme as livelihood support for the tribal farmers in West Bengal, Odisha and Assam.

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. I also convey my sincere thanks to Prof. B.S. Mahapatra, former Director, CRIJAF for his untiring efforts in execution of the R&D activities during the period of the report.

Place: Barrackpore
Date: 07.10.2013

(S. Satpathy)
Director, CRIJAF

Executive Summary

Crop Improvement and Seed Technology

- The germplasm of jute and allied fibres were enriched through new collection of 235 accessions (137 *Corchorus spp.*; 35 *Hibiscus spp.*; 36 *Crotalaria spp.*; 17 *Agave spp.*; 10 *Urena spp.*). Jute and allied fibre germplasm were collected from Tamil Nadu and Kerala and 6 new accessions of ramie were collected from Meghalaya and Assam. 750 accessions of *H. cannabinus* and 360 accessions of wild *Corchorus spp.* were regenerated.
- A core collection of 57 accessions (3.8%) was developed from 1502 accessions of tossa jute using both heuristic and non-heuristic search algorithms using M-strategy implemented in software POWERCORE. The core collection has similar mean values to that of entire germplasm collection, but has much more variability.
- Evolutionary relationships between kenaf, roselle and their wild relatives have been studied using 12 SSR and 13 ISSR markers. The cultivars of kenaf and roselle developed in India were found to have narrow genetic base but the germplasm collection was genetically as well as geographically diverse.
- In *C. capsularis,* 155 single plants from one set of F_5 generation and 45 individual plants from another set of F_5 progeny were selected. From 155 F_6 single plant progeny, 20 families having fibre yield more than 20 g/plant were selected. Based on evaluation of 50 single plant progenies of 10 F_6 populations of different crosses a total of 50 single plants were selected.
- Twenty six new F_1 crosses were grown along with parents for confirmation of hybrid identity. In segregating generation (F_2), one set of 10 crosses were advanced to F_3 generation in off-season nursery at Agali, Coimbatore. 34 F_5 populations of 17 crosses were evaluated and 12 uniform progenies were identified.
- A total of 43 F_5 populations of 12 different crosses in tossa jute were evaluated for premature flowering resistance by sowing on three different dates: 1st week, 2nd week and 3rd week of March, 2012. Based on which the lines, 7-2012, 20-2012, 2-2012 and 4-2012 were selected for further evaluation in micro-plot yield trials.
- Two lines namely, JOC 2 and JOC 16 were identified for multilocational testing under AINP JAF (IET) since both recorded better yield compared to checks (JRO 524 and S 19).
- In M_3 generation of tossa jute (Cv. JRO 204, JRO 8432) a large number of morphological mutants were identified. Out of these four novel mutants *viz.*, *soft stem*, *hard stem*, super dwarf, twisted bark mutant have been studied.
- Four entries *viz.,* JROK 13, JROK 14, JROK 15, and JROK 16 were included for multilocation testing under IET. Five selections superior in fibre yield and 13 selections having better fibre fineness were identified.
- A total of 162 RILs of tossa jute along with parents were grown at CRIJAF, Barrackpore and CSRSJAF, Budbud for phenotyping. Phenotyping for fibre fineness from one location have been completed. Results show that RILs population having normal distributed fibre fineness.
- There was no significant male sterile line in 230 jute germplasm accessions screened for male starility. Based on diversity analysis fourteen genotypes of tossa jute were selected and crossed in line X tester fashion to generate hybrids. In another set, seven genotypes (OEX-03, OEX-13, OEX-29, OIN-255, OMU-7, OMU-19 and OMU-27) of tossa jute were crossed in half diallel fashion to generate F_1s.
- Three gametocides, namely maleic hydrazide, benzotriazole and commercial detergent were used to induce male sterility in tossa jute. Benzotriazole (0.1%) was most effective on jute variety S 19 which induce 55-60% male sterility.

- Four virulent strains of *M. phaseolina* have been identified, purified and are being maintained. Crossing programme between resistant and susceptible parents of *C. olitorius* has been initiated at off-season nurseries at Agali, Kerala. A RIL mapping population comprising of 202 accessions has been sown in CRIJAF for phenotyping. Bioinformatic analysis for resistance gene analogs has been initiated and 10 R gene markers have been screened in *C. olitorius*.
- In jute, interspecific hybridization resulted in development of four F_1 plants from hybridization of *C. olitorius* x *C. trilocularis*. The hybrid plants resembled female parent (*C. olitorius*). The F_1 plants exhibited rough, crumpled leaf surface characteristic of interspecific hybrids earlier reported.
- A new tossa jute variety CO 58 for first growing cycle revealed distinctiveness, uniformity and stability.
- Ten varieties (six varieties of white jute - JRC 80, JRC 698, Monalisa, Bidhan Pat 1, Bidhan Pat 2, Bidhan Pat 3 and four of tossa jute - S 19, JRO 8432, JRO 128, JRO 66) as extant variety have been registered in PPV & FR authority.
- Good general combining parents were identified in kenaf for dry fibre weight (KIJ-20) fibre fineness (KIJ-186) and fibre tenacity (KIJ-27). The average performance of F_1 hybrids, in general was more than 30% higher over the parents.
- In kenaf few individual plant progeny rows derived from cross combinations KIJ-275 x AMC 108, KIJ-281 x AMC 108 and KIJ-31 x MT 150 were found to be completely resistant to yellow mosaic disease.
- In roselle parent HS 4288 has positively significant and highest *gca* effect for fibre strength and negatively significant and highest *gca* effect for fibre finenes. Crosses namely AMV-2 × AMV-5 and Non bris-4 × AMV-5 had highest significantly negative best parent heterosis for fibre fineness. Cross Non bris-4 × AMV-3 recorded highly significant positive heterosis for fibre strength.
- Pre- and post-zygotic barriers restricting interspecific hybridization in kenaf have been confirmed. Interspecific hybrids have been obtained between *H. cannabinus x H. surattensis, H. cannabinus x H. acetosella* and *H. cannabinus x H. radiatus* . The hybrid plants were of intermediate type and exhibited high hybrid sterility.
- A total of 10 SSR and ISSR primers were used to study the interspecific hybrids of *H. cannabinus* and *H. acetosella*. These hybrids exhibited higher genetic similarity with *H. acetosella* (J=0.51) than with *H. cannabinus* (J=0.38). On backcrossing of all the interspecific hybrids with *H. cannabinus*, only few BC_1F_1 plants could be produced from F_1 of *H. cannabinus* x *H. radiatus*.
- The ramie genotype, R 1415 exhibited maximum fibre yield in winter with adequate cold tolerance.
- There was no significant reduction in the growth parameters of exotic cultivated elite genotypes *viz.* , R 67-34, R 1411 of ramie compared to indigenous cultivated genotypes *viz.,* R 1424 (less tolerant) during screening for herbicide tolerance.
- Ramie genotypes *viz.,* R 1411, R 1413, R 1414 and R 1419 were found resistant against cercospora leaf spot, anthracnose leaf spot, mosaic and cane rot.
- One promising genotype of ramie namely, R 1411 (Hazarika) was identified for release in NER during the 27th annual workshop of AINP JAF. This variety has the fibre yield potential of 21 q/ha/year, low gum content (20.18%), better fibre strength (4.93%) and fibre fineness (5.88%).
- A field gene bank of ramie (72 accessions) has been established at CRIJAF, Barrackpore. Significant variability for reproductive characters has been observed in the germplasm, indicating wide variability for these characters.
- Three promising ramie mutants *viz.,* Ramie Mutant-1, Ramie Mutant-2 and Ramie Mutant-3 were selected in the M_1V_2 generation. Ramie Mutant-3 produced maximum dry fibre yield/plant (6.75 g) during winter season.

- In flax, F_1 generations of 20 crosses, F_3 generations of 12 crosses and F_4 generations of 15 crosses were grown for generation advancement and evaluation for fibre yield. Three new crosses *viz.,* FT-895 x JRF-2, H-5 x JRF 2, FT-897 x JRF-2 were effected.
- A total of 23 germplasm lines and six F_1 generations (SUIN 001 × SH 4, SUIN 019 × SH 4, SUIN 021 × SH 4, SUIN 030 × SH 4, SUIN 036 × SH 4, SUIN 038 × SH 4) of sunnhemp were evaluated along with their parents for fibre yield and attributing traits.
- Breeder seeds (13.5 q) of fourteen jute varieties were produced against DAC indent of 10.74q. Grow out test (GOT) was carried out to check the genetic purity of the breeder seeds of all the indented jute varieties.
- Nucleus seeds (4.2 q) of the released varieties of jute (27 varieties), mesta (9 varieties) and sunnhemp (3 varieties) were produced.
- In jute, 48.5 q of foundation seed, 28.64 q certified seed and 20 q of TL seeds have been produced under Mega Seed Project.
- Ideal sowing time for jute seed crop under low fertile upland and medium land was standardized to be mid-July and August-mid-September respectively in Purulia district of West Bengal.
- Under the RKVY programme at Bankura and Purulita district of West Bengal, a total of 67.80 q of certified seed and 4.91 q of TL seed of jute were produced and handed over to West Bengal State Seed Corporation Ltd.
- Application of GA_3 @100 ppm during 50% flowering stage significantly increased seed yield (10.3 q/ha) and 1000 seed weight (2.04 g).
- Application of NPK + S + Zn (40:60:60 kg N: P_2O_5: K_2O + 20 kg S + 20 kg $ZnSO_4.7H_2O$/ha) resulted into significantly higher plant height, yield attributes and seed yield (1.18 t/ha) compared to all other treatments in tossa jute.
- Paired row sowing (60:30 cm spacing) of jute along with application of 120 kg N/ha was found to be a better combination for higher seed production under late sown conditions.

Biotechnology

- An expressed gene catalog of *C. olitorius* cv. JRO 632 was developed by Roche 454 mRNA-seq based on Newbler 2.5.3, CLC 4.0.3 and SeqMan Ngen 3.0.4 were generated, and they were finally merged using CAP3 3.0. A BLASTx analysis of annotated transcript contigs of *Corchorus olitorius* cv. JRO 632 showed that maximum hits (homologies) were distributed in *V. vinifera* followed by *P. trichocarpa*, *A. thaliana* and *T. cacao*. Gene ontology (GO) analysis and Gene expression analysis of functionally annotated transcript contigs of *C. olitorius* cv. JRO 632 was also carried out.
- Five bi-parental mapping populations of *C. olitorius* were developed and two loci, ribbon leaf and internode length showing monogenic segregation have been mapped. Phenotyping of the association mapping population in *C. olitorius* was carried out in three test environments. Genotyping was done by next-generation restriction site-associated DNA (RAD) tag sequencing.

Soil Health and Nutrient Management

- Maximum crop yield was obtained with 100% NPK+FYM in jute (25.1 q/ha) and wheat (31.7 q/ha) whereas 150% NPK gave highest yield in rice (38.9 q/ha). Application of 150% NPK resulted in higher uptake of N, P and K in jute and rice while 100% NPK+ FYM recorded highest P (16.2 Kg/ha) and K (136 Kg/ha) uptake by wheat but N uptake was highest under 150% NPK. The highest SQI was found in 100% NPK + FYM followed by 150% NPK, 100% NPK, 100% NP, 50% NPK, 100% N and control (no fertilizer) respectively.
- Recommended doses of fertilizers (RDF) recorded highest fibre yield, net profit and B:C ratio in the follow-up trial of jute conducted at three locations followed by ST-TY (40 q/ha) + FYM treatment. The follow up trials on rice and garden pea conducted

respectively at 3 and 9 locations recorded the highest yield, net profit and B:C ratio under ST-TY + FYM (@ 5 t/ha) treatment for various yield targets.

- The targeted yield of jute fibre (4 t/ha), rice (5 t/ha) were achieved yield deviation of (-) 4.40%, (+) 9.40% respectively in ST-TY but the yield target of lentil (2 t/ha) could not be achieved. The P and K use efficiency in case of jute and N, P and K use efficiency in case of rice and lentil were comparatively higher with the application of fertilizers as per ST-TY over application of recommended dose (RD) and farmers' practice (FP).
- Maximum nitrogen use efficiency (NUE) was recorded in all the varieties at 40 kg N/ha level which declined in all the varieties with further increase in N dose. However, JRO 204, JRO 524 and JRO 8432 responded better than JRO 128, JBO 2003-H and S 19 to nitrogen use in terms of higher yield.
- *Bradyrhizobium* obtained from sunnhemp root nodules was effective over other isolates of *Bradyrhizobium* in respect of nodulation, fresh and dry weight of sunnhemp.

Biotic and Abiotic Stresses

- The early instars (up to third instars) of jute hairy caterpillar were more vulnerable to the density dependent mortality factors. The braconid larval parasitoids, *Meteorus spilosomae* and *Protapanteles obliquae* were the key mortality factors whereas in late instars, mortality due to virus was more as compared to the parasitoids.
- The toxicity of new insecticides against Bihar hairy caterpillar showed the LC_{50} values of 1 ppm for flubendiamide and lamda cyhalothrin, and 2 ppm and 3 ppm for emamectin benzoate and chlorantraniliprole, respectively.
- The use of mineral oil (0.2%) enhanced the toxicity through improving the mortality by 6% to 22% in different insecticides against mealybug. Maximum mortality of 100% was recorded in case of profenophos 50 EC (0.035%) with addition of 0.2% mineral oil.
- In jute yield-infestation relations were established through multiple regressions to determine the multiple pest economic injury levels (EILs) on jute. The EIL of yellow mite was 42 mites/cm^2 on second unfolded leaf and in case of lepidopteran pests (both BHC and jute semilooper) it was about 3% plant damage.
- The *capsularis* germplasm, CIN-512 and CEX-23 have shown lowest infestation of yellow mite. The least infestation of stem weevil, semilooper and Bihar hairy caterpillar was observed in CIN-13, CIN-001 and CIN-211 respectively. In case of olitorius germplasm, the least infestation of yellow mite, stem weevil, semilooper and BHC were recorded on OIN-507, OIJ-192, OIN-431 and OIN-401.
- The feeding preference of *Spilosoma obliqua* Walker in choice test indicated significant non-preference for *Corchorus trilocularis* and *C. tridens* compared to the cultivated species of jute, *C. olitorius*.
- Elevated level of phenol content in the wild jute species (*Corchorus fascicularis*, *C. tridens* and *C. aestuans*) which was more than cultivated species i.e. *C. olitorius* may be reason for greater antibiosis effect on the leaf feeder, *Spilosoma obliqua* Walker.
- Application of more nitrogenous fertilizer enhanced stem rot incidence while phosphatic and potassic fertilizers reduced the stem rot incidence.
- In jute seed treatment and foliar spray of carbendazim 50 WP (0.1%) and tebuconazole 25.9 (0.1%) were most effective for managing stem rot.
- Turmeric oil and Citronella oil caused radial growth inhibition of jute stem rot pathogen *Macrophomina phaseolina* in poison food technique (PDA media).
- Four pairs of EST primers viz. CBB1F/R, CBB2F/R (coffee berry borer gene specific), HST1 F/R, HST2 F/R (heat stress tolerant gene specific) were designed and synthesized for specific detection of the fungal entomopathogen, *Beauveria bassiana*.
- Foliar spray of carbendazim (0.1%), bêta amino butyric acid (BABA) (5 mM), salicylic (1 mM) acid

and calcium chloride (25 mM) significantly reduced jute stem rot incidence in jute.

- Chemical elicitors *viz*. chitosan @ 5.0%, salicylic acid @ 1.0 mM, Indole acetic acid (IAA) @ 1.0 mM; beta amino butyric acid (BABA) @ 5 mM , di-potassium hydrogen phosphate (K_2HPO_4) @ 50 mM, calcium chloride ($CaCl_2$) @ 25 mM and carbendazim @ 0.1% enhanced the activity of different enzymes *viz.*, Polyphenol oxidase (PPO), L phenyl alanine ammonia-lyase (PAL) and peroxidase in jute seedlings.

- Sowing of jute seed crop in third week of august and spraying of carbendazim (0.1%) either at pod setting or pod maturation stage ideal for increased production of disease free seeds.

- Under natural epiphytotic condition, two spp. (*A. cantala* and *A. ameniensis*) showed resistant reaction and three spp. (*A. miradorensis, A. aungustifolia, A. americana*) showed moderately resistant reaction to zebra disease of sisal. Twenty nine accessions showed resistant reaction, 14 showed moderately resistant reaction and 15 showed susceptible to highly susceptible reaction.

- The diseases such as *Cercospora* leaf spot (5-30%), anthracnose leaf spot (10-60%), *Sclerotium* rot (5-20%), damping off (5-20%), cane rot (10-100%) and yellow mosaic (30-70%) were recorded to be the prominent diseases of ramie crop in the North Eastern conditions. Among all genotypes R 1411, R 1413, R 1414 and R 1419 were found resistant against all these diseases.

- Propiconazole @ 0.1% followed by difenconazole @ 0.1% were found most effective in controlling of anthracnose and Cercospora leaf spot of ramie. Application of fungicides also increased strip weight, plant height, green weight and finally the fibre yield.

- Reduction in soil moisture content from 15% to 5% in one month period (from 16th April to 16th May, 2012) leads to jute plants mortality.

- The application of N:P:K::60:30:30 and elemental sulphur @ 30 kg/ha with one post sowing irrigation when plant available sulphur in soil <20kg/ha, yielded 26 q jute fibre/ha and was found most effective drought management practice.

Farm Mechanization and Post-Harvest Technology

- Improvement was made over the existing machine in the ribbon pulling system. The design and fabrication of a prototype model of Power Jute Ribboner machine is in progress.

- Seventy large scale retting trials on jute and mesta with talc based microbial formulation of CRIJAF were conducted in Baharaich district of Uttar Pradesh and Srikakulam district of Andhra Pradesh. Besides, 205 large scale retting demonstrations with newly developed talc-based microbial formulation were also conducted in West Bengal. The retting duration for jute and mesta was reduced by 6 days in Baharaich and 10 days in Srikakaulam district and fibre strength was 27.3 g/tex compared to 23.2 g/tex in conventional method.

- Molecular characterization of two pectinolytic alkalophilic bacteria have been completed through 16s rDNA sequencing process. Degumming with the consortium could complete in 2 to 3 days at 34-39°C with a weight loss of 22-32% on dry weight basis.

Technology Transfer

- Two hundred and sixty three (263) frontline demonstrations on improved jute and sisal varieties and production technologies were laid out in farmer's field covering an area of 64.68 hectares. Post-emergence application of quizalofop ethyl resulted in reduction of labour cost for weeding by Rs 10,559-13,867 per hectare over farmer's practice. Line sowing by multi row seed drill and soil-test based fertilizer use could save cost of input by Rs 1,624-6,852 and Rs 973–2,850 per hectare respectively, over farmer's practice. In terms of fibre yield, JRO 204 was the most superior variety with 31.14 q/ha fibre yield.

- In rainfed condition, application of elemental sulphur @ 30 kg/ha followed by augmented NPK nutrition (80:40:40) produced higher fibre yield of 15.57% and 13.58% over farmer's practice (60:30:30). Application of *green gram* waste (Pant Moong 5) as a green manure @ 2 ton/ha could increase the fibre yield by 18.32% (386 kg/ha) over farmer's practice. This technology was assessed in Nadia and Murshidabad districts.
- Sixty demonstrations were conducted in the farmers' fields to assess the performance of jute-paddy-mustard and jute-paddy-wheat sequences. Regardless of locations, jute-paddy-mustard sequence performed (1.42) better than jute-paddy-wheat (1.25) with higher benefit cost ratio, higher net return and lower total cost of cultivation.
- In a survey on opinions from the farmers, variety JRO 204 was given the highest score followed by four row seed drill and line sowing. The most serious constraint indicated by farmers were lack of organized market followed by high cost of labour, whereas the serious constraint listed by industries were lack of availability of labour, labour cost and competition from synthetic products.
- Under TSP, 81,272 healthy suckers of sisal were distributed among 31 tribal planters to cover 20.36 ha of plantation. In ramie, 26 ha area was planted in Lakhimpur, Dhemaji and Sonitpur districts of Assam and West Siang district of Arunachal Pradesh with the planting materials of ramie supplied by RRS Sorbhog under TSP.

AINP on JAF

- Four new varieties *viz.,* JROM 1 (Pradip) of *tossa* jute, JRCM 2 (Partho) of white jute, JBM 81 (Shakti) of kenaf and SUIN 037 (Ankur) of sunnhemp were released and notified by the Central Variety Release Committee for their commercial cultivation in the country.
- Three varieties, one each of white jute, JRC 9057 (Ishani), JRKM 9-1 (Satyen) of kenaf and R 1411 (Hazarika) of ramie have been identified for release by the Central Variety Release Committee during the 27th Annual Workshop of AINP on J&AF held at CRIJAF, Barrackpore.
- Newly developed talc based microbial formulation of CRIJAF for retting performed very well in various AINP centres located at different agro-climatic regions. Jute and mesta retting was completed in 8 to 13 days with microbial formulation and there was reduction in retting period by 5 to 9 days with significant improvement in fibre quality. The strength of treated fibre ranged between 26.9 to 30.6 g/tex compared to 22.6 to 28.4 g/tex recorded in control.
- Stem rot, root rot, anthracnose and mosaic diseases were common in jute whereas foot and stem rot, leaf spot and phytoplasma diseases were most common in mesta. In jute, semilooper, Bihar hairy caterpillar, yellow mite and stem weevil were the most common insect pests whereas in case of mesta, infestation of jassid, aphid, whitefly, mealybug and semilooper were prevalent. Maximum infestation of jute by Bihar hairy caterpillar was noticed at Barrackpore (60.40%) followed by Nagaon (44.38%) and Katihar (16.40%), which occurred at 75 DAS to 103 DAS during July.

Jute Informatics

- *JAFexpert*, a web-based client-server application has been developed by CRIJAF with knowledge related to problem diagnosis and management of jute. The system prompts the user to guided information, based on their selection.

KVK, Burdwan

- KVK, Burdwan conducted 7 on-farm trials and 114 FLDs to popularize various recommended technologies in the field of agriculture, horticulture, animal sciences, fishery, plant protection, etc. Several training programmes were conducted for the farmers, extension workers and the rural youths. Total of 1800 participants were benefited from such trainings.

कार्यकारी सारांश

फसल सुधार एवं बीज प्रौद्योगिकी

- पटसन एवं समवर्गीय रेशा फसलों के कुल 235 जननद्रव्यों (137 पटसन, 35 मेस्ता, 36 सनई, 17 सीसल तथा 10 उरेना) का संकलन तामिलनाडु तथा केरल प्रान्तों से तथा रेमी के कुल 6 जननद्रव्यों का संग्रह मेघालय तथा असम से किया गया। केनॉफ के कुल 750 तथा पटसन के 360 जंगली प्रभेदों का पुनर्उदभवन भी किया गया।
- तोषा पटसन के 1502 जननद्रव्यों के सम्मुच्य से 57 जननद्रव्यों का एक कोर कलेक्शन (3.8 प्रतिशत) विकसित किया गया है। कोर कलेक्शन तथा सम्मुच्चय जननद्रव्यों की औसत विभिन्नता समान होते हुए भी इनमें काफी विविधता पाई गई।
- केनॉफ, रोजेल तथा उनके जंगली कुटुम्बों के उदभवन संबंधों का अध्ययन 12 एस.एस.आर. तथा 13 आई.एस.एस.आर. मार्कर के माध्यम से किया गया। भारत में विकसित केनॉफ तथा रोज़ेल के लगभग सभी प्रजातियों की आनुवांशिक आधार संकीर्ण पायी गयी जबकि, संकलित जननद्रव्य आनुवांशिक तथा भौगोलिक दृष्टिकोण से अत्यन्त भिन्न थे।
- सादा पटसन के एफ5 संतति के एक समुच्चय से कुल 155 एकल पौधों तथा दूसरी समुच्चय से 45 एकल पौधों का चयन किया गया है। इन 155 एकल पौध संततियों में 20 ग्रा./पौध से ज्यादा रेशा उपज वाले कुल 20 उत्कृष्ठ समष्टियों का चयन किया गया है। विभिन्न संकरण से प्राप्त कुल दस एफ6 समुदायों से चुने हुए 50 एकल पौध संततियों से भी कुल 50 पौधों का चयन किया गया है।
- तोषा पटसन के नवीनतम 26 एफ1 संकरों की संकर एकरूपता के निर्धारण हेतु उनके पित्रों के साथ उगाया गया । दस संकरों के एक समुच्चय को उनके एफ2 संतति से एफ3 संतति में उन्नयन के उद्देश्य से कोयम्बटूर के आगाली में बेमौसम उगाया गया। सत्रह संकरों के 34 एफ5 संततियों से कुल 12 एकरूप संततियों की पहचान की गई है।
- पूर्वपक्वन पुष्पन प्रतिरोधक क्षमता के मूल्यांकन हेतु तोषा पटसन के 12 विभिन्न संकरों से प्राप्त कुल 43 एफ5 समुदायों की तीन विभिन्न तिथियों, मार्च 2012 के प्रथम, द्वितीय तथा तृतीय सप्ताह में बुआई की गई। इन परीक्षणों के आधार पर 7–2012, 20–2012, 2–2012 तथा 4–2012 आदि प्रभेदों का सूक्ष्म क्यारियों में परीक्षण हेतु चयन किया गया है।
- तोषा पटसन के दो प्रभेदों नामतः जे.ओ.सी.–2 तथा जे.ओ.सी.16 को चेक प्रजातियों (जे.आर.ओ.–524 तथा एस.–19) से बेहतर प्रदर्शन के आधार पर आई.ई.टी. 2013–14 में बहुस्थानीक परीक्षण के लिए चिन्हित किया गया है।
- तोषा पटसन के एम3 संततियों (प्रजाति जे.आर.ओ.–204 तथा जे.आर.ओ.–8432) से प्राप्त अनेकों उत्परिवर्ती प्रभेदों की पहचान हुई है जिनमें मृदुल तना, कठोर तना, अत्यन्त बौना तथा घुमावदार तना, चार उत्कृष्ट उत्परिवर्तियों का अध्ययन किया गया है।
- तोषा पटसन के चार उत्कृष्ट प्रभेदों नामतः जे.आर.ओ.के.–13, जे.आर.ओ.के.–14, जे.आर.ओ.के.15 तथा जे.आर.ओ.के.–16 को आई.ई.टी. के अन्तर्गत बहुस्थानीक परीक्षणों में शामिल किया गया है। रेशा उत्पादकता के आधार पर कुल पांच तथा रेशा महीनता के आधार पर कुल 13 प्रभेदों की पहचान हुई है।
- तोषा पटसन के कुल 162 आर.आई.एल. समुदायों के साथ उनके जनकों की फिनोटाइपिंग के प्रायोजन हेतु दो स्थानों बैरकपुर तथा बुद–बुद में बुआई की गई थी। एक स्थान पर रेशा महीनता की फिनोटाइपिंग सम्पन्न हो चुकी है। प्राप्त परिणामों से स्पष्ट है कि आर.आई.एल. समुदायों में रेशा महीनता के लिए समान वितरण मौजूद है।
- पटसन के कुल 230 जननद्रव्यों का परीक्षण उनमें नर बन्ध्यता गुण के लिए किया गया जो किसी भी जननद्रव्य में नहीं पाया गया। तोषा पटसन के चौदह विविध जननद्रव्यों को लाईन × टेस्टर पद्धति से संकरण किया गया है जबकि एक दूसरी सात जननद्रव्यों के समुच्चय को हाफ डायलिल विधि से संकरण करके एफ1 संकर प्राप्त किये गये।
- तोषा पटसन में नरबन्ध्यता उत्पन्न करने के लिए तीन प्रकार के युग्मकनाशी (गैमीटोसाइड) नामतः मैलिक हाईड्राजाइड, बेन्जोट्राईजोल तथा व्यवसायिक अपमार्जक का इस्तेमाल किया गया। बेन्जोट्राईजोल 0.1 प्रतिशत के दर से पटसन प्रजाति एस.–19 में 55–60 प्रतिशत तक नर बन्ध्यता उत्पन्न करने के साथ सबसे प्रभावी पाया गया।
- *एम. फैसियोलिना* के चार उग्र प्रभेदों की पहचान की गई है जिसे परिस्कृत करने के पश्चात संरक्षित किया गया है। तोषा पटसन के प्रतिरोधी तथा संवेदनशिल जनकों को आगाली (केरल) में बेमौसम नर्सरी उगाकर संकरित किया गया। 202 प्रभेदों से निर्मित एक आर.आई.एल. समुदाय के फिनोटाईपिंग हेतु बैरकपुर

में बुआई की गई है। तोषा पटसन में प्रतिरोधी जीन एनालॉग के लिए जैवसूचना विश्लेषण प्रक्रिया द्वारा 10 आर. जीन मार्कर की पहचान की गई है।

- पटसन में *सी. ऑलिटोरियस* तथा *सी. ट्राईलोकुलैरिस* के अन्तर–प्रजातीय संकरण से चार एफ1 पौधों को विकसित किया गया जो मादा पित्र (*सी. ऑलिटोरियस*) से मिलते–जुलते पाये गये। जैसा कि पहले भी प्रतिवेदित किया गया है, एफ1 पौधे की पत्तियाँ रूक्ष परिलक्षित हुई है।
- तोषा पटसन की नवीन प्रजाति सी.ओ.–58 को डी.यू.एस. परीक्षण के प्रथम परीक्षण चक्र में भिन्न, एकरूप तथा स्थायीत्व वाला पाया गया।
- पी.पी.वी. एवं एफ.आर. प्राधिकरण के द्वारा पटसन के कुल दस प्रजातियों (छः सादा तथा चार तोषा पटसन) का पंजीकरण प्रमाण–पत्र प्राप्त हुआ है।
- केनॉफ में शुष्क रेशा भार के लिए के.आई.जे.–20, रेशा महीनता हेतु के.आई.जे.–186 तथा रेशा मजबूती के लिए के.आई.जे.–27 जनकों को अच्छा सामान्य संयोजी पित्र पाया गया है। केनॉफ के एफ1 संकरों का औसत रेशा उत्पादन उनके पित्रों के सापेक्ष सामान्यतः 30 प्रतिशत से भी अधिक दर्ज किया गया।
- केनॉफ के संकर संयोगों नामतः 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 कुछ एकल पादप संततियाँ पित्त सिरा मोज़ेक रोग से पूर्णतः प्रतिरोधी पायी गयी।
- रोज़ेल में एच.एस.–4288 पित्र की रेशा मजबूती सार्थकरूप से ध नात्मक तथा उच्चतम जी.सी.ए. प्रभाव तथा रेशा महीनता उच्चतम किन्तु नाकारात्मक जी.सी.ए. प्रभाव वाला दर्ज किया गया। संकर संयोगों ए.एम.वी.–2 × ए.एम.वी.–5 तथा नॉन–ब्रीस–4 × ए.एम.वी.–5 में रेशा महीनता के लिए संकर ओज़ उनके श्रेष्ट पित्र की तुलना में बेहतर पाई गई। संकर नान–ब्रीस–4 × ए.एम.वी.–3 में रेशा मजबूती के लिए अधिकतम संकरओज़ पाया गया।
- पराग तथा पिस्टिल इन्टरेक्शन के अध्ययन से यह ज्ञात हुआ कि युग्मक (जाइगोट) निर्माण के पूर्व तथा पश्चात दोनों ही तरह की बाधाएं केनॉफ में सफलतापूर्वक अन्तर–प्रजातीय संकरण को संकुचित करती हैं। मेस्ता में *एच. कैनाबिनस* × *एच. सुराटेनसीस, एच. केनाबिनस* × *एच. एसिटोसीला* तथा एच. केनाबिनस × एच. रेडिएटस संकरणों से अन्तर–प्रजातिय संकर प्राप्त किया गया है जो दोनों ही पित्रों के गुणों के बीच किन्तु उच्च बन्धयता वाले पाए गए।
- अन्तर प्रजातीय संकर *एच. कैनाबिनस* × *एच. एसीटोसीला* के अध्ययन के लिए एस.एस.आर. तथा आई.एस.एस.आर. के कुल 10 प्राइमर का इस्तेमाल किया गया। इस अन्तर–प्रजातीय संकर की *एच. केनाबिनस* (जे.=0.38) जनक की तुलना में *एच. एसीटोसीला* (जे.=0.51) से ज्यादा अनुवांशिक समानता पाई गई। सभी अन्तर–प्रजातीय संकरों की *एच. केनाबिनस* से बैक क्रास करने पर केवल *एच. केनाबिनस* × *एच. रेडिएट्स* के ही कुछ बी.सी.$_1$एफ.$_1$ बीज प्राप्त हुए।
- शरदकालीन रेमी की ठण्ड सहिष्णुता परीक्षण के दौरान प्रभेद आर.– 1415 ने 5.56 कु./है. अधिकतम रेशा उपज के साथ अव्वल स्थान हासिल किया।
- शाकनाशी सहिष्णुता मूल्यांकन के दौरान पाया गया कि रेमी के देशज कृषित प्रभेद आर.–1424, जो कि शाकनाशियों के प्रति कम सहिष्णु है, की तुलना में रेमी के विदेशज प्रभेदों जैसे– आर.–67–34 तथा आर.–1411 के वानस्पतिक वृद्धि में कोई सार्थक ह्रास नहीं पाया गया।
- रेमी के आर.–1411, आर.–1413, आर.–1414 तथा आर.–1419 आदि प्रभेदों को सर्कोस्पोरा लीफ स्पॉट, एन्थ्रैक्नोज, मोज़ेक तथा तना सड़न रोगों के प्रति अवरोधी पाया गया।
- बैरकपुर में आयोजित ए.आई.एन.पी. के वार्षिक कार्यशाला में रेमी के उन्नत प्रभेद आर.–1411 (हाजारिका) को विमोचन हेतु चिन्हित किया गया है। इस प्रजाति की रेशा उत्पादकता 21 कु0/है0/वर्ष, गोंद की मात्रा (20.18%) कम तथा रेशा मजबूती (4.93%) एवं रेशा महीनता (5.88%) अधिक है।
- रेमी के कुल 72 जननद्रव्यों का एक जीन बैंक के.प.रे.अ.सं. बैरकपुर में स्थापित किया गया जिनके जनन गुणों में सार्थक विविधता व्याप्त होने के कारण यह सिद्ध होता है कि इन गुणों के लिए पर्याप्त विभिन्नता मौजूद है।
- रेमी के एम.$_1$वी.$_2$ उत्परिवर्ती संततियों से तीन उत्कृष्ट उत्परिवर्तियों, जैसे उत्परिवर्ती–1, 2 तथा 3 का चयन किया गया जिनसे शरद ऋतु में अधिकतम 6.75 ग्रा./पौध शुष्क रेशा उपज प्राप्त हुआ। रेमी उत्परिवर्ती–3 ने शरदकालीन फसल में अधिकतम (6.75 ग्रा./पौधा) शुष्क रेशा उपज दर्ज कराया।
- फ्लैक्स में रेशा उपज मूल्यांकन तथा संतति उत्क्रमण के उद्देश्य से 20 एफ$_1$, 12 एफ$_3$ तथा 15 एफ$_4$ संततियों को उगाया गया तथा इसके अतिरिक्त तीन नवीन संकर संयोगों जैसे एफ.टी.–895 × जे.आर.एफ.–2, एच.–5 × जे.आर.एफ.–2 तथा एफ.टी.–897 ×

जे.आर.एफ.–2 को भी विकसित किया गया है।

- सनई के 23 जननद्रव्यों के साथ–साथ छः संकरों तथा उनके पित्रों (एस.यू.आई.एन.–001, 019, 021, 030, 036 तथा 038 का संकरण एस.एच.–4 से) का मूल्यांकन उनकी रेशा उपज क्षमता तथा इससे समबद्ध गुणों के लिए भी किया गया है।
- कृषि एवं सहकारिता विभाग, भारत सरकार की 10.74 कु0 पटसन बीज मांग के सापेक्ष पटसन के चौदह प्रजातियों का कुल 13.5 कु0 जनक बीज तैयार किया गया। इन सभी प्रजाति के जनक बीजों की अनुवांशिक शुद्धता के परीक्षण हेतु "ग्रो आऊट टेस्ट" भी किया गया है।
- पटसन के 27, मेस्ता के 9 तथा सनई के 3 विमोचित प्रजातियों का कुल 4.2 कु0 केन्द्रक बीज भी उत्पादित किया गया है।
- मेगा सीड प्रोजेक्ट के अन्तर्गत तोषा पटसन का 48.5 कु0 आधारीय बीज, 28.64 कु0 प्रमाणित बीज तथा 20 कु0 टी.एल. बीज का उत्पादन किया गया है।
- पश्चिम बंगाल के पुरुलिया जिले की निम्न उर्वरता वाली ऊँची तथा मध्यम मृदा में क्रमशः मध्य जुलाई तथा अगस्त से मध्य सितम्बर के बीच पटसन बीज फसल की बुआई करना उपयुक्त पाया गया है।
- राष्ट्रीय कृषि विकास योजना के अन्तर्गत पश्चिम बंगाल के बांकुड़ा तथा पुरूलिया जिले में कुल 67.80 कु0 पटसन का प्रमाणित बीज तथा 4.91 कु0 टी.एल. बीज उत्पादित करके पश्चिम बंगाल राज्य बीज निगम को हस्तांतरित किया गया है।
- पटसन में पचास प्रतिशत पुष्पन की अवस्था में जी.ए.$_3$ 100 पी.पी.एम. की दर से छिड़काव करने पर बीज उत्पादन (10.3 कु0/है0) तथा 1000 बीज भार (2.04: ग्रा.) में सार्थक वृद्धि पाई गई।
- तोषा पटसन में अन्य उपचारों की तुलना में एन.पी.के. (40:60:60 कि.ग्रा. एनः पी$_2$ओ$_5$: के$_2$ओ) के साथ सल्फर (20 कि.ग्रा.) तथा जींक (20 कि.ग्रा. ‍द ै व$_4$ 7भ्$_2$व प्रति हैक्टर) के प्रयोग से पौधे की ऊँचाई तथा बीज उपज क्षमता (1.18 कु0/है0) में सार्थक वृद्धि दर्ज की गई।
- पछेती बुआई की दशा में पटसन की दो कतारों (60:30 सें.मी.) में बुआई करने तथा 120 कि.ग्रा./है. की दर से नत्रजन के प्रयोग से अधिकतम बीज उत्पादन प्राप्त होता है।

जैव प्रौद्योगिकी

- रौक–454 एम.आर.एन.ए. के द्वारा तोषा पटसन के जे.आर.ओ.–632 प्रजाति की एक एक्सप्रेस्ड जीन कैटलॉग को विकसित किया गया है जो अन्ततः सी.ए.पी.–3.0 की मदद से सम्मिश्रित किए जा चुके हैं। तोषा पटसन के जे.आर.ओ.–632 प्रजाति की सी.ए.पी.–3 में विलिन एसेम्बल्ड ट्रांसक्रिप्ट कंटिग्स के बी.एल.ए.एस.टी.एक्स. वितरण विश्लेषण से प्रतित हुआ कि इसकी अधिकतम समानता *वाईटिस विनिफेरा* में वितरित पायी गयी जिसके बाद क्रमशः *पी. ट्राईकोकार्प, ए. थैलियाना तथा टी. काकाओं* का स्थान था। *सी. ऑलीटोरियस* के जे.आर.ओ.–632 प्रजाति की परिभाषित ट्रांसक्रिप्ट कटिंग्स का जीन औन्टोलोजी तथा एक्सप्रेशन विश्लेषण भी किया गया है।
- *सी. ऑलीटोरियस* के पाँच द्विपैत्रिक मैपिंग समुच्चय को विकसित किया गया है तथा दो लोसाई (जीन), रिबन लीफ तथा पर्णवृन्त लम्बाई, जो कि एकल जीनी अपब्यूहन प्रदर्शित करते हैं, का खाका तैयार किया गया है। तीन परीक्षण पर्यावरणों में *सी. ऑलीटोरियस* के एसोसिएशन मैपिंग पॉपुलेशन की फिनोटाईपिंग की गई है। आगामी संतति रिस्ट्रीकटेड साईट–एसोसिएटेड़ डी.एन.ए. (आर.ए.डी.) टैग सिक्वेशिंग के द्वारा जीनोटाईपिंग की प्रक्रिया सम्पन्न की गई है।

मृदा स्वास्थ्य एवं पोषक तत्व प्रबन्धन

- शत–प्रतिशत एन.पी.के. के साथ–साथ एफ.वाई.एम. का प्रयोग करने से पटसन (25.1 कु0/है0) तथा गेहूँ (31.7 कु0/है0) का अधिकतम पैदावार प्राप्त हुआ जबकि धान की अधिकतम पैदावार (38.9 कु./है.) 150 प्रतिशत एन.पी.के. के इस्तेमाल से प्राप्त हुआ। पटसन तथा धान में 150 प्रतिशत एन.पी.के. के प्रयोग से इनका अधिकतम अवशोषण पाया गया जबकि गेहूँ में फास्फोरस (16.2 कि.ग्रा./है.) तथा पोटाश (136 कि.ग्रा./है.) का अधिकतम अवशोषण 100 प्रतिशत एन.पी.के. के साथ–साथ एफ.वाई.एम. के प्रयोग से पाया गया लेकिन नत्रजन का अधिकतम अवशोषण 150 प्रतिशत एन.पी.के. के प्रयोग से ही पाया गया। सर्वाधिक एस.क्यू.आई. मान शत प्रतिशत एन.पी.के. के साथ–साथ एफ.वाई.एम. के इस्तमाल वाले उपचार में दर्ज किया गया जिसके बाद क्रमशः 150 तथा, 100 प्रतिशत एन.पी.के., 100 प्रतिशत एन.पी., 100 प्रतिशत नत्रजन तथा बिना उर्वरक (कंट्रोल) वाले उपचार का स्थान था।
- तीन स्थानों पर पटसन के फालोअप परीक्षणों में संस्तुत उर्वरकों की मात्र (आर.डी.एफ.) के प्रयोग से सर्वाधिक रेशा उपज, शुद्ध आय तथा लाभ : लागत (बी.सी. रेसियो) अनुपात दर्ज किया गया जिसके बाद मृदा परीक्षण आधारित उपज लक्ष्य (40 कु0/है0) के साथ एफ.वाई.एम. के प्रयोग वाले उपचार का स्थान था। धान तथा मटर की क्रमशः 3 तथा 9 स्थानों पर किए गए

फॉलो–अप परीक्षणों में सर्वाधिक रेशा उपज, शुद्ध आय तथा लाभ – लागत अनुपात विभिन्न उपज लक्ष्यों के अन्तर्गत मृदा परीक्षण आधारित उपज लक्ष्य के साथ एफ.वाई.एम. (5 टन/है.) के प्रयोग से प्राप्त हुआ।

- मृदा परीक्षण आधारित उपज लक्ष्य के अन्तर्गत पटसन (4 टन/है0) तथा धान (5 टन/है0) का क्रमशः–4.40 प्रतिशत तथा 9.40 प्रतिशत विचलन उपज के साथ उपज लक्ष्य की प्राप्ति हुई किन्तु मसूर का उपज लक्ष्य (2 टन/है0) प्राप्त नहीं हो सका। कृषकों में प्रचलित तथा संस्तुत उर्वरकों की मात्रा के सापेक्ष मृदा परीक्षण आधारित उपज लक्ष्यों के अनुरूप उर्वरकों के प्रयोग से पटसन में फास्फोरस तथा पोटाश एवं धान तथा मसूर में नत्रजन, फास्फोरस एवं पोटाश उपयोग क्षमता बेहतर पाई गई।
- पटसन के सभी प्रजातियों ने 40 कि.ग्रा./है0 नत्रजन के प्रयोग से अधिकतम नत्रजन उपयोग क्षमता दर्ज कराये किन्तु नत्रजन की मात्रा इससे ज्यादा बढ़ाने पर सभी प्रजातियों के नत्रजन उपयोग क्षमता में ह्रास पायी गयी। पटसन के जे.आर.ओ.–204, जे.आर.ओ.–524 तथा जे.आर.ओ.–8432 प्रजातियों की उपज क्षमता अन्य तीन प्रजातियों (जे.आर.ओ.–128, जे.बी.ओ.–2003 एच. तथा एस.–19) की तुलना में सार्थकतापूर्वक अधिक दर्ज की गई।
- सनई के जड़ों से प्राप्त ब्रैडिराइजोबियम के प्रभेद बी.आर.सी.–6, बी.आर.सी.–7 तथा बी.आर.सी.–1 अन्य ब्रैडिराइजोबियम प्रभेदों की तुलना में सनई के हरित तथा शुष्क जैवभार बढ़ाने एवं नोडूलेशन दर को बढ़ाने में अत्यन्त प्रभावी पाये गये।

जैविक एवं अजैविक तनाव

- पटसन के बिहार रोमिल सूँड़ी के प्राकृतिक जैव नियंत्रण हेतु ब्रकोनिड समूह की सूँड़ियों *(मेटिओटस स्पाइलोसोमा एवं प्रोटापैण टेनिस अब्लिकुआ)* को मुख्य परभक्षी तथा न्यूक्लियर पाली हेड्रोसिस विषाणु को जैव नियंत्रक के रूप में अभिलेखित किया गया।
- नए कीटनाशियों की पटसन के बिहार रोमिल सूँड़ी के प्रति एल.सी.–50 की विषाक्तता हेतु फ्लुबेण्डिएमाइट व लैम्डा सायहैलोथ्रिन की 1 पी.पी.एम. व इमाक्टिन बेन्जोएट की 2 पी.पी.एम. एवं क्लोरनट्रानिलिप्रोल की 3 पी.पी.एम. मात्रा प्रभावी पाई गई है।
- मिलीबग के नियंत्रण हेतु प्रयोग होने वाले विभिन्न कीटनाशियों के साथ 0.2% खनिज़ तेल के प्रयोग से इसकी मृत्यु दर में 6 से 22% तक की वृद्धि पाई गई। जबकि प्रोफेनोफॉस 50 ई.सी. (0.035%) के साथ 0.2% खनिज़ तेल के प्रयोग से मृत्यु दर शतप्रतिशत अभिलेखित की गई।
- पटसन की फसल में आर्थिक क्षति के स्तर के निर्धारण हेतु पीली मकड़ी की संख्या शीर्ष से दूसरी पत्ती में 42/वर्ग सें.मी. एवं लेपिडोप्टेरन पीड़कों हेतु 3 प्रतिशत पौध क्षति के रूप में प्रेक्षित की गई।
- सादा पटसन के जननद्रव्यों सी.आई.एन.–512 एवं सी.ई.एक्स.–23 में पीली मकड़ी का संक्रमण न्यूनतम पाया गया। जबकि सी.आई.एन.–13, सी.आई.एन.–001 तथा सी.आई.एन.–211 को क्रमशः तना घुन, अर्धकुण्ड़लक तथा बिहार रोमिल सूँड़ी के प्रति ज्यादा अवरोधी पाया गया। तोषा पटसन के जननद्रव्य ओ.आई.एन.–507, ओ.आई.जे.–192, ओ.आई.एन.–431 तथा ओ.आई.एन.–401 में क्रमशः पीली मकड़ी, तना घुन अर्धकुण्ड़लक तथा बिहार रोमिल सूँड़ी का प्रकोप अत्यन्त कम देखा गया।
- चयन परीक्षण के आधार पर *स्पाइलोसोमा अब्लिकुआ* (वाकर) की भक्षण वरीयता का निर्धारण किया गया। इस कीट की पटसन की कृषित प्रजाति (*सी. ऑलीटोरियस*) के प्रति भक्षण वरीयता ज्यादा थी जबकि अकृषित प्रजातियों, *(सी. ट्राइलोकुलैरिस एवं सी. ट्राइडेन्स)* पर इसका सार्थक पोषण नहीं देखा गया।
- अकृषित पटसन की प्रजातियों, *(सी. फैसिकुलैरिस, सी. ट्राइडेन्स* एवं *सी. एस्टुऑन्स)* में फिनाल की मात्रा पटसन के कृषित प्रजाति *(सी. ओलिटोरियस)* में मौजूद फिनाल की तुलना में ज्यादा था जिसे *स्पाइलोसोमा आब्लिकुआ* के प्रति मुख्य प्रतिजैविक कारक के रूप निरूपित किया जा सकता है।
- नत्रजन उर्वरकों के अधिक इस्तेमाल से पटसन के तना सड़न रोग का प्रकोप अधिक देखा गया जबकि फोस्फेटिक तथा पोटाश की अधिक मात्रा इस रोग के प्रकोप को कम करने में कारगर साबित हुए।
- पटसन के तना सड़न रोग के नियंत्रण हेतु कवकनाशियों कार्बेण्डाजिम 50 डब्ल्यू.पी.(0.1%) तथा टेबुकोनाजोल 25.9% ई.सी.(0.1%), का छिड़काव अत्यन्त प्रभावी पाया गया।
- हल्दी, सिट्रोनेला एवं मेन्था के आसवन से प्राप्त तेल का प्रयोग तना सड़न रोग के रोगजनक *(मैक्रोफोमिना फेसिओलिना)* का अन्तःपात्रे नियंत्रण हेतु किया गया जिसमें हल्दी व सिट्रमेला का तेल जैव नियंत्रण हेतु प्रभावी रहा जबकि मेन्था का तेल अप्रभावी पाया गया।
- कीटनाशी कवक *बेउवेरिया बेसिआना* के पहचान हेतु चार जोड़े इ.एस.टी. प्राइमर्स उदाहरणार्थ सी.बी.बी.–1 एफ./आर., एच.एस.टी.–1 एफ./आर. तथा एच.एस.टी.–2 एफ./आर. का निर्माण एवं संश्लेषण किया गया।

- पटसन के तना सड़न रोग के नियंत्रण हेतु कार्बेण्डाजिम (0.1%), बीटा एमीनो ब्यूटायरिक एसिड (बाबा) (5 एम.एम.), सैलिसायलिक एसिड (1 एम.एम.) एवं कैल्शियम क्लोराइड (25 एम.एम.) का प्रयोग प्रभावी पाया गया।
- रासायनिक इलीसिटर्स जैसे काइटोसान 5.0% की दर से, सैलिसायनिक एसिड (1.0 एम.एम.), इण्डोल एसीटिक एसिड (1.0 एम.एम.), बीटा एमीनो ब्यूटायरिक एसिड (5.0 एम.एम.), डाई पोटोशियम हाइड्रोजन फॉस्फेट (50 एम.एम.), कैल्शियम क्लोराइड (25 एम.एम.) एवं कार्बेण्डाजिम (0.1%) का पटसन की फसल में छिड़काव करने से पटसन पौध में पालीफिनाइलपरआक्सीडेज, एलफिनाइलअमोनियम लायेज एवं परआक्सीडेज की मात्रा में वृद्धि पाई गई।
- बीजोत्पादन हेतु पटसन की अगस्त के तृतीय सप्ताह में करने तथा फली बनते समय कार्बेण्डाजिम (0.1%) का छिड़काव करने पर रोग मुक्त पटसन बीज उत्पादन में सार्थक वृद्धि दर्ज की गई।
- सीसल की प्राकृतिक संक्रमण दशा में जेब्रा रोग के प्रति प्रतिरोधिता का परीक्षण करने से पता चला कि केवल *ए. कैण्टाला* एवं *ए. अमेनिइन्सिस* जेब्रा रोग के प्रति प्रतिरोधी हैं जबकि तीन प्रजातियों, (*ए. मीराडोरेन्सीस, ए. अंगस्टीफोलिया तथा ए. अमेरिकाना*) ने जेब्रा रोग के प्रति मध्यम अवरोधी पाए गए। 58 जननद्रव्यों के प्राकृतिक संक्रमण की दशा में परीक्षण से कुल 29 जननद्रव्य अवरोधी, 14 मध्यम अवरोधी तथा 15 संवेदनशील से अत्यन्त संवेदनशील पाये गये।
- रेमी के मुख्य रोगों के रूप में सर्कोस्पोरा पर्ण चित्ती, (5–30%), एंथ्रेकनोज पर्ण धब्बा (10–60%), स्केलेरोशियम तना गलन (5–20%), आर्द्र तना गलन (5–20%), तना गलन (10–100%) एवं पीला मोज़ैक (30–70%) को अभिलेखित किया गया। रेमी के जनन द्रव्यों के परीक्षण में आर.–1411, आर.–1413, आर.–1414 और आर.–1419 को रेमी के मुख्य रोगों के प्रति प्रतिरोधी पाया गया।
- रेमी के पर्ण धब्बा रोगों के नियंत्रण हेतु प्रोपिकोनाजोल के बाद डाइफेनकोनाजोल का 0.1% पर्णीय छिड़काव प्रभावी कवकनाशी के रूप में अभिलेखित किया गया। कवकनाशियों के प्रयोग से रेमी के पौधों की ऊँचाई, तने का भार, हरित जैव भार तथा अन्ततः रेशे की उपज में भी वृद्धि दर्ज की गई।
- एक महीने की अवधि (16 अप्रैल से 16 मई 2012) में 5–15: तक मृदा नमी में ह्रास पटसन के पौधों में मृत्युदर को बढ़ाता है।
- 20 कि.ग्रा./है. से कम उपलब्ध सल्फर वाली मृदा में 60:30:30 कि.ग्रा./है. एन:पी:के. के साथ–साथ 30 कि.ग्रा./है. सल्फर अवयव के प्रयोग से 26 कु./है. तक रेशा उपज के साथ यह अत्यन्त ही प्रभावी शुष्क प्रबंधन विधि साबित हुआ है।

प्रक्षेत्र यंत्रीकरण एवं कटाई उपरान्त प्रौद्योगिकी

- शक्तिचालित पटसन रिबनर मशीन का रेशा निष्कर्षण हेतु सुधार किया गया एवं इसका आदर्श प्रतिरूप नमूना बनाने हेतु कार्य किया जा रहा है।
- टी.एम.जे. परियोजना के अन्तर्गत पटसन एवं मेस्ता के रेशा के निष्कर्षण हेतु के.प.स.रे.अ.सं. के टाल्क आधारित सूक्ष्मजीवीय सम्मिश्रण का बहराइच (उत्तर प्रदेश) एवं श्रीकाकुलम (आन्ध्र प्रदेश) में कुल 70 प्रक्षेत्र प्रदर्शन किया गया जिससे रेशे के निष्कर्षण की प्रक्रिया सामान्य समय की तुलना में 6–10 दिन पहले पूरी हो गई। इसके अतिरिक्त पश्चिम बंगाल में बड़े पैमाने पर कुल 205 प्रक्षेत्र प्रदर्शन भी किए गए। इस तकनीक से निष्कर्षित पटसन के रेशे की तनाव क्षमता (27.3 ग्रा./टेक्स.) परंपरागत तरीके से निष्कर्षित रेशे की तनाव क्षमता (23.2 ग्रा./टैक्स) से ज्यादा थी।
- 16 एस. राईबोसोमल डी.एन.ए. अनुक्रम प्रतिरूप के द्वारा दो पेक्टिनोलाइटिक क्षार सहिष्णु जीवाणुओं की आण्विक लक्षणता निरूपित की गई है। सूक्ष्मजीवाणु सम्मिश्रण के द्वारा रेमी में गोंद निष्कर्षण की प्रक्रिया 34–39^0 से.ग्रे. तापक्रम पर 2–3 दिनों में पूरी कर ली गई।

प्रौद्योगिकी हस्तांतरण

- पटसन एवं सीसल की उन्नत तकनीक पर आधारित 263 अग्रिम पंक्ति प्रदर्शन 64.68 है. प्रक्षेत्र में किए गए जिसमें जे. आर.ओ.–204 का उत्पादन 31.14 कु0/है0 रहा। इस प्रदर्शन में पाया गया कि पटसन के अंकुरण के बाद की अवस्था में खरपतवार नाशी क्विजॉलोफॉप इथाइल के प्रयोग से श्रमिक व्यय में भी रू.10,559–13867 की बचत होती है। पटसन की पंक्तिबद्ध बुआई के साथ अनुशंसित पोषक तत्वों के प्रयोग से कृषकों को रू. 1,624–6,852/है. की अतिरिक्त बचत होती है। इसी प्रकार से सीसल की फसल में अनुशंसित उर्वरकों की मात्रा के प्रयोग से रू.7,568–9,978/है. की बचत होती है।
- नदिया व मुर्शिदाबाद जिलों में पटसन की उन्नत तकनीक के प्रभावों का परीक्षण किया गया और देखा गया कि वर्षा आश्रित पटसन की खेती में गंधक 30 कि.ग्रा./है. के साथ नत्रजन:फास्फोरस:पोटाश 80:40:40 की दर से प्रयोग करने पर रेशा उत्पादन में 15.57 प्रतिशत की वृद्धि होती है। मूँग (पंत मूँग

5) की फसल को हरी खाद के रूप में 2 टन/है. की दर से प्रयोग करने पर रेशा उत्पादन में 18.32% की वृद्धि पाई गई।

- 2012–13 में पटसन–धान–सरसों और पटसन–धान–गेहूँ के फसल चक्र के प्रभावी परीक्षण हेतु कृषकों के प्रक्षेत्र में कुल 60 प्रक्षेत्र प्रदर्शन किए गए जिसमें पटसन–धान–सरसों का चक्रण लागत आय के अनुपात के आधार पर पटसन–धान–गेहूँ चक्रण से ज्यादा लाभदायी रहा।
- पटसन की उन्नत उत्पादन तकनीकों के अनुकूलन सर्वेक्षण के आधार पर त्रिस्तरीय श्रृंखला, अनुसंधान–कृषक– उद्यौगिकी का विश्लेषण करने पर पाया गया कि जे.आर.ओ.–204 कृषकों की सबसे ज्यादा लोकप्रिय किस्म के साथ–साथ चार पंक्तियों वाला सीड़ ड्रील तथा पंक्तियों में बुआई है। इसके अलावा अन्य समस्याओं को भी निरूपित किया गया जैसे नियमित बाजार की अनुपलब्धता, श्रमिकों का उच्च पारिश्रमिक, श्रमिकों की अनुपलब्धता एवं संश्लेषित उत्पादों का पटसन उत्पादों से प्रतिस्पर्द्धा आदि।
- टी.एस.पी. परियोजना के अन्तर्गत सीसल के 81,272 प्रवर्ध (रोपण सामग्री) को जनजातीय कृषकों को प्रदान किया गया जिसे कृषकों ने 20.36 है. में रोपित किया। असम के लखीमपुर, धीमाजी एवं सोनितपुर जिलों एवं अरूणाचल प्रदेश के पश्चिम सियांग जिले में 26.0 है0 में रेमी फसल की बुआई की गई जिसका रोपण सामग्री रेमी अनुसंधान केन्द्र सरभोग, असम के द्व ारा उपलब्ध कराया गया।

अखिल भारतीय नेटवर्क परियोजना

- चार नई किस्मों विशेषतः पटसन की जे.आर.ओ.एम.–1 (प्रदीप), जे.आर.सी.एम.–2 (पार्थो), केनाफ की जे.बी.एम.–81 (शक्ति) एवं सनई की एस.यू.आई.एन.–037 (अंकुर) को केन्द्रीय किस्म विमोचन समिति द्वारा व्यवसायिक खेती हेतु अनुशंसित करने के साथ–साथ राज सूचनाधिपत्र में भी रेखांकित किया गया है।
- सादा पटसन की जे.आर.सी.–9057 (इशानी), केनॉफ की जे. आर.के.एम.–9–1 (सत्येन) और रेमी की आर–1411 (हजारिका) केन्द्रीय किस्म अनुशंसा समिति द्वारा अ.भा.ने.प. के 27वीं वार्षिक कार्यशाला (बैरकपुर) के दौरान अनुशंसित की गई।
- संस्थान के सूक्ष्मजीवीय सम्मिश्रण का अखिल भारतीय नेटवर्क परियोजना के सभी केन्द्रों पर पटसन के रेशा निष्कर्षण हेतु प्रायोगिक प्रदर्शन किया गया। इस पद्धति से रेटिंग की प्रक्रिया 8–13 दिन की अवधि में पूर्ण हो जाती है एवं इससे सामान्य रेटिंग की प्रक्रिया में लगने वाले समय में 5–9 दिनों की बचत होती है। इसके अलावा सूक्ष्मजीवीय रेशा निष्कर्षण से निष्कर्षित रेशे की तनाव शक्ति (26.9 से 30.6 ग्रा./टेक्स) चेक प्रजाति (22.6 से 28.4 ग्रा./टेक्स) से अधिक पाई गई।
- पटसन में तना सड़न/जड़ गलन, एंथ्रेक्नोज, मौज़ेक एवं मेस्ता में जड़ सड़न पर्णीय धब्बा रोगों एवं फायटोप्लाज्मा के विकृतियों के प्रभाव को अभिलेखित किया गया। इसी प्रकार पटसन के पीड़कों में अर्धकुण्डलक, बिहार रोमिल सूंड़ी, पीली मकड़ी, तना घुन जबकि मेस्ता में फुदका, माहू, सफेद मक्खी, मिलीबग, अर्धकुण्डलक आदि को अभिलेखित किया गया। पटसन में बिहार रोमिल सूंडियों का क्षति प्रभाव बुआई के 75 से 103 दिन की अवधि में बैरकपुर (60.40 प्रतिशत) नागांव (44.38 प्रतिशत) एवं कटिहार में (16.40 प्रतिशत) दर्ज की गई।

पटसन सूचना तंत्र

- संस्थान मे "जैफएक्सपर्ट" नामक अन्तःजाल आधारित कम्प्यूटर कार्यक्रम की शुरूआत की गई है जिससे कृषकों को प्रश्नोत्तर सत्र के रूप में पटसन के कीट पीड़कों एवं रोगों की पहचान, निदान एवं प्रबंधन हेतु प्रभावी सूचना मिलेगी।

कृषि विज्ञान केन्द्र, बर्द्धवान

- कृषि विज्ञान केन्द्र, बर्द्धवान ने उन्नत व अनुशंसित, कृषि उद्यानिकी, पशु वैज्ञानिकी, मत्स्यकी एवं पौध संरक्षण तकनीकों को कृषकों तक पहुंचाने हेतु सात प्रक्षेत्र परीक्षण व 114 प्रथम पंक्ति प्रदर्शन किया। इसके अलावा कृषकों, प्रसार अधिकारियों एवं ग्रामीण युवा समूह के लिए विभिन्न प्रकार के प्रशिक्षण कार्यक्रमों का संचालन किया गया जिसमें 1800 सहभागी लाभान्वित हुए।

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

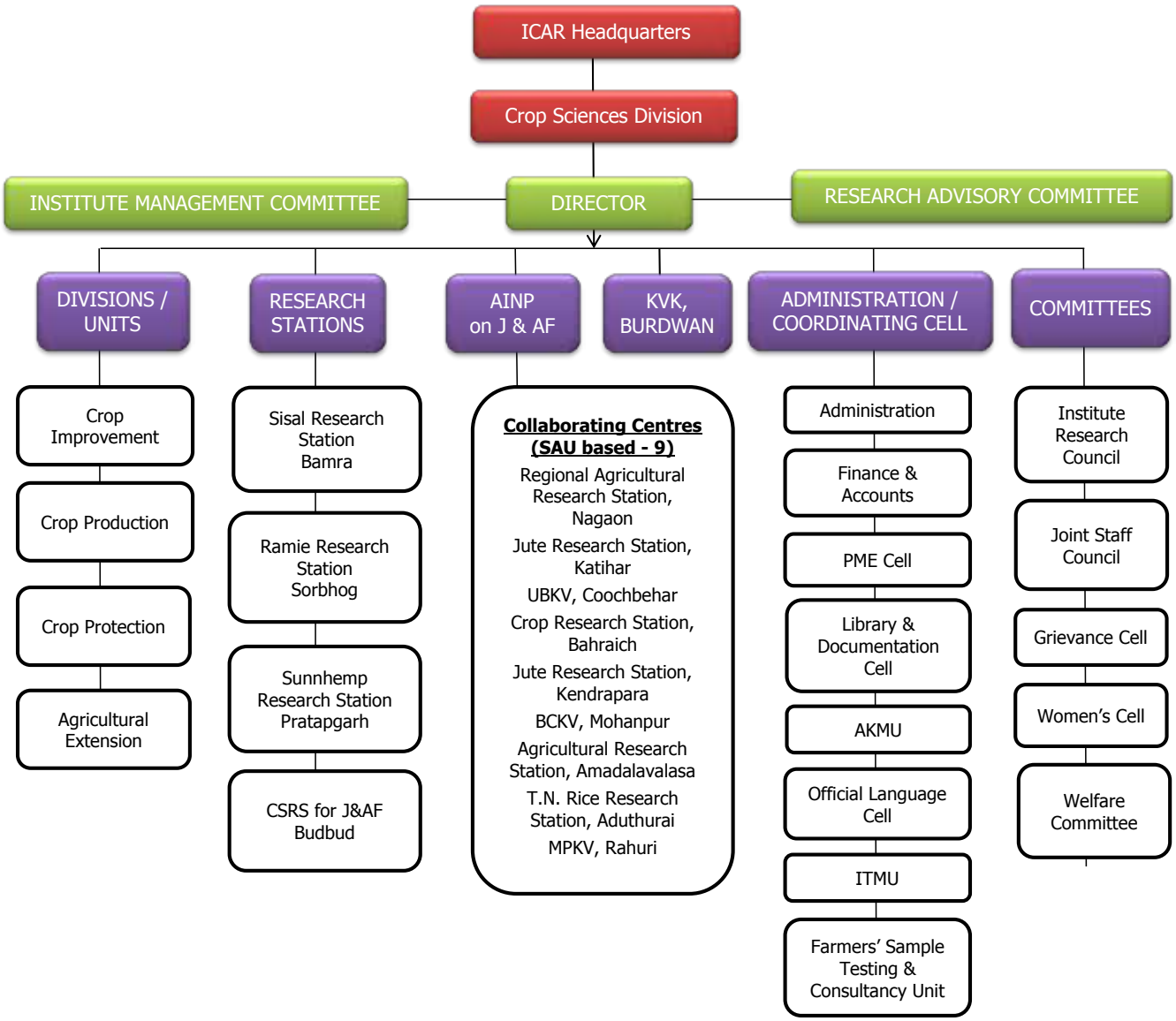
The institute has 3 research divisions *viz.*, Crop Improvement, Crop Production, Crop Protection and

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

1.1.1 Collection

A total of 235 accessions (*Corchorus* spp. 137; *Hibiscus* spp. 35; *Crotalaria* spp. 36, *Agave* spp. 17; *Urena* spp. 10) of jute and allied fibre germplasm have been collected from different districts of Tamil Nadu and Kerala states in two explorations (Table 1.1). Different species of jute and allied fibres found in their natural habitat are presented in Fig. 1.1. A total of 17 accessions of *Agave* spp. have been sent to SRS, Bamra, Odisha for acclimatisation and further utilization *(Source: JB 1.1. Contributors: P.G. Karmakar, S.B. Choudhary, H.K. Sharma and Anil Kumar).*

Table1.1: Number of germplasm accessions of jute and allied fibres collected from Tamil Nadu and Kerala

Species covered	Nov-Dec, 2012	Feb, 2013	Total
Corchorus spp.	53	84	137
Hibiscus spp.	13	22	35
Crotalaria spp.	22	14	36
Agave spp.	9	8	17
Urena spp.	10	-	10
Total	107	128	235

Fig. 1.1: Jute and allied fibre species in their natural habitat

1.1.2 Regeneration and conservation

A total of 750 accessions of *H. cannabinus* have been successfully regenerated at SRS, Bamra, Odisha and 360 accessions of wild *Corchorus* spp. have been regenerated at CRIJAF, Barrackpore. One hundred sixty accessions of jute and allied fibre supplied by NBPGR, New Delhi, have been grown for identification *(Source: JB 1.1. Contributors: P.G. Karmakar, S.B. Choudhary, H.K. Sharma and Anil Kumar).*

1.1.3 Characterization and evaluation

A total of 1226 indigenous accessions of *C. olitorius* were evaluated for plant height, basal diameter, green weight, dry fibre weight and fibre fineness. The range for plant height varied from 169.2 to 416.4 cm and fibre yield varied from 3.2 to 30.0 g/plant whereas, the fibre fineness was found between 0.60 to 3.80 tex. Indigenous collection of tossa jute showed normal distribution for all the traits evaluated (Fig. 1.2) *(Source: JB 1.1. and TMJ MM 1.2, Contributors: P.G. Karmakar, S.B. Choudhary, H.K. Sharma and Anil Kumar).*

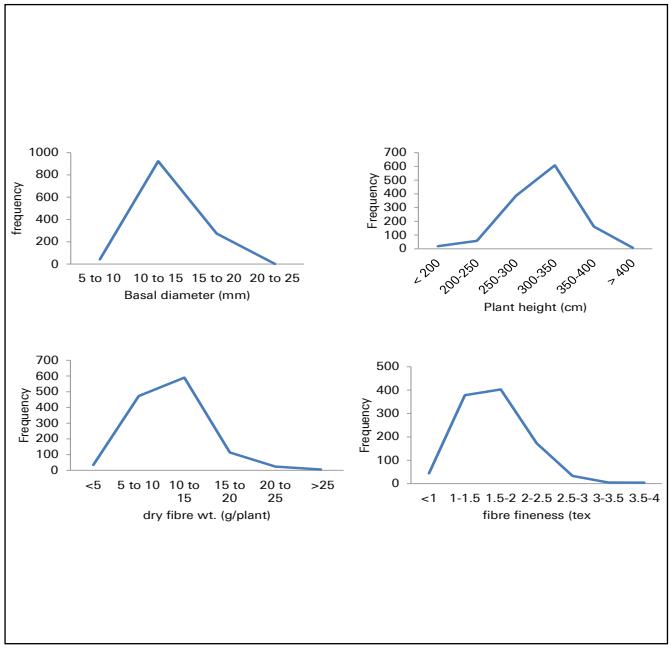


Fig. 1.2: Frequency distribution for fibre yield and attributing traits of Indigenous accessions of tossa jute

A total of 129 germplasm accessions of roselle (*H. sabdariffa*) (REX: 30, RIJ: 61, RIN: 38) along with 10 released varieties were evaluated in microplots for fibre yield and its attributing traits (plant height and basal diameter) and calyces yield (Table 1.2). Mean fibre yield was 10.53 g/plant with a range of 0.40 - 23.06 g/plant while fresh calyx weight varied between 3.20 to 50.00 g/plant with an average of 15.37 g/plant *(Source: JB 1.1. Contributors: P.G. Karmakar, S.B. Choudhary, H.K. Sharma and Anil Kumar).*

Table 1.2: Descriptive statistics for different traits of *H. sabdariffa*

Parame-ters	Plant height (cm)	Basal diameter (mm)	Dry fibre weight (g)	No. of capsules	Fresh calyx wt. (g)
Mean	256.52	14.83	10.53	26.82	15.37
Range	96.00-360.00	7.83-20.42	0.40-23.06	5.80-99.40	3.20-50.00
SEm±	6.03	0.24	0.52	1.04	0.64
CV(%)	27.52	18.79	57.84	46.93	50.02

A total of 127 accessions of flax were characterized for flower morphology (Fig. 1.3) and fibre yield and attributing traits (Table 1.3). The plant height and fibre yield/20 plants varied from 65.4 to 134.8 cm and 10.0 to 50.60 g, respectively *(Source: JB 1.1. Contributors: P.G. Karmakar, S.B. Choudhary, H.K. Sharma and Anil Kumar).*

Table 1.3: Range of fibre attributing traits of flax germplasm

Traits	Range
Plant height (cm)	65.4 to 134.8
Basal diameter (mm)	2.45 to 4.89
Days to maturity (days)	67 (early) to 103 (late)
Fibre yield/ 20 plant (g)	10 to 50.6

A total of 139 accessions of flax (*Linum usitatissimum)* were evaluated for five qualitative and 10 quantitative characters along with four checks namely, JRF-2, JRF-4, FT-895 and FT-897. The data recorded for plant height ranged from 95.0 cm to 145.0 cm, number of primary branches/plant ranged from 2.0 to 6.0 and basal diameter ranged from 3.2 cm to 5.2 cm *(Source: SNHB 1.8. Contributors: B Chaudhary, M.K.Tripathi and H. Bhandari).*

Fig. 1.3: Variation for flower morphology in flax

A total 140 germplasm lines of *Crotalaria juncea* L. and 17 lines of wild *Crotalaria* spp. were evaluated and maintained. Data were recorded on fibre yield and yield component. Plant height range were recorded from 49.0 cm to 279.0 cm, basal diameter ranged from 4.9 mm to 12.6 mm and test weight ranged from 34.0 g to 49.4 g *(Source: SNHB 1.8. Contributors: B.Chaudhary, M.K.Tripathi, H. Bhandari and S.K. Pandey).*

1.1.4 Distribution

A total of 875 accessions of jute and allied fibres were 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 and H.K. Sharma).*

1.1.5 Development of core collection in *C. olitorius*

A total of 1502 accessions of *C. olitorius* (tossa jute) were evaluated for ten quantitative characters. Mean plant height of the accessions was 301.1 cm while mean basal diameter of the accessions was recorded to be 13.63 mm. Mean fibre yield of the 1502 accessions was found to be 10.36 g/plant. A core collection of 57

(3.8%) accessions was developed using both heuristic and non-heuristic search algorithms using M-strategy implemented in software POWERCORE (Fig. 1.4). Both approaches identified same set. Mean difference between the core and entire collection was recorded to be 14.96%, while variance difference was 62.65%, showing the core collection has similar mean values to that of entire germplasm collection, but has much more variability. The coincidence rate of core and entire collection was 97.34%, indicating high resemblance between core and entire collection. Another core collection of 78 (5.19%) accessions was developed using random search algorithms. The mean difference between this core collection and entire collection was 11.89%. The coincidence rate of core and entire collection was 94.4%. A total of 23 accessions were common to both sets *(Source: JB 8.6. Contributors: P. Satya, D. Sarkar and C.S. Kar).*

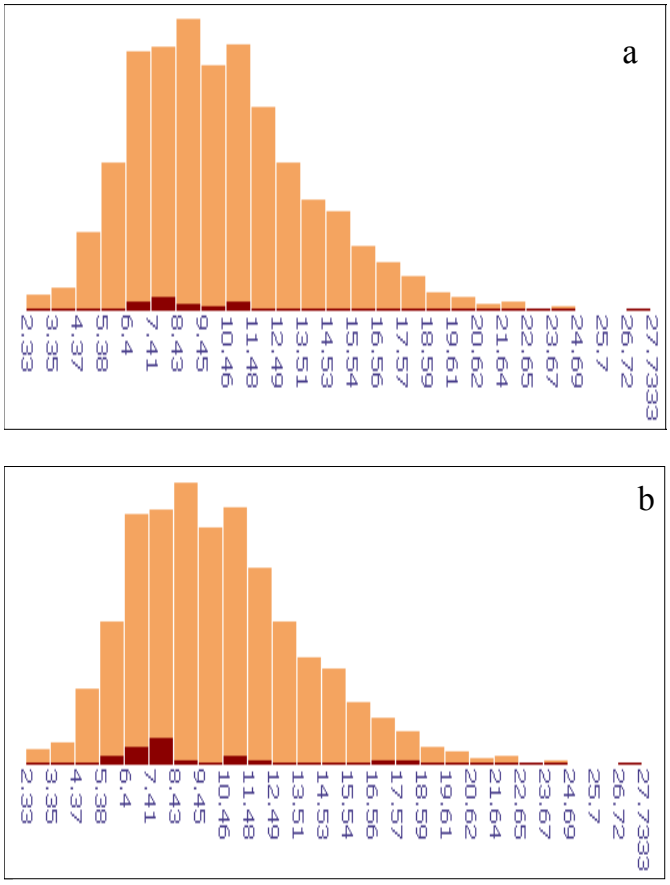


Fig.1.4: Distribution of fibre yield of entire collection (1502 accessions) and core collection using heuristic search (a) and random search (b)

1.1.6 Genetic diversity analysis in mesta

Evolutionary relationships between kenaf, roselle and their wild relatives have been studied using 12 SSR and 13 ISSR markers. The cultivars of kenaf and roselle developed in India were found to have narrow genetic base but the germplasm collection was genetically as well as geographically diverse.

Cluster analysis revealed that the kenaf accession and varieties with similar genetic background and geographical origin formed closely related groups due to high genetic similarity (Fig. 1.5). High genetic diversity between Indian and exotic kenaf accessions was observed, although Indian kenaf germplasm was genetically diverse. *H. surattensis* was found to have closer genetic similarity with kenaf compared to other species including roselle (*H. sabdariffa*). Other wild species were genetically distinct from the cultivated species. At sub-genus level, members of sections like Trichospermum (*H. calyphyllus*), Ketmia (*H. caesius*) or Pterocarpus (*H. vitifolius*) formed separate groups and also exhibited higher genetic distance from members of section Furcaria (*H. cannabinus, H. sabdariffa, H. surattensis, H. acetosella* and *H. radiatus*) *(Source: JB 8.7. Contributors: P. Satya, J. Mitra, S.K. Pandey and S.B. Choudhary).*

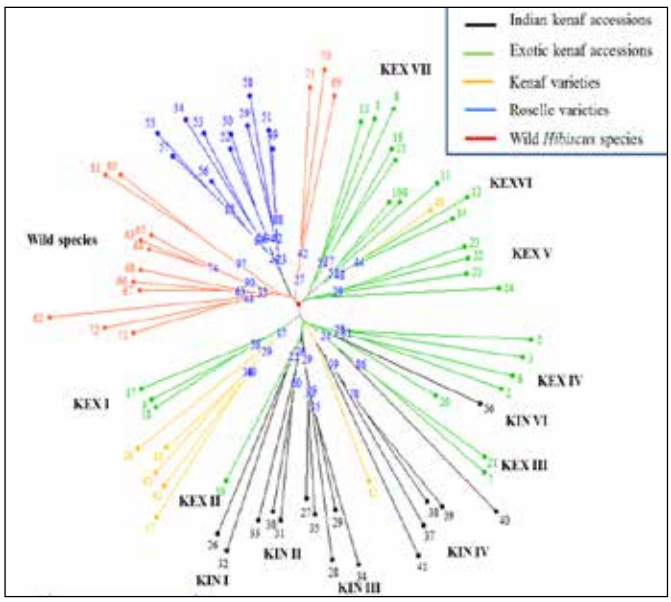


Fig. 1.5: Genetic diversity of kenaf, roselle and their wild relatives

1.2 Varietal development

1.2.1 Jute

1.2.1.1 White jute (*C. capsularis*)

Single plant progeny of F_5 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) was evaluated in Rabi 2011-12 at off-season nursery of SBI, Agali. From this F_5 progeny, 155 single plants from different crosses were selected and resultant single plant progenies were evaluated at Barrackpore in *kharif* 2012-13.

From 155 F_6 single plant progeny, 20 families were selected based on mean performance of progeny in comparison to checks JRC 698 and JRC 321. Graphical presentation of 20 families for fibre yield/plant (Fig. 1.6) indicates at least 4 families (No. 6, 8, 17, 19) having fibre yield more than 20 g/plant are very promising lines. These 20 selected families have been grown in *rabi* 2012-13 at off-season nursery of SBI, Agali.

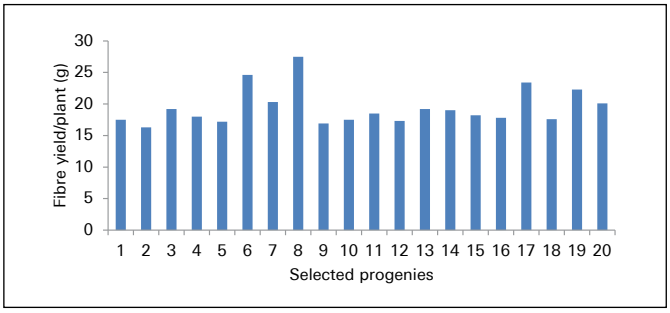


Fig.1.6: Mean fibre yield (g/pl.) of plant progeny of selected 20 families

Selection in F_6

Based on evaluation of 50 single plant progenies of 10 F_6 populations of different crosses (JRC 698 × Bidhan Pat 3, CEX 006 × JRC 4444, CMU 010 × Bidhan Pat 3, CMU 010 × JRC4444, Bidhan Pat 3 × KTC 1, Bidhan Pat 3 × JRC 4444, Bidhan Pat 3 × CIJ 001, KTC 1 × CEX 007, JRC 4444 × CEX 007 and CEX 007 × CIJ 001), 10 individual plants from each of selected 5 crosses (JRC 698 × Bidhan Pat 3, CEX 006 × JRC 4444, KTC 1 × CEX 007, JRC 4444 × CEX 007, CEX 007 × CIJ 001) thus making a total of 50 single plants were selected (Table 1.4) *(Source: JB 8.4. Contributors: J. Mitra and C.S. Kar).*

Table 1.4: Mean performance of F_6 progeny of five selected crosses

Cross	Plant height (cm)	Basal diameter (mm)	Green weight/ plant (g)	Fibre yield/plant (g)
CEX 006 × JRC 698	355.50	18.90	300.30	17.50
JRC 4444 × JRC 321	358.60	17.80	298.30	16.30
CMU 010 × CIN 010	363.20	16.70	322.40	19.20
CEX 006 × KTC 1	365.40	16.60	308.70	18.00
CEX 007 × CIN 010	362.10	16.80	291.30	17.20

Selection in F_5

From another set of single plant F_5 progeny of three populations of different crosses (CIJ 126 X JRC 80, CIJ 126 X CIJ 121, JRC 321 X CIJ 121) a total of 45 individual plants (15 single plant from each cross) were selected and evaluated for fibre yield and its attributing traits (Table 1.5).

Table 1.5: Performance of selected F_5 population (progeny mean) of three crosses

Cross	Plant height (cm)	Basal diameter (mm)	Green weight/ plant (g)	Fibre yield/ plant (g)
CIJ 126 × JRC 80	356.20	18.90	395.30	20.30
CIJ 126 × CIJ 121	355.60	20.60	337.80	19.60
JRC 321 × CIJ 121	352.50	20.10	303.20	18.60

Station trial with 5 lines from different crosses resulted in identification of one high yielding line (designated as JRCJ-5) which was nominated in IET trial 2013-14 under AINP (Table 1.6) *(Source: JB 8.4. Contributors: J. Mitra and C.S. Kar).*

Table 1.6: Mean fibre yield of 5 lines as compared to 3 checks

Parental combination	Fibre yield (q/ha)
CIN 117 × CIN 206	24.56
PADMA × CIJ 031	26.50
CIN 147 × CIN 206	32.15 (JRCJ-5)*
CIN 147×UPC 94	28.63
CIN 146 × CIN 312	25.62
JRC 321 (Check)	28.63
JRC 212 (Check)	28.20
JRC 698 (Check)	29.53
CD $_{(P=0.05)}$	2.30

* nominated in AINP trial

1.2.1.2. Tossa jute (*C. olitorius*)

1.2.1.2.1 Conventional breeding

In 2012-13, one new cross was attempted between JRO 204 × JRO 2407. F_1 seeds have been harvested for sowing in next generation. From F_1 generation of 2011-12, 26 new crosses were grown along with parents for confirmation of hybrid identity at CRIJAF during *kharif* 2012. The parents of these crosses were OIN 004, OIN 007, OIN 008, OIN 054, OIN 058, OIN 082, OIN 102, OIN 106, OIN 198 (indigenous accessions), OIN 125 and OIN 154 (donor of *Macrophomina* resistance), JRO128, JRO 204, JBO 1 and S19 (elite lines). In segregating generation (F_2), one set of ten crosses were advanced to F_3 generation in offseason nursery at Agali, Coimbatore. In another study, 34 F_5 populations of 17 crosses were evaluated in plant to row progenies during *kharif* 2012. A total of 340 progeny rows were grown. Based on plant height and base diameter, 12 uniform progenies were identified and harvested in bulks. A second set was grown for pre-mature flowering tolerance, where 43 F_5 populations of 12 different crosses were sown to evaluate their potential for premature flowering resistance characters. These lines were sown on three different dates: 1st week, 2nd week and 3rd week of March, 2012. When sown in 1st week of March progeny no. 7-2012, 20-2012, 27-2012, 34-2012 originating from cross OIJ 071 × S 19, OIJ 100 × S 19, OIJ 257 × S 19, OIN 343 × S 19 respectively exhibited less than 1% flowering at 35-47 DAS after sowing. Progeny no. 7-2012, 20-2012 exhibited comparatively less flowering (<5%) even after 60 DAS. When sown in 2nd week of March no flowering was observed after 52 DAS in line no 2-2012, 4-2012. Based on the above result lines 7-2012, 20-2012, 2-2012, 4-2012 were selected for further evaluation in micro-plot yield trials. In another F_6 population, 39 populations were grown during *kharif* 2012 at Barrackpore. Based on plant height, basal diameter and fibre yield, nine progenies were bulked for evaluation in station trials in microplots. Fourteen bulks were evaluated for yield in station trial with two checks JRO 524 and S 19. JOC 2 and JOC 16 only were found to have better yield compared to both checks (Table 1.7). Two new entries have been entered in IET in 2013. *(Source: JB 8.3. Contributors: C.S. Kar, S.K. Sarkar and A.K. Ghorai).*

Table 1.7: Performance of *C. olitorius* breeding lines in station trial

Line	Plant height (cm)	Basal diameter (mm)	Fibre yield (q/ha)
JOC 2	355.00	16.10	32.00
JOC 3	362.70	17.30	25.00
JOC 4	353.00	16.10	20.60
JOC 5	356.90	15.40	26.40
JOC 6	354.30	16.30	25.90
JOC 7	357.20	15.50	23.50
JOC 8	368.30	16.10	24.10
JOC 10	369.00	15.60	24.90
JOC 11	351.30	15.80	26.00
JOC 12	354.90	15.60	26.20
JOC 13	348.10	15.30	28.00
JOC 14	359.30	14.90	27.20
JOC 15	351.30	16.10	26.90
JOC 16	358.80	16.30	30.30
JRO 524	349.20	16.00	29.30
S 19	357.50	16.30	30.90
CV (%)			13.81
CD $_{(P=0.05)}$			NS

1.2.1.2.2 Mutation breeding

In M_3 generation of tossa jute (Cv. JRO 204 & JRO 8432) a large number of morphological mutants were identified (Table 1.8). Four of which are soft stem mutant with undulated phenotype, producing lesser fibre with low lignin content. These apparently have defects in secondary fibre development especially lignin content. Additionally, one hard stem mutant having coarser fibre producing ability compare to control has been identified. Besides, one super dwarf mutant having plant height about 30 cm in contrast to control (320 cm) has been identified. A twisted bark mutant has been identified which may be an example of anomalous secondary growth in tossa jute (Fig. 1.7) *(Source: JB 8.9. Contributors: S.B. Choudhary, C.S. Kar and H.K. Sharma).*

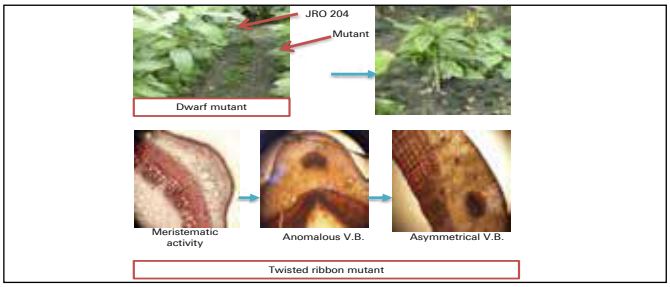


Fig. 1.7 Dwarf and twisted ribbon mutants of tossa jute

Table 1.8: List of mutants identified in M_3 generation

Trait	Type of mutant
Chlorophyll mutant	Alboviridis, Chlorina, Virescent
Leaf shape mutant	Lanceolate, cordate, crinkled, palmate
Stem length	Dwarf, long
Bark	Twisted bark
Stem hardiness	Soft, hard
Floral mutant	Scaly sepals
Pod	Smooth ridge, oval pod, small

1.2.1.2.3 Quality breeding

One entry of tossa jute namely JROK 10 having finer fibre quality and superior yield has been promoted to AVT-I stage of multi-location testing under AINP of jute and allied fibres. Four entries viz., JROK 13, JROK 14, JROK 15, and JROK 16 were included for multi-location testing under IET. Five (05) selections superior for fibre yield and 13 selections having better fibre fineness were identified. *(Source: TMJ MM 1.2. Contributor: P. G. Karmakar).*

A total of 162 RILs of tossa jute along with parents were grown at CRIJAF, Barrackpore and CSRSJAF, Budbud for phenotyping. Phenotyping for fibre fineness from one location has been completed. Results show that fibre fineness in RIL population is normaly distributed. Further, DNA was extracted from 162 RILs and parents and screening for parental polymorphism was done using 100 SSR markers *(Source: JB 9.2. Contributors: S. B. Choudhary, P. G. Karmakar, D. Sarkar, H. K. Sharma, Kanti Meena, Amit Bera and H. Bhandari).*

1.2.1.2.4 Hybrid technology development

A total of 230 jute accessions from National Active Germplasm site of Central Research Institute for Jute and Allied fibres were screened. Pollen Fertility was studied by staining with aceto-carmine (2%) and KI-I_2 solution. No significant male sterility was observed; although some germplasm accessions exhibited less than 90% fertility. Fourteen genotypes were chosen for crossing in line X tester mating design. Genotypes were selected based on diversity analysis and based on their yield potential. Three gametocides, namely Maleic Hydrazide, Benzotriazole and commercial detergent were used to induce male sterility. Three treatment options for each gametocide were fixed. Benzotriazole @ 0.1 % was most effective on jute variety S 19 (Fig. 1.8). Commercial detergent @ 0.5% and 1.5% gave satisfactory induction of male sterility *(Source: RKVY. Contributors: H. K. Sharma, P. Satya, Anil Kumar, D. Sarkar, J. Mitra, C.S. Kar and S.B. Choudhary).*

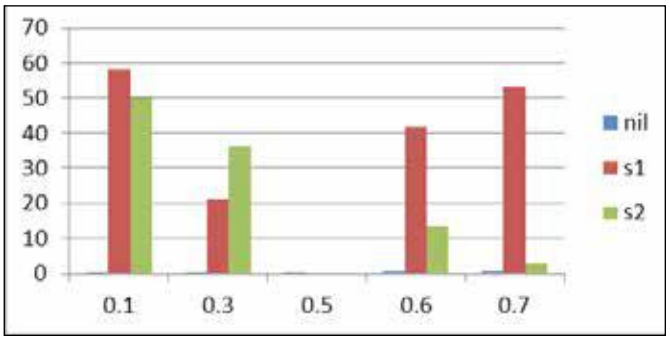


Fig. 1.8: Sterility induced by Benzotriazole treatment on variety S 19

Total seven genotypes (OEX-03, OEX-13, OEX-29, OIN-255, OMU-7, OMU-19 and OMU-27) of tossa jute were crossed in half diallel fashion. The resulted 21 hybrids along with parents and best checks will be evaluated for hybrid combinations for fibre yield and yield attributing characters *(Source: JB 9.1. Contributors: A. Anil Kumar, C. S. Kar and J. Mitra).*

1.2.1.2.5 Genetic analysis of resistance to stem rot in jute

Four virulent strains of *M. phaseolina* have been identified, purified and are being maintained. Eight parental lines (two of *C. capsularis* and six of *C. olitorius*) have been sown and genomic DNA has been extracted from these parental lines. Crossing programme between resistant and susceptible parents of *C. olitorius* has been initiated at off-season nurseries at Agali, Kerala.

A RIL mapping population comprising of 202 accessions has been sown in CRIJAF for phenotyping. Bioinformatic analysis for resistance gene analogs has been initiated and 10 R gene markers have been screened in *C. olitorius*. *(Source: DBT project. Contributors: P. Satya, P. G. Karmakar, C. Biswas, P. K. Gupta and H. S. Balyan).*

1.2.1.2.6 Interspecific hybridization

In jute, interspecific hybridization resulted in development of four F_1 plants from hybridization of *C. olitorius* x *C. trilocularis*. The hybrid plants resembled female parent (*C. olitorius*). The F_1 plants exhibited rough, crumpled leaf surface characteristic of interspecific hybrids earlier reported *(Source: JB 8.7. Contributors: P. Satya, J. Mitra, S.K. Pandey and S.B. Choudhary).*

1.2.1.2.7 Protection of jute varieties and DUS testing

A new tossa jute variety CO 58 was tested for first growing cycle during 2012-13 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 is distinct for leaf shape. Confirmation of uniformity and distinctiveness of CO 58 was revealed by monitoring team visited on 16-17 Aug, 12

Ten varieties (six varieties of white jute - JRC 80, JRC 698, Monalisa, Bidhan Pat 1, Bidhan Pat 2, Bidhan Pat 3 and four of tossa jute - S 19, JRO 8432, JRO 128, JRO 66) have been registered as extant under PPVFR Act.

All the reference varieties of both tossa jute (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. Application for registration of a new tossa jute variety- JRO 2407 (Samapti) has been accepted by PPV & FR authority and this candidate variety will be tested in 2013-14 *(Source: DAC. Contributor: J. Mitra).*

1.2.2 Mesta

1.2.2.1 Kenaf *(H. cannabinus)*

Progenies were developed from selecting a diverse set of parental lines and intercrossing these lines in 2010. A trial comprising of 39 F_1s and F_2s along with 18 parents of kenaf was constituted for evaluation of fibre yield and attributing traits in RBD with 3 replications. Parental lines KIJ-213, KIJ-28, KIJ-27 and KIJ-20 were found to be good general combiners for plant height and basal diameter (Table 1.9). For dry fibre weight parental line KIJ-20 showed highest *gca* effect. KIJ-186, KIJ-281 and KIJ-213 also showed high *gca* (Fig.1.9).

Under the study for inheritance of fibre quality traits in kenaf, parental line KIJ-186 was found to be the best general combiner for fibre fineness followed by KIJ-28, KIJ-275 and KIJ-255 (Fig. 1.10). Whereas, parental line KIJ-27 was the best general combiner for fibre tenacity trait followed by KIJ-275 and HC 583 (Fig. 1.11). These lines can be utilized in breeding programme for the improvement of fibre quality traits in kenaf. The average performance of F_1 hybrids, in general was more than 30% higher over the parents (Fig. 1.12) *(Source: JB 8.5. Contributors: S. K. Pandey, R. K. Dey, S. Satpathy, P. Satya and H. K. Sharma).*

Table 1.9: General combining ability (*gca*) effects of parents for dry fibre weight and contributing traits.

Parent	*gca*				
	Plant height	Base diameter	Green weight	Dry stick weight	Dry fibre weight
KIJ-20	4.496	2.005	47.584	8.732	1.945
KIJ-27	6.940	0.597	-10.194	-0.262	0.239
KIJ-28	8.162	0.159	-0.638	3.160	-0.066
KIJ-31	-7.404	-0.137	-17.583	-0.890	-0.522
KIJ-165	-0.282	-0.307	-4.083	-1.024	0.573
KIJ-186	-0.504	0.437	16.195	0.024	1.456
KIJ-213	17.940	-0.126	38.973	1.110	1.145
KIJ-255	-4.726	-2.148	-28.694	-2.429	-0.744
KIJ-261	-7.393	0.520	49.028	-0.535	0.573
KIJ-275	-13.615	-1.032	-20.916	-4.568	-2.077
KIJ-281	4.385	0.060	-0.727	2.943	1.189
KIJ-296	8.496	-0.576	-52.072	-6.601	-3.655
KIJ-309	-16.393	0.547	-16.872	0.321	-0.055
HC 583	1.803	-0.070	4.803	0.738	-0.163
AMC 108	8.701	0.312	-0.053	-0.806	0.115
MT 150	-10.504	-0.242	4.750	0.068	0.048

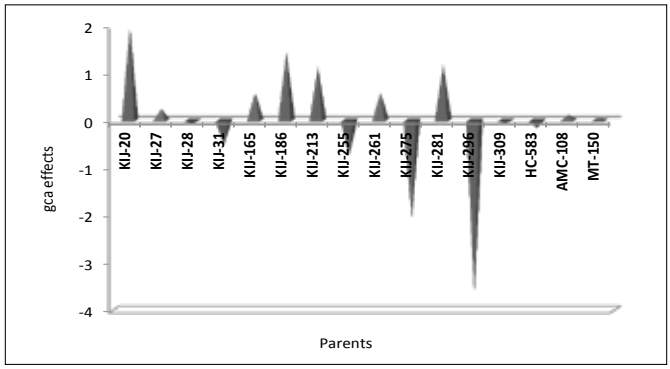


Fig. 1.9: General combining ability (*gca*) effects of parental lines of kenaf for dry fibre yield.

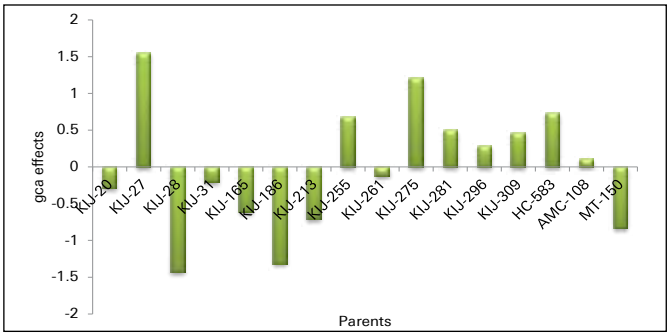


Fig. 1.11: General combining ability (*gca*) effects of parental lines of kenaf for fibre tenacity.

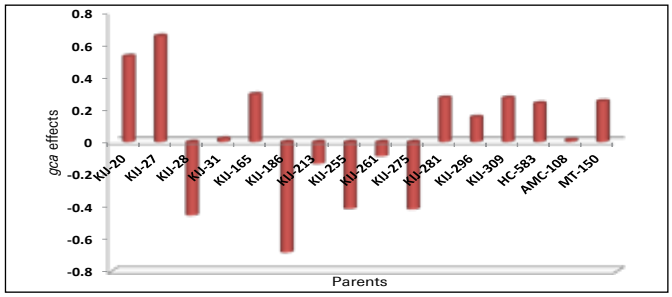


Fig. 1.10: General combining ability (*gca*) effects of parental lines of kenaf for fibre fineness

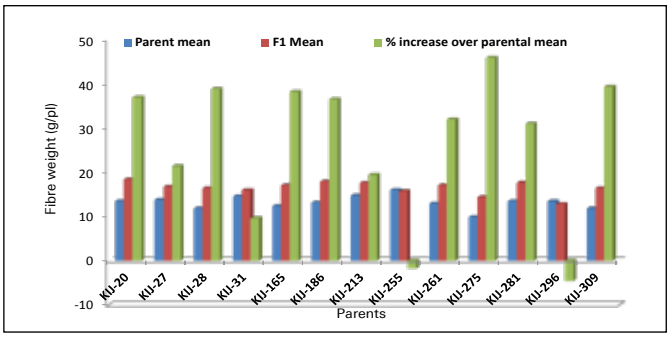


Fig. 1.12: Heterosis (%) of F_1 hybrids of kenaf over parents for dry fibre weight

A total of 725 single plant progeniy rows comprising of F_3 and F_4 generations of kenaf were evaluated for growth parameter and reaction to diseases especially YVMV, a devastating disease of mesta. Promising plants between and within progeny rows were selected on the basis of plant height, base diameter and other growth parameters. Few individual plant progeny rows derived from cross combinations KIJ-275 x AMC 108, KIJ-281 x AMC 108 and KIJ-31 x MT 150 were found to be highly resistant to yellow mosaic disease (Fig. 1.13). Seeds of more than 577 individual promising plant showing complete resistant to yellow vein mosaic disease were collected separately to confirm their stable expression in the next generation *(Source: JB 8.5. Contributors: S.K. Pandey, P. Satya, H.K. Sharma, S. Satpathy and R.K. De).*

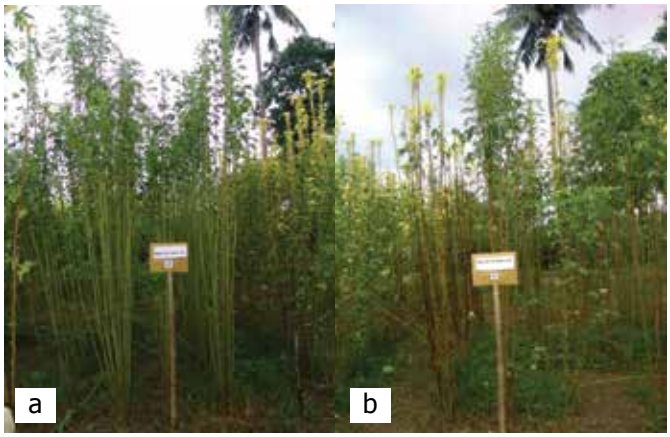


Fig. 1.13: Progenies from cross (a) KIJ-275 x AMC 108 and (b) KIJ-281 x AMC 108

1.2.2.2 Roselle *(H. sabdariffa)*

21 F_1s, reciprocals and parents of *H. sabdariffa* were evaluated for fibre fineness and strength. Data analysis was done following Grififng's numerical approach (Method 1 with fixed effect model). Range for fibre fineness and strength varied from 1.38 to 3.41 tex and 9.84 to 21.04 g/tex, respectively. Parent HS 4288 recorded positively significant and highest *gca* effect (1.158) for fibre strength and negatively significant and highest *gca* effect (-0.106) for fibre fineness (Fig.1.14). Crosses namely AMV-2 × AMV-5 and Non bris-4 × AMV-5 recorded highest significantly negative best parent heterosis for fibre fineness. Cross Non bris-4 × AMV-3 recorded highly significant positive heterosis for fibre strength.

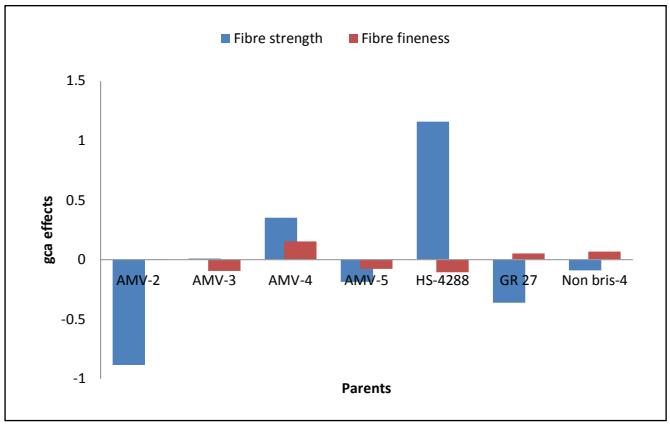


Fig. 1.14: The *gca* effects of different parents for fibre quality parameters in *H. sabdariffa*

The F_2 populations of 42 crosses and parents were evaluated for fibre yield and its attributing traits (plant height, basal diameter, green weight, fibre weight). Plant height ranged between 316.73 to 364.06 cm with an average of 349.84 cm and fibre yield varied from 12.03 to 24.87 g/plant with mean value of 19.87 g/plant. Individual plants from different crosses were selected on the basis of plant height and other phenotypic characters for F_3 generation advancement *(Source: JB.9.0. Contributors: H.K. Sharma, P. Satya and S.K. Pandey).*

1.2.2.3 Interspecific hybridization in mesta

Pollen-pistil interaction studies revealed both pre-and post-zygotic barriers restricting interspecific hybridization in kenaf. Interspecific hybrids have been obtained between *H. cannabinus x H. surattensis*, *H. cannabinus x H. acetosella* and *H. cannabinus x H. radiatus* through rigorous crossing. The hybrid plants were of intermediate type and could be distinguished using both morphological and molecular markers. All the F_1 plants exhibited high hybrid sterility.

The interspecific hybrids of *H. cannabinus* and *H. acetosella* were studied in detail using molecular markers. A total of 12 interspecific hybrids could be generated from the harvested seeds. The interspecific hybrids exhibited reddish tints in leaf and red patches in the stem and calyx, which intensified with maturity. A total of 10 SSR and ISSR primers each were used which exhibited good amplification in interspecific hybrids.

The ISSR primers BDB(ACA)5, DDC(CAC)4CA, DHB (CGA)5, DBD(AC)7, BDB(CAC)5, (CCG)6 and SSR primers MJM 432, MJM 467, MJM 563, MJM 591, MJM 606, MJM 618 and MJM 634 could clearly distinguish the interspecific hybrids from the parents. These hybrids exhibited higher genetic similarity with *H. acetosella* (J = 0.51) than with *H. cannabinus* (J = 0.38) (Fig. 1.15).

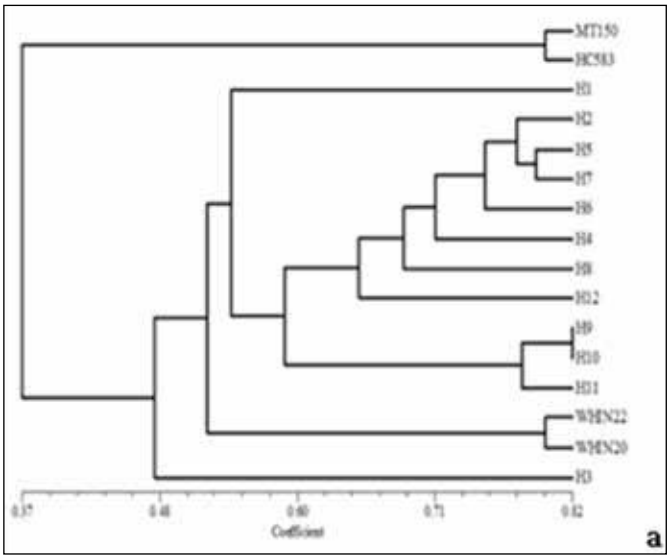


Fig. 1.15: Genetic relationship of interspecific hybrids of *H. cannabinus x H. acetosella* revealed through Cluster analysis using ISSR and SSR markers

Backcrossing of interspecific hybrids with *H. cannabinus*, only few BC_1F_1 plants could be produced from F_1 of *H. cannabinus x H. radiatus* *(Source: JB 8.7. Contributors: P. Satya, J. Mitra, S.K. Pandey and S.B. Choudhary).*

1.2.3 Ramie (*Boehmeria nivea*)

1.2.3.1 Evaluation of ramie germplasm

Cold tolerance in ramie is required for an additional cutting of the crop during winter season, which will help farmers to get more fibre per year. Seven ramie accessions were evaluated in winter season for cold tolerance and additional fibre production over normal 4 cuttings. The genotype R 1415 exhibited maximum dry fibre yield (5.56 q/ha) followed by R 67-34 (4.32 q/ha) and R 52 (4.31 q/ha) whereas minimum dry fibre yield was exhibited by R 1416 (1.86 q/ha) and R 1418 (2.38 q/ha) (Table 1.10).The fibre quality was also observed better during winter as compared to the kharif (main) season. Thus by applying 2-3 irrigations, two additional cuttings can be taken (8-10 q/ha dry fibre) by using tolerant genotypes *(Source: RB 1.0. Contributors: A.K. Sharma and S.P. Gawande).*

Three promising genotypes were evaluated for different quality parameters. Well decorticated (un-degummed) fibre sample of three genotypes *viz.*, R 67-34 (Kanai), R 67-20 and R 1411 (Hazarika) were analyzed for 4 different fibre quality traits. Data presented in Table 1.11 revealed that genotype R 1411 showed minimum residual gum content (20.18 %) and maximum fibre fineness (0.64 tex) however R 67-20 showed maximum bundle tenacity (27.68 q/tex) followed by R 1411 (Hazarika) *(Source: RB 1.0. Contributors: A.K. Sharma and S.P. Gawande).*

Table 1.10: Mean performance of the genotypes under irrigated winter season

Germplasm	Plant height (cm)	BD (cm)	Green wt. (q/ha/cutting)	Stripe wt. (q/ha/cutting)	Dry Fibre Yield (q/ha/cutting)
R 1414	103.33	1.1	131.67	70.00	3.05
R 1415	121.67	1.3	201.67	130.00	5.56
R 1416	95.00	1.0	113.33	56.67	1.86
R 1418	120.00	1.1	185.00	101.67	2.38
R 52	123.33	1.1	200.00	123.33	4.31
R 67-34	121.67	1.1	183.33	101.67	4.32
R 1411	113.33	1.1	156.67	78.33	3.09
$CD_{(P=0.05)}$	NS	NS	49.69	38.45	1.11
SEm±	6.92	0.07	15.95	12.35	0.36
SE(d)	9.79	0.10	22.56	17.46	0.51
CV(%)	10.51	10.56	16.51	22.6	17.60

Table 1.11: Fibre quality performance of elite ramie genotypes

Ger-mplasm	Gum content (%)	Bundle tenacity (g/tex)	Fibre fineness (tex)	Single fibre fineness
R 67-34	21.75	21.29	0.68	0.36 N
R 1411	20.18	22.34	0.64	0.54 N
R 67-20	20.86	27.68	0.92	0.64 N

Six diverse genotypes *viz*., R 67-34, R 67-20 and R 1411 (cultivated exotic types), R 1424 (cultivated indigenous type), R 1410 (green ramie) and RMB 2 (wild ramie) were screened for herbicide tolerance. There was no significant reduction in the growth parameters of cultivated elite genotypes *viz*., R 67-34, R 1411 and R 67-20 whereas, a significant reduction in growth parameters under study was observed in indigenous cultivated genotypes *viz.,* R 1424 (less tolerant) (Table 1.12). Green (R 1410) and wild ramie (RMB 2) exhibited maximum reduction in growth parameters (susceptible) *(Source: RB 1.0. Contributors: A.K. Sharma and S.P. Gawande).*

Table 1.12: Screening for herbicide tolerance in ramie

Entries	Control (50 days manual weeding)			Herbicide spray (50 days)		
	No. of plants /m^2	Plant height (cm)	BD (cm)	No. of plants /m^2	Plant height (cm)	BD (cm)
R 67-34	50	138.5	1.0	47	140.5	1.20
R 1411	55	130.0	1.0	50	146.0	1.10
R 67-20	45	115.0	0.90	40	128.0	1.00
R 1424	50	100.0	0.90	29	86.0	0.95
R 1410	45	40.00	0.60	15	10.00	0.65
RMB 2	10	25.0	0.20	0.00	0.00	0.00

A total of 25 number of elite cultivated germplasm maintained at Ramie Research Station, Sorbhog, Assam were evaluated. The accesions were screened during winter season against different diseases like *Cercospora* leaf spot, Anthracnose leaf spot, mosaic and cane rot disease of ramie causing considerable damage (Table 1.13).

As there was no substantial report on occurence of diseases in this crop no scale is available for screening. Disease sevearity was assesed by rating the symptom expression on 0 to 6 scale for *Cercospora*, Anthracnose leaf spot and cane rot and 0 to 5 scale for mosaic disease. During winter season, the *Cercospora* leaf spot incidence was very less as compare to anthracnose leaf spot. Among all genotype under study, the genotypes *viz.,* R 1411, R 1413, R 1414 and R 1419 were found resistant against all the diseases as compared to other genotypes. In case of *Cercospora* leaf spot R 67-20 and R 1418 were found susceptible genotypes. Genotype R 1449, R 1452, R 67-20, R 67-46 and Hakuhi were found resistant whereas R 67-52, RH 1, R 1417, R 1418 and R 1421 identified as susceptible against Anthracnose leaf spot incidence. Likewise regarding mosaic, R 1449 and R 1413 genotype were observed to be resistant; however genotype R 67-20, RH 1, R 1418 and R 1420 were found to be highly susceptible. Also during winter season in the month of November and December the incidence of cane rot was very high and R 1427 was identified as highly susceptible genotype for cane rot diseases (Table 1.13).

Fig. 1.16: Promising ramie genotype R 1411

Table 1.13: Screening of elite ramie genotypes against major diseases

Geno-types	Disease score			
	Cercospora leaf spot	Anthracnose leaf spot	Mosaic	Cane rot
R 1411	1	2	2	2
R 1412	2	2	2	2
R 1449	2	1	1	3
R 1452	2	1	2	4
R 67-34	2	2	2	4
R 67-20	3	1	4	0
R 67-52	1	3	2	1
R 67-46	2	1	3	0
R 67-51	2	2	2	4
RH 1	2	3	4	0
R 1450	2	2	3	0
R 1413	1	2	1	0
R 1414	1	2	2	0
R 1415	0	2	3	0
R 1416	1	2	2	2
R 1417	2	3	2	0
R 1418	3	3	4	0
R 1419	1	2	2	0
R 1420	2	2	4	0
R 1421	1	3	3	0
R 1422	1	2	3	0
Hakuhi	1	1	4	0
Saikishan	1	1	4	0
R 1427	2	4	2	5 (HS)
R 1428	1	3	2	0

1.2.3.2 Genetic improvement

1.2.3.2.1 Identification of ramie variety R 1411 (Hazarika) for its release in NER

One promising genotype, R 1411 (Fig. 1.16) tested in Adaptive trial of AINPJAF during 2012-13 has been identified in the name of Hazarika during the annual AINPJAF workshop held at CRIJAF (ICAR), Barrackpore. This variety has the potential to produce 21 q/ha/ year fibre yield and exhibited 6.77% higher productivity in National trials and 12.32% in Adaptive trials from the check variety (R 67-34). R 1411 has low gum content (20.18%) and exhibits 4.93% better fibre strength and 5.88% finer fibre than check.

1.2.3.2.2 Identification of environmental sensitive female line

During the evaluation of ramie germplasm under irrigated winter conditions one promising genotype with complete female flowers has been observed and identified (Fig. 1.17). Ramie plant flowers twice in a year under agro-climatic conditions of Assam. At 60 days old crop during 1st week of February (Temperature: 10^0C - 25^0C) under irrigated conditions an environmental sensitive female line, which develops female flowers only has been identified *(Source: RB 1.0. Contributors: A. K. Sharma and S.P. Gawande).*

Fig. 1.17: (a) Environmental sensitive female line in the field (b)RAC Chairman Dr. P. Raghava Reddy observing the crop in the field

1.2.3.3 Genetic variability of ramie germplasm

Gum content of 54 ramie genotypes varied from 20.2 to 28.2% with an average of 24.57%. A field gene bank of ramie has been established at CRIJAF under the project to facilitate stage specific gum determination containing 72 accessions. A total of six new accessions have been collected this year from the project mission from different parts of Meghalaya and Assam, and established at Ramie Research Station, Sorbhog for acclimatization. Significant variability for reproductive characters has been observed in the germplasm, indicating wide variability for these characters. In all the accessions, the male and female flowers were borne on separate inflorescences (Fig. 1.18). Male inflorescence was larger (50.6 – 124.2 cm) than the female inflorescence (30.8 – 68.5 cm). The number of male flower clusters was higher (23.8) than the number of female flower clusters (9.7). Male flowers bear four stamens, each with lobed anther, that burst with great force at maturity. Heritability of the reproductive characters varied from 0.36-0.9.

A Na_2CO_3 based method for gum removal has been developed for degumming in ramie which is less efficient but more environment friendly than standard sodium hydroxide based degumming method. This method also preserves better fibre structure and fibre properties *(Source: NFBSFARA FQ 3030. Contributors: P. Satya, S. Mitra, A.K. Sharma and D.P. Ray).*

1.2.3.4 Mutation breeding

Macro mutations (other than chlorophyll mutations) were observed and selected. The M_1V_2 generation was multiplied and finally three promising mutants viz., Ramie Mutant-1, Ramie Mutant-2 and Ramie Mutant-3 were selected (Fig. 1.19) and evaluated during winter season. Data presented in Table 1.14 & 1.15 revealed that the Ramie Mutant-3 produced maximum dry fibre yield per plant (6.75 g) followed by Ramie mutant-1 (4.93 g) than other mutant and parents. Maximum base diameter (2.01 cm) along with less infestation of insect pest and diseases was exhibited by ramie Mutant-3. Other morphological mutants of ramie were also observed in M_1V_2 generation (Fig. 1.20) *(Source: RB 2.3. Contributors: A.K. Sharma and S.P. Gawande).*

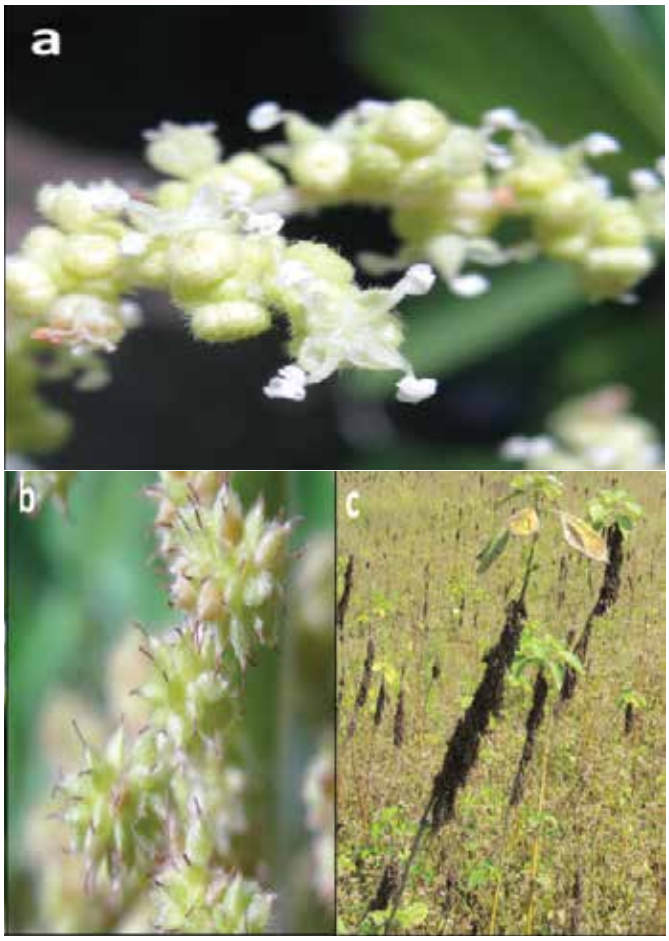


Fig. 1.18: Flowers and seed of ramie. a. Male flower, b. Female flower. c. Inflorescence with matured seed

Table 1.14: Description of the selected promising mutants of ramie along with parents

Mutant	Parent	Treatment EMS	Trait
Ramie Mutant -1	R 1411	100 mM	Deep green & upward leaf orientation, green petiole, flower colour green
Ramie Mutant-2	R 1411	150 mM	Red petiole with upward leaf orientation.
Ramie Mutant-3	R RH-1	100 mM	Leaves with more than one leaf tips and high BD

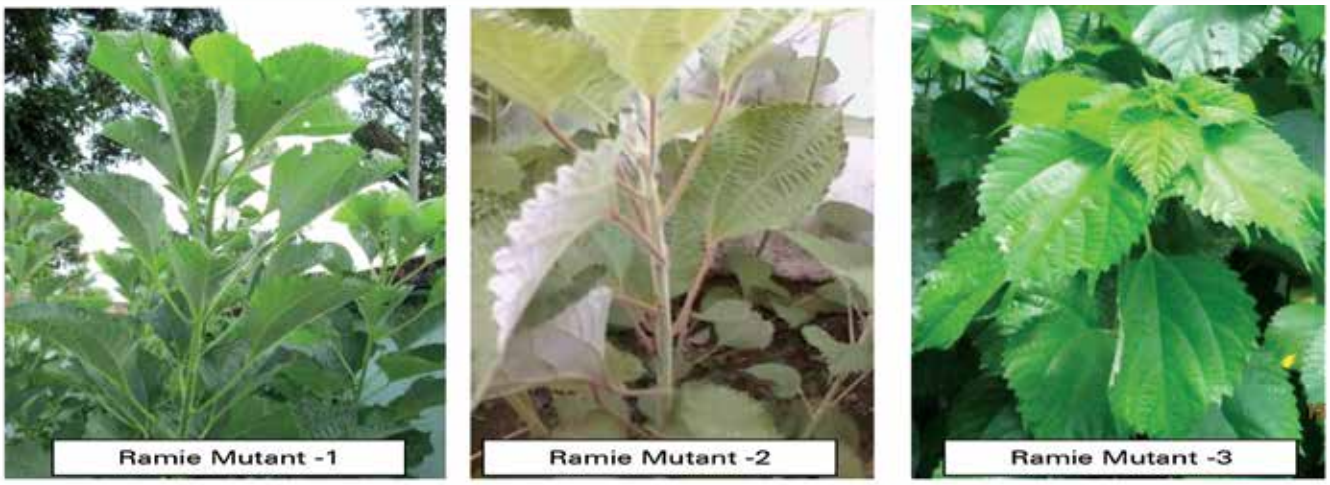


Fig. 1.19: Three selected mutants of ramie

Table 1.15: Mean performance of mutants alongwith parents

Mutant	Parent	Plant height (cm)	Basal diameter (cm)	Green stripe wt/plant (g)	Dry fibre yield / plant (g)	Cercospora/ anthracnose Leaf spots	Indian red admiral caterpillar (%)
Ramie Mutant-1	R 1411	150	1.50	215	4.93	1/1	0.60
Ramie Mutant-2	R 1411	125	1.35	205	4.35	2/2	0.34
Ramie Mutant-3	R RH 1	140	2.01	250	6.75	1/1	1.74
R 1411		135	1.20	185	4.15	1/2	1.57
R RH 1		120	1.15	170	4.00	2/ 3	3.75

Fig. 1.20: Morphological mutants of ramie observed in M_1V_2 generation

Fig. 1.21: Single plant selection of flax from F_3 generation

1.2.4 Flax (*Linum usitatissimum*)

1.2.4.1. Genetic improvement

F_1 generations of 20 crosses, F_3 generations of 12 crosses and F_4 generations of 15 crosses were grown for

generation advancement and evaluation of fibre yield. Three new crosses; FT 895 x JRF 2, H 5 x JRF 2, FT 897 x JRF 2 & two backcrosses (JRF 2 x FT 897) x JRF 2; (JRF 4 x JRF 2) x JRF 2) were effected to obtain new combinations from different parents. Total 20 single plants were selected from F_3 and other segregating generations (Fig. 1.21) *(Source: SNHB 1.8. Contributors: B. Chaudhary, M.K. Tripathi and H.R. Bhandari).*

1.2.5 Sunnhemp (*Crotalaria juncea*)

1.2.5.1 Genetic improvement

A total of 23 germplasm lines of sunnhemp were evaluated for fibre yield and its contributing traits *viz.*, plant height, basal diameter, fresh weight, fibre weight and stick weight (Table 1.16). Plant height range from 212.8 cm to 257.0 cm and basal diameter ranged from 7.3 mm to 10.7 mm., fresh weight ranged from 5.0 kg to 14.5 kg, stick weight ranged from 500.0 g to 2110.0 g and fibre weight/plot ranged from 120.0 g to 340.0 g. Disease data of vascular wilt also recorded in the scale of 0.0 to 2.0.

Six F_1 generations (SUIN 001 X SH 4, SUIN 019 X SH 4, SUIN 021 X SH 4, SUIN 030 X SH 4, SUIN 036 X SH 4, SUIN 038 X SH 4) of sunnhemp were evaluated along with their parents for fibre yield and attributing traits *(Source: SNHB 1.8. Contributors: B. Chaudhary, M.K. Tripathi and S.K. Pandey).*

Table 1.16: Mean performance of best 23 single plant progenies from sunnhemp germplasm

Plant Progenies	Plant height (cm)	Base diameter (mm)	Fresh wt (g)/plant	Fiber wt (g)/plant	Stick wt (g)/plant	Vascular wilt (grade)
SUIN 018-4	220.0	7.6	28	0.8	3.7	2
SUIN 019-2	219.2	7.3	31	1.0	4.2	1
SUIN 019-3	235.0	7.5	35	1.3	6.2	1
SUIN 024-2	218.4	9.0	46	1.3	6.0	0
SUIN 024-1	229.8	8.6	53	1.3	7.4	0
SUIN 023	232.4	8.7	45	1.1	6.0	0
SUIN 021	213.0	7.8	71	2.0	10.9	1
SUIN 019-4	231.6	8.7	53	1.9	8.7	2
SUIN 36-1	243.2	8.3	57	1.5	6.4	1
SUIN 036-3	235.4	8.3	58	1.6	8.0	1
SUIN 037-1	228.8	8.7	52	1.4	8.3	0
SUIN 38-1	225.8	7.9	33	0.9	4.6	0
SUIN 041	230.0	8.2	39	1.3	4.7	1
SUIN 047-2	212.8	8.5	53	1.3	5.3	2
SUIN 083-1	240.4	8.4	41	1.1	4.7	1
SUEX 004-1	236.8	8.9	54	1.3	7.3	2
SUIN 094-1	234.4	7.7	75	1.9	9.1	2
SUIN 086-2	226.6	9.2	63	1.5	8.6	1
SUIN 083-3	230.6	8.2	82	2.0	10.7	1
SUIN 083-2	236.4	8.4	60	1.7	8.7	1
SH-4-1	253.0	9.1	64	1.4	9.4	1
SH-4-2	234.0	8.9	41	0.7	4.5	1
SH-4-3	257.0	10.7	70	1.4	10.1	1
Range	212.8-257.0	7.3-10.7	28-82	0.7-2.0	3.7-10.9	0-2.0

2. Seed Science and Technology

2.1 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, Budbud, Burdwan, WB.

2.1.1 Seed production and distribution under National Seed Project

2.1.1.1 Breeder seed production and distribution

In *kharif* 2012, 13.5 q breeder seeds of fourteen jute varieties (11 nos. *olitorius* and 03 nos. *capsularis*) have been produced against indent of 10.74 q jute breeder seeds (Table 2.1) by the DAC. Harvested seeds were processed, labeled, sealed for distribution to the secondary seed producing agencies after confirmation of genetic purity through 'Grow Out' test.

2.1.1.2 Grow Out test

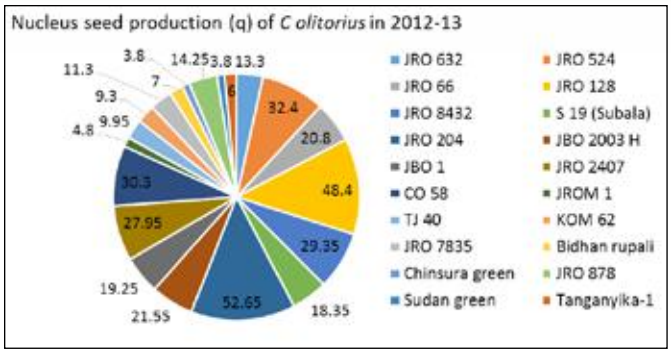
'Grow Out' test (GOT) was carried out to check the genetic purity of the breeder seeds of all the indented varieties of jute. Percent off types present in the varieties was recorded by making critical observations on the important morphological parameters related to leaf shape, pigmentation on leaf, stem, no. of capsules/pod, seed coat etc. In the year 2012, 26.14 q breeder seed was produced and supplied to various seed producing agencies against DAC indent. GOT was conducted during March-May, 2012, before supplying breeder seed. Percent off type present in each of the jute and allied fibres varieties were within the permissible limit.

2.1.1.3 Production and maintenance of nucleus seeds

Nucleus seeds of released varieties of jute, mesta and sunnhemp were produced at CSRSJAF, Budbud. Seeds harvested from selected individual true-to-type plants of a variety were used to raise progeny rows. Progeny rows which were true to the type of varieties (jute, mesta and sunnhemp) were bulked to constitute nucleus seed. Off type plant, if any, found in any progeny row of nucleus seed plots, entire progeny row was eliminated to obtain purest seeds. About 4.2 q of nucleus seeds of the released varieties of jute (27 varieties), mesta (9 varieties) and sunnhemp (3 varieties) were produced (Table 2.2) and kept safely for breeder seed production in *kharif* 2013-14.

Table 2.1: Variety wise breeder seed production at CSRSJAF, Budbud during 2012-13

Name of variety	DAC Indent (q)	Production (q)	Deficit(-)/Surplus(+) over target (q)
JRC 517	1.05	1.20	(+) 0.15
JRC 532	1.08	1.20	(+) 0.12
IRA (JBO 2003H)	0.35	0.50	(+) 0.15
JRO 204 (Suren)	1.25	2.00	(+) 0.75
Subala (S 19)	1.31	1.50	(+) 0.19
JRO 128	1.05	1.16	(+) 0.11
JRO 8432 (Shakti Tossa)	0.22	0.40	(+) 0.18
JRO 66 (PBO 6)	0.20	0.30	(+) 0.10
Navin (JRO 524)	3.73	4.20	(+) 0.47
Monalisa (RRPS-27-C-3)	0.10	0.30	(+) 0.20
JBO 1	0.10	0.30	(+) 0.20
CO 58	0.10	0.12	(+) 0.02
JBC 5	0.10	0.20	(+) 0.10
JRO 2407	0.10	0.12	(+) 0.02
Total	10.74	13.50	(+) 2.76



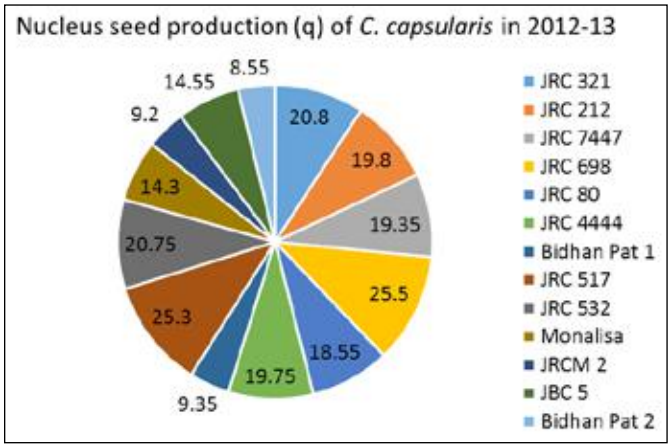


Fig. 2.1: Nucleus seed production of jute

Table 2.2 : Nucleus seed production (q) of mesta and sunnhemp in 2012-13

Mesta	Seed production (q)
HS 7910	13.0
AMV 1	11.0
AMV 2	12.0
AMV 3	8.0
AMV 4	7.0
HS 4288	12.0
AMC 108	10.0
HC 583	10.0
MT 150	13.0
Sunnhemp	
K 12 yellow	14.0
SH 4	22.0
SUIN 053	12.0
SUIN 037 (Ankur)	5.0

2.1.2 ICAR seed project (Mega Seed Project)

Besides breeder seeds, 48.5 q of foundation seed of jute (six *olitorius* varieties), 28.64 q certified seed and 20 q of TL seeds of jute have been produced under Seed Project (Mega Seed Project). About 16 q seed of sunnhemp varieties and 1.5 q TL seeds of mesta varieties were produced and supplied to the farmers (Table 2.3).

Truthfully labelled (TL) seeds of other crops like paddy (228 q), wheat (90 q), mustard (28 q) and dhaincha (30 q) etc. was also produced to provide quality seeds to local farmers.

Table 2.3: Crop wise seed production under Mega Seed Project in 2012-13

Crop	Target (q)	Production (q)
Jute (F + C+ TL)	20.0	97.14
Mesta (TL)	4.0	1.5
Sunnhemp (TL)	10.0	16.0
Paddy (TL)	150.0	228.0
Mustard (TL)	20.0	49.2
Dhaincha (TL)	15.0	30.0
Wheat (TL)	30.0	90.0

Seed Day: To create awareness regarding importance of quality seed as vital input for increasing productivity, a "Seed Day" programme under 'ICAR Seed Project' was organized at (CSRSJAF) Central Seed Research Station for Jute and Allied Fibres, Budbud, Burdwan West Bengal on 21st November, 2012 and on 8th November 2012 at Sunnhemp Research Station, Pratapgarh, U. P.

Fig. 2.2: Seed day celebration at CSRSJAF, Budbud, Burdwan

About two hundred sixty participants from different fields of agriculture (Agricultural Research and Education, Govt. authorities involved in seed production and certification) along with the farmers participated in the programme *(Source: MSP. Contributor: C.S. Kar)*

2.1.3 Jute seed production in West Bengal

The project was initiated in the year 2010-11 with the financial assistance from Department of Science & Technology, Govt. of West Bengal at Kashipur block of Purulia district. Six villages namely, Amdiha, Liya, Sonajhuri, Chuna, Chitra and Sumadihi at Kashipur block of Purulia district were selected. Two numbers of trainings were conducted during crop growth period. Seed yield up to the tune of 3-6 q/ha has been achieved in case of August sown crop (in upland situation) in Purulia district. Test Weight (1000 seed weight) of seed ranged between 1.76-1.92 g. Maximum net return was Rs. 14200/- per ha while crop duration ranged between 100-125 days. Last three years results revealed that in upland condition (*Tarh* land- land with low fertility and low water holding capacity) sowing should be done during mid-July to achieve maximum seed yield (6-7 q/ha). In medium lands (*Baid* land) August-Mid September sowing can provide high seed yield (up to 8.5 q/ha) *(Source: DST project. Contributors: A. Bera, C.S. Kar and H. Chowdhury).*

2.1.4 Adaptive research on jute seed production in West Bengal

A total of 37 farmers including small marginal, tribal farmers were involved in this project. All the farmers were entirely new because farmers trained on improved techniques for jute seed production from TMJ MM II project on Adaptive research on jute seed production in West Bengal during 2011, *kharif* season were inducted in RKVY Project. The detail of farmers village-wise and block-wise are given in table 2.4.

CRIJAF has imparted training on improved package of practice by adopting late sowing of jute seed crop in the month of July-August so that farmers can harvest seed crop after 90- 110 days in December–January. A total of 19.85 q raw jute seed was produced under this project. Farmers were given training for drying and winnowing of jute seed and they were encouraged to sell seeds to private enterprises *(Source: TMJ MM-II. Contributers: C.S. Kar A. Bera and H. Bhandari).*

Table 2.4: Jute seed production in different regions of Bankura district

Block	Location (Village)	No. of farmer	Variety	Area (ha)	Seed produced (q)
Onda	Hunumanhir	5	JRO 8432	0.93	6.86
	Asthal	2	JRO 8432	0.47	
	Banagari	3	JRO 8432	1.40	
Taldan-gra	Dhunduria	5	JRO 8432	2.13	3.60
	Sidabad	1	JRO 8432	1.07	
Banku-ra I	Chelebankra	3	JRO 204	1.60	9.39
	Siyarabada	5	JRO 204	2.53	
	Supurdihi	6	JRO 204	1.67	
	Tariboter dihi	7	JRO 204	2.00	
	Total	37		13.80	19.85

Fig. 2.3: Farmers training on advanced jute seed production at Onda, Bankura

Another seed production project was implemented in

two districts of West Bengal namely Bankura and Purulia under RKVY programme. In Purulia district about 40 villages located in 7 blocks namely Kashipur, Purulia II, Bagmundi, Balarampur, Arsha, Purulia I and Puncha, covered under jute seed production. In Bankura about 50 villages scattered around 7 blocks namely, Bankura I, Indpur, Onda, Hirbandh, Simlapal, Chattna and Bishnupur were selected under this project. A total of 620 farmers including small, marginal, tribal farmers were involved in this project. Out of these 230 farmers were from Purulia and 392 were from Bankura district. A total of five new recently released tossa (C. *olitorius*) varieties, namely, S 19, JRO 128, JRO 8432, JRO 204 and JBO2003 H were used for seed production under this project. A total of 99.76 q raw jute seed was produced under this project. After Processing at CSRSJAF, Budbud, Burdwan a total of 67.80 q of certified seed and 4.91 q of TL seed were packaged in 1 kg size packets in the "CRIJAF SEED" trade mark and handed over to West Bengal State Seed Corporation Ltd through Govt. of West Bengal *(Source: RKVY. Contributors: A.B. Mandal, R.K. De, C.S. Kar, S. Satpathy, S. Kumar, A. Bera and M. Kumar).*

Fig. 2.4: Director CRIJAF monitoring farmers field at Uporsol village, Onda block

Fig. 2.5: Weeding in jute seed crop using CRIJAF Nail Weeder

Fig. 2.6: Field day celebration under RKVY project

Fig. 2.7: Harvested jute seed crop under RKVY during 2012-13 cropping season

2.2 Seed Research

2.2.1 Enhancement of seed yield of tossa jute through application of growth regulator

Different combinations of BA (6-Benzyl aminopurine) (50 ppm and 100 ppm at 45 DAS) and GA_3 (50 ppm and 100 ppm during flowering period) were applied in jute seed crop. Spraying of GA_3 @100 ppm during 50% flowering stage provided significantly high seed yield (10.3 q/ha) compared to control (6.8 q/ha). This also increased (GA_3 @ 100 ppm) 1000 seed weight significantly (2.04 g) over the control (1.78 g) *(Source: JAFSP 2.2. Contributor: A. Bera).*

2.2.2 Assessment of planting methods and nutrient management options in jute seed crop

A field experiment (on exploratory mode) was conducted during 2012-13 at CRIJAF, Barrackpore, to study the effect of planting methods and nutrient management options in transplanted jute seed crop. The experiment was conducted in a spit plot design, keeping three row-to-row spacings (45 cm, 60 cm and 60:30 cm paired row planting) in main plots and four nitrogen doses (no nitrogen, 40 kg N/ha, 80 kg N/ha and 120 kg N/ha) in sub plots and was replicated three times. The transplanting of jute (variety: JRO 128) was done on 27th September, 2012 and harvested on 29th January, 2013.

The perusal of the data (Table 2.5) revealed that paired row planting (60:30 cm spacing) of jute was significantly superior over line sowing (45 cm spacing) followed by line sowing (60 cm spacing) with respect to plant height, yield attributes and seed yield (0.66 t/ha). Among the nitrogen levels, application of 120 kg N/ha to jute seed crop was significantly better than all other N levels with respect to plant height, yield attributes and seed yield (0.67 t/ha). Paired row sowing (60:30 cm spacing) of jute along with application of 120 kg N/ha was found to be a better combination for higher seed production under late sown conditions. However, all the interactions were non-significant *(Source: Expl. A4. Contributor: A. Singh).*

Table 2.5 : Effect of planting methods and nitrogen levels on plant height, yield attributes and seed yield of jute

Treatment	Plant height (cm)	Branches per plant	Pods per plant	Seed yield (t/ha)
Planting Methods (row spacing in cm)				
45	71.9	4.62	20.96	0.57
60	69.9	4.25	19.05	0.45
60:30 (Paired row)	78.2	5.94	26.41	0.66
SEm±	0.76	0.086	0.753	0.019
$CD_{(p=0.05)}$	2.98	0.337	2.958	0.074
Nitrogen levels (kg N ha^{-1})				
0 (control)	66.9	3.31	16.94	0.43
40	70.6	4.52	19.84	0.55
80	74.9	5.42	23.85	0.59
120	80.9	6.50	27.92	0.67
SEm±	0.75	0.107	0.381	0.019
$CD_{(p=0.05)}$	2.23	0.318	1.132	0.057

2.2.3 Assessment of nutrient management options in jute seed crop

A nutrient management study was done keeping six fertilizer combinations. The transplanting of jute (variety: JRO 128) was done on 27th September, 2012 and harvested on 29th January, 2013. Table 2.6 shows that application of NPK + S + Zn (40:60:60 kg N: P_2O_5: K_2O + 20 kg S + 20 kg $ZnSO_4.7H_2O$/ha) resulted into significantly higher plant height, yield attributes and seed yield (1.18 t/ha) compared with all other treatments. The experimental data also revealed that sulphur application @ 20 kg/ha application alone along with NPK (40:60:60 kg N: P_2O_5: K_2O/ ha) recorded significantly higher plant height, yield attributes and seed yield (1.05 t/ha) compared with all other treatments *(Source: Expl. A3. Contributor: A. Singh).*

Table 2.6: Effect of nutrient management options on plant height, yield attributes and seed yield of jute

Treatment	Plant height (cm)	Branches per plant	Pods per plant	Seed yield (t/ha)
T_1	66.8	2.55	11.83	0.49
T_2	76.8	3.05	16.35	0.60
T_3	83.8	4.05	19.55	0.82
T_4	90.5	4.95	22.05	0.90
T_5	100.3	5.88	25.98	1.05
T_6	109.5	6.97	29.15	1.18
SEm±	2.27	0.289	1.053	0.043
$CD_{(p=0.05)}$	6.83	0.872	3.174	0.128

T1 = Control (no fertilizer application); T2 = N only (40 kg N ha-1); T3 = NP only (40:60 kg N: P_2O_5 /ha); T4 = NPK (40:60:60 kg N: P_2O_5:K_2O /ha); T5 = NPK +S (40:60:60 kg N: P_2O_5:K_2O + 20 kg S /ha); T6 = NPK +S + Zn (40:60:60 kg N: P_2O_5:K_2O + 20 kg S + 20 kg $ZnSO_4.7H_2O$/ha)

3. Biotechnology

3.1 Biotechnology in jute

3.1.1 An expressed gene catalog of *Corchorus olitorius* produced by 454 mRNA-seq

An expressed gene catalog of *Corchorus olitorius* cv. JRO 632 was developed by Roche 454 mRNA-seq. Raw mRNA-seq dataset read statistics are shown in Table 3.1.

Table 3.1: Raw mRNA-seq dataset read statistics of *Corchorus olitorius* cv. JRO 632

Description	JRO 632
Filter pass reads (bp)	8,10,484
Percent quality reads	82.8
Average read length (bp)	409.50
Total bases (bp)	331,896,625
Number of trimmed reads (bp)	748,141
Number of trimmed bases (bp)	305,870,769
Mean length of trimmed reads (bp)	408
Median length of trimmed reads (bp)	438

Read statistics in terms of numbers of trimmed reads, raw bases and trimmed bases were calculated. Trimmed read-length statistics are shown in Fig. 3.1.

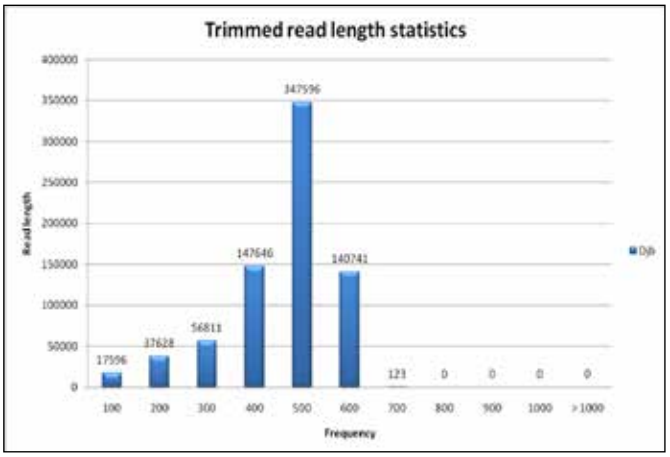


Fig. 3.1: Histogram showing trimmed read-length statistics for *C. olitorius* cv. JRO 632

Three different transcriptome assemblies based on Newbler 2.5.3, CLC 4.0.3 and SeqMan Ngen 3.0.4 were generated, and they were finally merged using CAP3 3.0. Basic assembly metrics for different assemblers are shown in Table 3.2.

Table 3.2: Basic assembly metrics for *Corchorus olitorius* cv. JRO 632 datasets

Statistics	Newbler	CLC	SeqMan	CAP3
Number of contigs	8,419	19,713	5,560	19,597
Total bases	265,180,043	296,787,139	277,948,138	297,562,148
Mean contig length	1,060	816	1,456	924
Summed contig length	8,931,066	16,097,606	8,096,513	18,124,745
Number of contigs ^{3} 1 kbp	3,251	4,797	4,097	6,065
Total bases (in contigs ^{3} 1 kbp)	5,429,092	7,447,794	6,816,570	10,008,691
Maximum contig length	16,322	6,274	15,622	1,6405
Minimum contig length	102	100	188	110
N50	1,185	935	1,572	1,095
Number of contigs in N50	2,365	5,420	1,790	5,163

Average coverage statistics (Fig. 3.2) and coverage per base (CPB) statistics (Table 3.3) of assembled transcripts were compared between different assemblers.

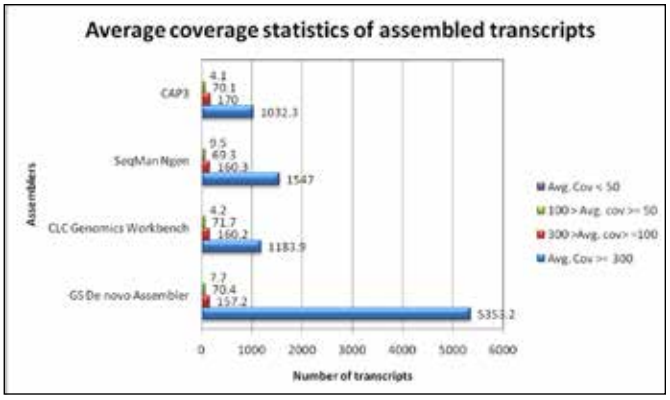


Fig. 3.2: Average coverage statistics of assembled transcripts of *C. olitorius* cv. JRO 632

CAP3-merged assembled transcript contigs were functionally annotated using NCBI nr protein sequences of *Arabidopsis thaliana, Vitis vinifera, Populus trichocarpa* and *Theobroma cacao* (Fig. 3.3).

Table 3.3: Coverage per base (CPB) statistics of assembled transcript contigs of *Corchorus olitorius* JRO 632

Description	Newbler	CLC	SeqMan	CAP3
Median CPB per contig	5.42	2.54	7	2.47
Highest range of CPB	27827.12	16014.96	6986.55	4262.28
Lowest range of CPB	0.17	0.32	1.57	0.05

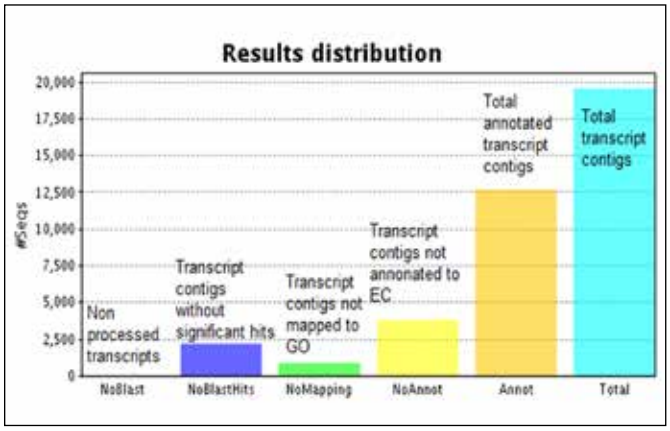


Fig. 3.3: Functional annotation of assembled transcript contigs of *C. olitorius* cv. JRO 632

An analysis of BLAST datasets showed that maximum hits (homologies) were distributed in *Vitis vinifera* followed by *Populous trichocarpa*, *Arabidopsis thaliana* and *Theobroma cacao*. The distribution of top-hit annotated transcript contigs are shown in Fig. 3.4.

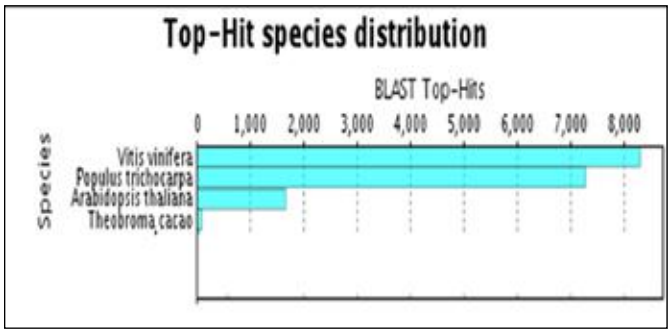


Fig. 3.4: BLASTx top-hit distribution of annotated transcript contigs of *Corchorus olitorius* cv. JRO 632

Gene ontology (GO) analysis was performed to map GO-level distribution (biological process, cellular component and molecular function). GO-level distribution of functionally annotated transcript contigs are shown in Fig. 3.5.

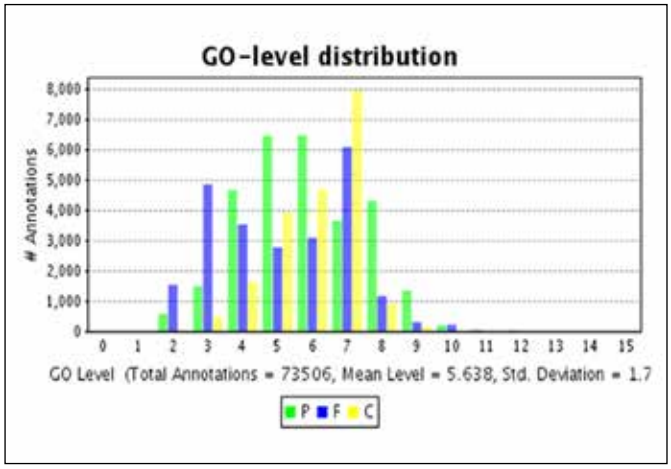


Fig. 3.5: GO analysis of functionally annotated transcript contigs of *C. olitorius* cv. JRO 632

Gene expression analysis of 19,597 transcript contigs was carried out by mapping all high quality reads on assembled transcripts and FPKM (fragments per kilobase of exon per million fragments mapped) values were calculated. Results are shown in Table 3.4 *(Source: JBT 4.1. Contributors: D. Sarkar and P. Satya).*

Table 3.4: Gene expression statistics for functionally annotated transcript contigs of *Corchorus olitorius* cv. JRO 632

FPKM	JRO 632
FPKM ³ 300	208
300 > FPKM ³ 100	393
100 > FPKM ³ 50	596
FPKM < 50	18,401

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

3.2.1 Construction of high-density genetic maps of *C. olitorius*

Construction of bi-parental mapping populations: Of thirty different bi-parental crosses involving nine *C.*

olitorius accessions and two wild species, *viz. C. aestuans* and *C. fascicularis*, five mapping populations were finally selected. These five mapping populations are as follows: i) *C. olitorius* cv. Sudan Green × *C. olitorius* mt. *bfs*; ii) *C. olitorius* cv. JRO 632 × *C. olitorius* cv. Sudan Green; iii) *C. olitorius* cv. Sudan Green × *C. olitorius* cv. JRO 632; iv) *C. olitorius* cv. JRO 632 × *C. aestuans*; and v) *C. olitorius* cv. JRO 632 × *C. olitorius* mt. *bfs*. These have been successfully advanced to $F_{2:3}$ and RI_3 (recombinant inbred) generations. Two morphological loci, namely, ribbon leaf and internode length showing monogenic segregation have been mapped.

Construction of multi-parental mapping populations

Jute is characterized by narrow genetic bases, resulting in restricted allelic variation in synthetic biparental mapping populations. Since bast fibre quality traits are very complex, it has been found that restricted allelic variation in conventional biparental mapping population does not allow a thorough dissection of these traits. Hence, we initiated the construction of a multiparent advanced generation inter-cross (MAGIC) mapping population. The MAGIC lines have been initiated by intercrossing 20 founder accessions of *C. olitorius* (Table 3.5). These founder accessions were selected because they represent a wide geographical distribution. The first intermating has produced F_1, which will be further intermated for four generations followed by selfing for six generations.

Genotyping of biparental mapping populations

Large-scale DNA isolation was carried out from four F_2 mapping populations, namely, *Corchorus olitorius* cv. JRO 632 × *C. aestuans*, *C. olitorius* cv. JRO 632 × *C. olitorius* mt. *bfs*, *C. olitorius* cv. Sudan Green × *C. olitorius* cv. JRO 632, *C. olitorius* cv. Sudan Green × *C. olitorius* mt. *bfs*, comprising 296, 271, 240 and 328 individuals, respectively. Two of these F_2 mapping populations will be genotyped by AFLP and SSR markers for the construction of ultra high-density genetic linkage maps, using the automated high-throughput genetic analyzer.

Table 3.5: Accessions used for creating a MAGIC population of *Corchorus olitorius*

Accession/ genotype	Common name	Country	Continent
JRO 620	JRO 620	India	Asia
Chinsurah Green	Chinsurah Green	India	Asia
Bidhan Rupali	Bidhan Rupali	India	Asia
Sudan Green	Sudan Green	Sudan	Africa
Tanganyika-1	Tanganyika-1	Tanzania	Africa
OEX-013	OEX-013	Australia	Australia
OEX-032	Russian Green	Russia	Europe
OIJ-254	Brazil Nonsoong	Brazil	South America
OEX-019	OEX-019	Germany	Europe
OEX-007	Peaking	China	Asia
OEX-005	Bangkok	Thailand	Asia
OEX-021	Nigeria Ibaden	Nigeria	Africa
OEX-009	Olit 3 Burma	Myanmar	Asia
OIJ-002	KEN/DS/015C	Kenya	Africa
OIJ-173	IDN/SU/053C	Indonesia	Asia
OIJ-204	NPL/JRC/550	Nepal	Asia
OIJ-297	Golden	Pakistan	Asia
OIN-004	Binpur 1	India	Asia
OIN-009	Olit. Deep Red	India	Asia
OIN-010	Wild Olit. Dwarf	India	Asia

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

Construction of an association mapping panel: A total of 225 accessions of *C. olitorius* representing all geographical regions, *viz.,* India (155), Africa (29), Rest of Asia (35), Australia (1), America (2) and Europe (3) was selected to construct an association mapping panel. Nucleus seeds were produced for all these 225 accessions.

First-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.

Genotyping of association mapping panel: The 225 accessions of the association mapping panel of *C. olitorius* were genotyped by sequencing. Next-generation restriction site-associated DNA (RAD) tag sequencing, a reduced-representation sequencing approach for genotyping-by-sequencing (GBS), was undertaken to call a large number of SNPs as well as RAD markers. The experiment was carried out using Illumina HiSeq 2000 next-generation sequencing platform, with a objective of dissecting the genetics of bast fibre quality traits by SNP-based genome-wide association mapping. The bioinformatics analyses are presently underway, and preliminary results show that a total of 1,59,260 SNPs have been discovered. Preliminary results based various filters are shown in Table 3.6 *(Source: NFBSFARA. Contributor: D. Sarkar).*

Table 3.6: Number of SNPs called using various minor allele frequency (MAF) and missing data thresholds

MAF	Missing data threshold (%)	SNPs
0.01	50	28,484
0.05	50	19,459
0.10	50	12,481
0.01	20	7,314
0.05	20	4,443
0.10	20	2,750
0.01	10	2,734
0.05	10	1,444
0.10	10	571

3.3. Accredited Test Laboratory (ATL) under the National Certification System for Tissue Culture-raised Plantlets (NCS-TCP)

Routine genetic fidelity testing was performed under the NCS-TCP. Tissue culture plants of banana (*Musa* spp.) and potato from different generations together with their stock cultures were received from M/s Elegant Flower Company Private Limited, Kolkata (West Bengal), M/s Sristi Agrobiotech Private Limited, Howrah (West Bengal) and M/s Synergy Private Ltd., Durgapur (West Bengal). These tissue cultured plants were tested for genetic fidelity using inter-simple sequence repeat (ISSR) markers and for known viruses by RT-PCR. All tissue culture plants were found true-to-type and free from virus. Quality certificates and virus free certificates in prescribed formats were issued to these companies, according to DBT rules and regulations.

3.4. *In-vitro* tissue culture in jute

A surface sterilization protocol was standardized which involves soaking of seeds in dH_2O for 5 min fortified with 1g/l Carbendazim 50WP, repeated wash followed by treatment with freshly prepared 0.1 % $HgCl_2$, rewashed, blot dried and cultured on MS medium. It showed 100% uncontaminated germination. Four different explants - hypocotyl, cotyledonary-petioles, leaf disc and root from JRC 532, JRC 517, JRC 321 & JRC 212 variety of *C. capsularis* were used for identification of best explants in respect of *in vitro* culture response. Based on the initial observation it was found that hypocotyl was the most responsive explant followed by leaf disc for *in vitro* culture. Root showed no response. JRC 532 and JRC 321 showed *~100% callus* induction with hypocotyls and leaf discs. Four different explants were cultured on MS+0.5 mg/l NAA + 0.5 mg/l BAP +1g/l activated charcoal and kept in culture room under 16/8h light (~130 µ Einstein m^{-2} s^{-1}) / dark to assess the influence of diverse growth hormones in influencing *in vitro* culture response. Shoot bud initiation was observed from four explants *viz.,* stem cuttings (83), cotyledonary-petioles (120), leaf disc (25) and root (14) in JRC 532 ; stem cuttings (69), cotyledonary-petioles (40), leaf disc (10) and root (16) in JRC 517; stem cuttings (46), cotyledonary-petioles (120), leaf disc (25) and root (14) in JRC 321 and stem cuttings (72), cotyledonary-petioles (150), leaf disc (23) and root (13) in JRC 212, respectively; root formation was observed on leaf disc and in stem cuttings.

Sterile cotton was found to be superior as germination medium than MS medium (Fig. 3.6). Four *capsularis* (JRC

532, JRC 517, JRC 321, JRC 212) and *olitorius* jute (JRO 8432, JRO 7835, JRO 204, JRO 524) were used for *in vitro* culture. *Capsularis* varieties were found to be much more responsive to *in vitro* culture than *olitorius* on MS medium fortified with 2 mg/l 2,4-D (Fig. 3.7). Plenty of microcalli developed from the cut edges of leaf and either side of the hypocotyls from 7 days old *in vitro* grown seedlings (Fig. 3.7). Calli were greenish to off white in colour, mucilaginous containing narrow tubular cells. Genotypic specificity was distinctly discernible among the *capsularis* and *olitorius* varieties.

Fig. 3.6: Axenic seedlings developed from matured disinfected seeds growing luxuriantly on sterile wet cotton to serve as source of explants to undertake *in vitro* culture

JRO 524 was found superior in respect of *in vitro* culture response in *olitorius* and JRC 517 in *capsularis* jute. Green spots appeared on relatively off white coloured callus with miniature shootlets without any roots. Prolific callus induction was observed at the cut end of the explants on the culture medium especially of the stem cuttings (3-4 cm long) when placed vertically (in standing position on MS medium fortified with activated charcoal) *(Source: JB 9.3. Contributors: A.B. Mandal and H.K. Sharma).*

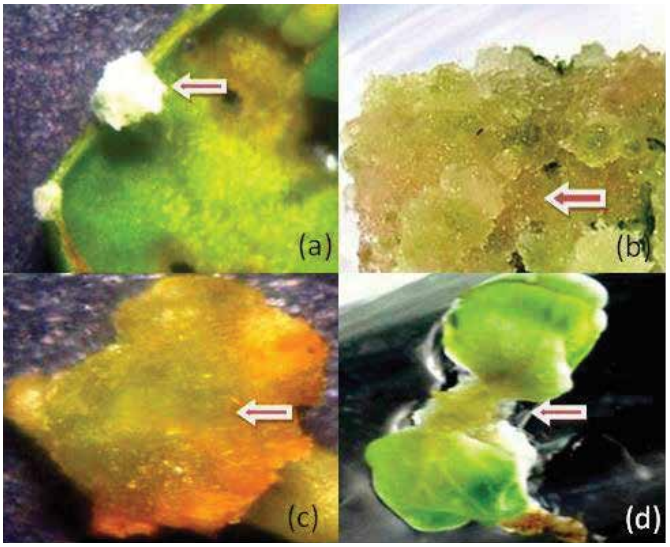


Fig. 3.7: Induced callus in *capsularis* jute at different stages from leaf disc and hypocotyl explants

4. Soil Health and Nutrient Management

4.1 Soil health

4.1.1 Long term fertilizer experiment (LTFE)

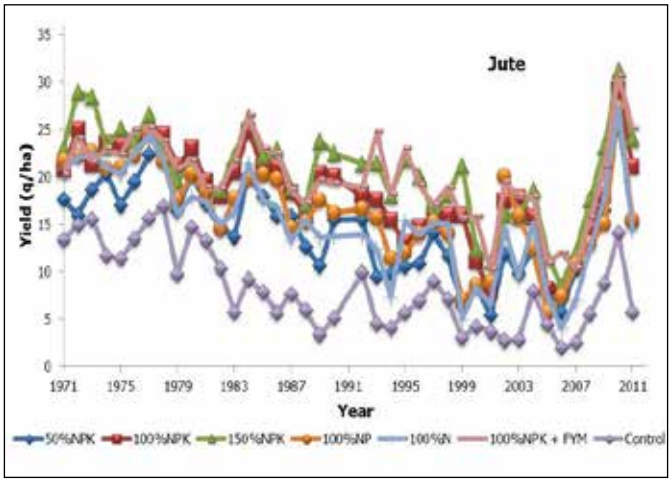
Effects of continuous cropping and addition of organic manures along with inorganic fertilizers on crop yield, nutrient uptake and soil fertility of jute based cropping system is being monitored since 1971 in a permanent experimental field under hot subhumid to humid conditions. During the period under report, 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 summarized below

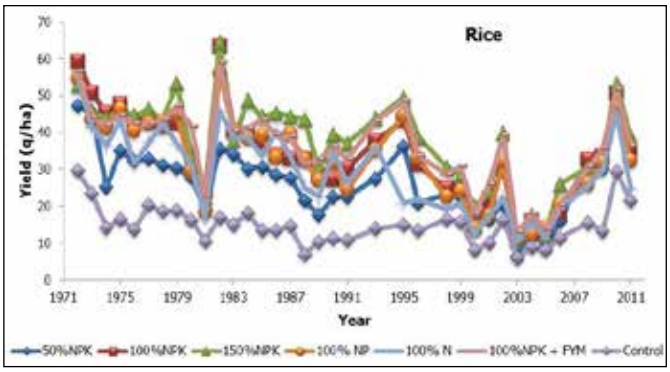
4.1.1.1 Crop yield: Yield of jute, rice and wheat ranged from 5.75 to 25.1 q/ha, 21.5 to 38.9 q/ha and 8.46 to 31.4 q/ha, respectively, under different treatments, the lowest being in unfertilized control plots for all the crops during 2012-2013. The yield improved with the balanced application of NPK fertilizers and highest crop yield was obtained with 100% NPK+FYM in jute and wheat whereas 150% NPK gave highest yield in rice. Yield trends of these crops over the last 41 years under different fertilizer/manurial treatments are presented in Fig. 4.1.

4.1.1.2 Nutrient uptake: The uptake of nutrients by jute, rice and wheat in the unfertilized control plots was significantly lower than that under other treatments (Fig. 4.2). Application of 150% NPK resulted in higher uptake of N, P and K in jute and rice as compared to 100% NPK+ FYM treatment. Plots receiving 100% NPK+ FYM had highest P (16.2 kg/ha) and K (136 kg/ha) uptake by wheat, whereas N uptake was highest under 150% NPK.

4.1.1.3 Soil fertility: Soil organic carbon increased in all the treatments and it was highest (8 g C/kg) when FYM was applied in combination with inorganic fertilizers (Table 4.1). Among the treatments highest soil available N was recorded in 150% NPK treated plot and the lowest in control. There was depletion of P in P omitted treatments as compared to the initial value (41.5 kg/ha) and significantly higher P buildup was observed in NPK+FYM followed by 150% NPK treated plots. Available K content was highest in 150% NPK followed by 100% NPK +FYM and 100% NPK (hand weeding) treatments. Soil available K was found to increase in all the plots except 100% NP and 100% N treated plots and this may be due to the varying release pattern of non-exchangeable K besides differential crop uptake.

Keeping in view the importance of soil quality in jute based cropping system, an attempt was made to develop an overall soil quality index by using the indicators that are meaningful to the jute based agricultural system. Soil samples were collected after the harvest of jute and were analyzed for physical, chemical and biological parameters. Multivariate statistical techniques were used to determine the indicators. The available P, urease activity, OC, available K, DHA, FDA and Mn were the most important indicators in this study. A multiple regression was run to evaluate the efficacy of minimum data set (MDS) taking jute yield as goal (r^2 =0.852). Each MDS was transformed into score. The Soil Quality Index (SQI) was calculated by using weighing factors derived from principal component analysis for each score MDS variable. The highest SQI was found in 100% NPK + FYM followed by 150% NPK, 100% NPK, 100% NP, 50% NPK, 100% N and control respectively (Fig. 4.3) *(Source: JC 5.2. Contributors: D.K. Kundu, A.R. Saha, B. Majumdar, A.K. Ghorai, S.R. Singh, S. Paul Mazumder and B.S. Mahapatra).*





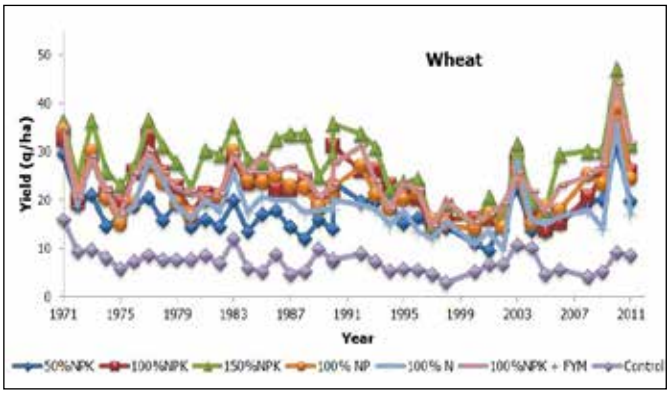
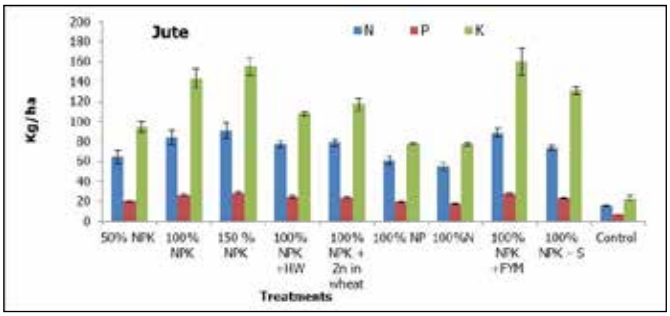
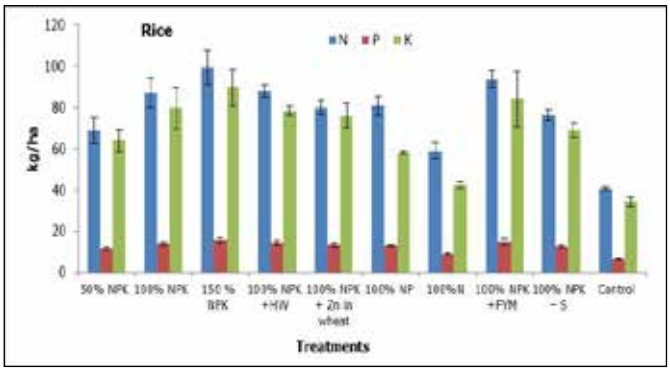


Fig 4.1: Yield trends of jute, rice and wheat in intensively cultivated field at Barrackpore





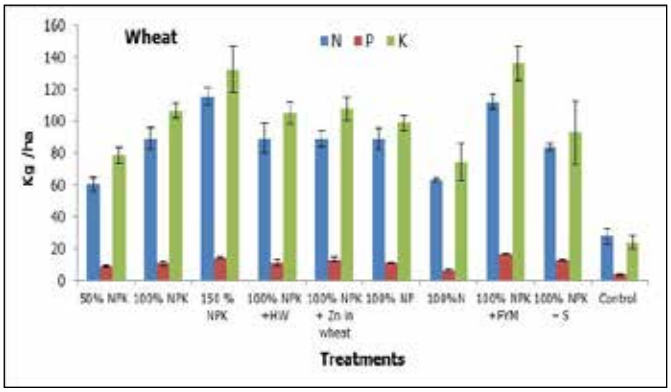


Fig. 4.2: Influence of continuous cropping and fertilization on uptake of nutrients (kg/ha) in 41th cycle of jute-rice-wheat cropping sequence

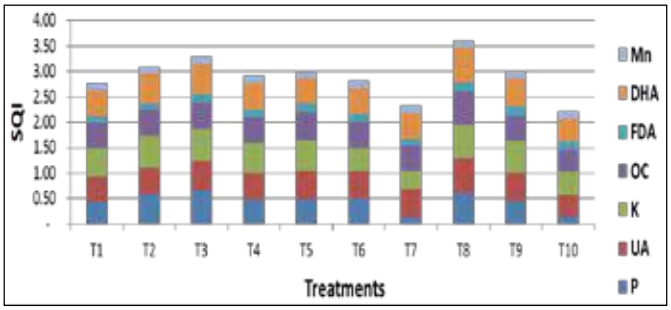


Fig. 4.3: Soil quality index in LTFE plots under different fertilizer/ manurial treatments

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, K and S which is evidenced by increasing trend of dry matter yield of maize from lower to higher fertility gradient as well as available N, K and S status. After harvesting of maize as an exhaust crop, the test crop viz., jute and rice were grown and the basic data and targeted yield equations for jute (cv. JRO 2407) and rice (cv. Hybrid) were developed (Table 4.2). These targeted yield equations developed for jute and rice will be verified under farmers' field condition in the coming season.

4.2.1.2 Follow-up trials on jute and rice: The targeted yield equations of jute (JRO 128) and rice (MTU 1010) developed during the 2009 were verified during 2012-13 in farmers' field at different locations. From the mean value of follow up trial on jute (var. JRO 128) conducted at three locations, it was found that the

Table 4.1: Soil fertility status after 41 years of cropping

Treatments	pH	EC (dS/m)	OC (g/kg)	N (kg/ha)	P (kg/ha)	K (kg/ha)
50% NPK	7.41	0.263	6.1	233	50.2	203.8
100% NPK	7.32	0.190	6.3	241	80.2	226.5
150% NPK	7.21	0.264	6.6	263	100.5	278.9
100% NPK+HW	7.42	0.265	6.2	240	70.8	233.9
100% NPK+Zn in wheat	7.5	0.224	6.2	248	63.0	217.0
100% NP	7.56	0.235	6.1	248	83.3	133.9
100% N	7.39	0.225	5.5	241	8.9	127.4
100% NPK+FYM	7.41	0.276	8.0	256	127.2	261.3
100% NPK - S	7.52	0.255	5.8	248	59.8	220.0
Control	7.34	0.233	5.6	226	14.0	147.2

application of fertilizers as per ST-TY without and with FYM achieved the target of 35 q/ha fibre production of jute with (-) 3.97 and (+) 0.16% yield deviation whereas target of 40 q/ha with (-) 4.45 and 1.53% yield deviation, respectively (Table 4.3). The highest yield and net profit in rice and vegetable pea were recorded under ST-TY and ST-TY plus FYM @ 5 t/ha over recommended dose of fertilizers (RDF) and farmers' practice (FP). However, highest fibres yield of jute, net profit and B: C ratio was recorded under RDF treatment followed by ST-TY (40 q/ha) + FYM treatment. Application of fertilizers based on ST-TY could save about 14.5, 75 and 75% N, P_2O_5 and K_2O kg/ha over RDF and achieved the targeted yield of jute fibre at par with RDF (80:40:40 kg N, P_2O_5 and K_2O/ha). A total of three number of test verification trials were conducted with rice (var. MTU 1010). In all the trials, targeted yield (40 and 50 q/ha) was achieved with (+) 1.39 to (-) 4.44% yield deviation, proving the validity of the equations. Application of fertilizers as per soil test values and targeted yields (40 and 50 q/ha) of rice with FYM (@ 5 t/ha), achieved the targeted yield of rice grain with (+) 5.56 and 0.44% yield deviations, respectively (Table 4.4). The follow up trials on garden pea (var. Azad P-3) was conducted at nine locations in farmers' field. Application of fertilizers as per ST-TY without and with FYM achieved the target of 90 q/ha green pod production of vegetable pea with (+) 0.37 and (+) 3.89% yield deviation whereas target of 100 q/ha with (+) 4.33 and (+) 9.67% yield deviation, respectively (Table 4.5) *(Source: JC 5.6. Contributors: S.R. Singh, B. Majumder and A.R. Saha).*

Table 4.2: Basic data and targeted yield equations for jute and rice

Basic Data	Jute (JRO 2407) (2012)			Rice (Hybrid) (2012)		
	N	K	S	N	K	S
Nutrient requirement (kg/q)	2.79	4.97	0.78	1.93	2.31	0.24
Soil efficiency (%)	22.22	69.99	179.4	23.33	48.49	76.40
Fertilizer efficiency (%)	39.52	287.5	29.76	51.90	237.30	20.72
Organic efficiency (%)	8.58	19.62	9.34	4.24	11.20	4.37
Targeted yield equations			Jute FN = 7.06 T – 0.58 SN– 0.22 ON FK = 1.93 T – 0.27 SK – 0.08 OK FS= 2.63 T – 6.03 SS – 0.30 OS		Rice FN = 3.73 T – 0.45 SN– 0.08 ON FK = 0.97 T – 0.20 SK – 0.05 OK FS= 1.18 T – 3.69 SS – 0.21 OS	

Table 4.3: Average fibre yield, yield response, net return, yield deviations and B:C ratio against fixed target of jute (JRO-128) under follow-up trials during 2012-13

Treatments	Fibre yield (q/ha)	Response yield (q/ha)	Net return (Rs/ha)	Yield deviation (%)	B:C ratio
Control	26.4	-	20104	-	1.53
Farmers' Practice (FP)	31.5	4.2	28507	-	1.70
Recommended dose of fertilizers (RDF)	41.1	9.2	48648	-	2.17
ST-TY (35 q/ha)	33.6	13.0	34621	(-) 3.96	1.88
ST–TY (35 q/ha) +FYM@ 5 t/ha	35.1	17.3	37943	(+) 0.16	1.97
ST-TY (40 q/ha)	38.2	12.5	43748	(-) 4.56	2.09
ST–TY (40 q/ha) +FYM @ 5 t/ha	39.4	14.7	46556	(-) 1.53	2.16

Table 4.4: Average grain yield, yield response, net return, yield deviations and B:C ratio against fixed target of rice (MTU 1010) under follow-up trials during 2012-13

Treatments	Grain yield (q/ha)	Response yield (q/ha)	Net return (Rs/ha)	Yield deviation (%)	B:C ratio
Control	25.8	-	4222	-	1.15
Farmers' Practice (FP)	42.9	10.8	21839	-	1.69
Recommended dose of fertilizers (RDF)	49.1	14.6	29612	-	1.93
ST-TY (40 q/ha)	40.6	27.9	21381	(+) 1.39	1.73
ST–TY (40 q/ha) +FYM@ 5 t/ha	42.2	33.3	23576	(+) 5.56	1.81
ST–TY (50 q/ha)	47.8	17.6	28680	(-) 4.44	2.92
ST–TY (50 q/ha) + FYM@ 5 t/ha	50.2	21.1	31969	(+) 0.44	2.04

Table 4.5: Average green pod yield, yield response, net return, yield deviations and B:C ratio against fixed target of garden pea (Azad P-3) under follow-up trials during 2012-13

Treatments	Green pod yield (q/ha)	Response yield (q/ha)	Net return (Rs/ha)	Yield deviation (%)	B:C ratio
Farmers' Practice (FP)	64.5	0.0	19085	-	1.7
ST-TY (90 q/ha)	92.1	29.8	36395	(+) 2.3	2.3
ST–TY (90 q/ha) +FYM @ 5 t/ha	96.9	34.7	40480	(+) 7.7	2.5
ST–TY (100 q/ha)	104.4	42.1	44032	(+) 4.4	2.5
ST–TY (100 q/ha) + FYM @ 5 t/ha	111.4	49.2	49647	(+) 11.4	2.8

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 of jute fibre (4 t/ha) was achieved (3.82 t/ha) with yield deviation of (-) 4.40% (Table 4.6) whereas targeted yield of rice grain (5 t/ha) was achieved (5.47 t/ha) with yield deviation of (+) 9.4%, in T_2 (ST-TY) (Table 4.7). The targeted yield of lentil (2 t/ha) could not be achieved with the application of fertilizers as per ST-TY (Table 4.8). The nutrient use efficiency of P and K in case of jute and N, P and K in case of rice and lentil apparently increased over general recommendation (GRD) and farmers practice (FP) with the application of fertilizers as per ST-TY. However, N use efficiency was recorded low as compared to RDF in case of jute production. All the fertilizers treatments significantly increased microbial population, microbial biomass C, soil respiration & enzymatic activities (Table 4.9, 4.10 and 4.11) over the control at different growth stages of jute growth. Integration of *Azotobacter* and PSB either with organic (FYM) or inorganic fertilizers significantly decreased the fungal counts over the control at all the growth stages of plant. Lowest counts (3.70×10^4 cfu/g soil) of *Azotobacter* were observed at T_2 treatments followed by T_5 and T_3 at 35 DAS but growth of *Azotobacter* maintained at later stage of plant growth (Table 4.11). Integrated application of inorganic fertilizer with FYM and *Azotobacter* and phosphate soliubilizing bacteria (PBS) based on soil test and targeted yield significantly improved microbial biomass C and microbial population, soil respiration and enzymatic activities over rest of the treatments (Table 4.9 & 4.10). However, treatment T_4 (ST-TY 3.5 t/ha + FYM @ 5 t/ha) recorded significantly ($P\leq0.05$) higher bacteria, actinomycetes, soil respiration and acid and alkaline phosphatase over rest of treatments at all the stages of plant growth. The highest count of phosphate solubilizing microorganisms and microbial biomass C content was recorded with T_8 treatment in different growth stages of jute *(Source JC 5.6A. Contributors: S.R. Singh, B. Majumdar and A.R. Saha).*

Table 4.6: ST-TY based fertilizer application on fibre yield and NUE of jute in jute-rice-lentil sequence

Treatment	Fertilizer dose (kg/ha)			Fibre yield (t/ha)	NUE (kg fibre/kg nutrient)		
	N	P_2O_5	K_2O		N	P	K
T_1 = Control	0	0	0	1.90	-	-	-
T_2 = ST-TY(5 t/ha)	161	48	74	3.82	0.22	0.23	0.88
T_3 = ST-TY(4 t/ha)	127	40	61	3.33	0.13	0.11	0.53
T_4 = T_3+FYM (5 t/ha)	117	36	57	3.70	0.20	0.19	0.71
T_5 = T_3+Azot.+PSB	117	36	57	3.60	0.15	0.15	0.55
T_6 = T_4+Azot.+PSB	117	36	57	3.70	0.21	0.26	0.93
T_7 = FYM @ 5 t/ha	0	0	0	2.20	-	-	-
T_8 = T_7+Azot.+PSB	0	0	0	2.40	-	-	-
T_9 = RDF	80	40	40	3.20	0.19	0.13	0.56
T_{10} = FP	23	60	60	2.62	0.56	0.07	0.39
CD $_{(P=0.05)}$				0.36			

Table 4.7: Effect of ST-TY based fertilizer application on grain yield and NUE of rice in jute-rice-lentil sequence

Treatment	Fertilizer dose (kg/ha)			Grain yield (t/ha)	Straw yield (t/ha)	NUE (kg grain/kg nutrient)		
	N	P_2O_5	K_2O			N	P	K
T_1 = Control	0	0	0	2.90	3.50	-	-	-
T_2 = ST-TY(5 t/ha)	135	34	65	5.50	6.21	0.37	0.23	0.85
T_3 = ST-TY(4 t/ha)	77	24	46	4.40	4.93	0.32	0.18	0.64
T_4 = T_3 +FYM (5 t/ha)	74	23	43	5.20	5.80	0.50	0.33	0.91
T_5 = T_3 +Azot.+PSB	74	23	43	5.40	5.95	0.52	0.31	0.89
T_6 = T_7 +Azot.+PSB	74	23	43	4.93	5.92	0.55	0.28	0.79
T_7 = FYM @ 5 t/ha	0	0	0	3.30	3.90	-	-	-
T_8 = T_7 +Azot.+PSB	0	0	0	3.60	4.21	-	-	-
T_9 = RDF	80	40	40	4.94	5.63	0.48	0.15	0.99
T_{10} = FP	60	30	30	3.64	4.30	0.25	0.07	0.39
CD $_{(P=0.05)}$				0.39	0.37			

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

Treatment	Fertilizer dose (kg/ha)			Grain yield (t/ha)	Straw yield (t/ha)	NUE (kg grain/kg nutrient)		
	N	P_2O_5	K_2O			N	P	K
T_1 = Control	0	0	0	0.90	1.12	-	-	-
T_2 = ST-TY(2 t/ha)	69	72	141	1.52	1.63	0.503	0.063	0.115
T_3 = ST-TY(1.5 t/ha)	44	50	96	1.12	1.24	0.303	0.043	0.065
T_4 = T_3+FYM (5 t/ha)	41	48	90	1.35	1.52	0.635	0.075	0.139
T_5 = T_3+Rhiz.+PSB	41	48	90	1.50	1.72	0.861	0.102	0.196
T_6 = T_4+Rhiz.+PSB	41	48	90	1.61	1.94	0.944	0.091	0.243
T_7 = FYM @ 5 t/ha	0	0	0	0.94	1.18	-	-	-
T_8 = T_7+Rhiz.+PSB	0	0	0	1.02	1.29	-	-	-
T_9 = RDF	30	40	20	1.20	1.52	0.618	0.064	0.528
T_{10} = FP	15	30	20	1.01	1.23	0.524	0.032	0.187
CD $_{(P=0.05)}$				0.11	0.11			

Table 4.9: Effect of different treatments on soil respiration and microbial biomass carbon and FDHA at different growth stages of jute

Treatment	Soil respiration (µg CO_2/g of oven dry soil/hr)			Microbial biomass-C (µg C/g of oven dry soil)			FDHA (µg fluorescein/g oven dry soil/hr)		
	35 DAS	70 DAS	105 DAS	35 DAS	70 DAS	105 DAS	35 DAS	70 DAS	105 DAS
T_1 = Control	3.04	1.98	2.59	102.0	74.9	138.8	153.5	102.0	119.6
T_2 = ST-TY(5 t/ha)	3.72	3.29	6.75	139.8	117.0	182.6	175.2	116.1	129.7
T_3 = ST-TY(4 t/ha)	3.95	4.07	7.66	178.9	261.7	283.7	185.2	119.4	132.4
T_4 = T_3+FYM (5 t/ha)	4.99	5.11	8.04	217.4	350.8	342.6	232.0	140.8	154.3
T_5 = T_3+Azot.+PSB	3.61	4.42	7.79	191.2	301.5	631.5	187.7	129.2	138.5
T_6 = T_4+Azot.+PSB	4.65	5.14	7.13	201.3	456.0	771.8	241.0	156.6	169.9
T_7 = FYM @ 5 t/ha	4.74	3.59	5.12	306.9	400.5	843.5	164.8	116.6	134.1
T_8 = T_7+Azot.+PSB	4.96	3.80	7.39	308.1	478.6	852.0	197.6	129.8	151.9
T_9 = RDF	3.42	2.89	5.82	151.9	210.9	616.9	175.9	122.8	139.7
T_{10} = FP	3.32	2.61	4.01	137.0	138.0	256.6	165.5	109.5	131.2
CD $_{(P=0.05)}$	0.27	0.31	0.52	13.7	15.3	26.2	13.7	10.2	11.9

Table 4.10: Effect of different treatments on soil enzymatic activities at different growth stages of jute

Treatment	Dehydrogenase (µg TPF/g of oven dry soil/hr)			Urease (µg Urea hydrolyzed/g oven dry soil/hr)			Acid Phosphatase (µg p-nitrophenol released/g oven dry soil/hr)		
	35 DAS	70 DAS	105 DAS	35 DAS	70 DAS	105 DAS	35 DAS	70 DAS	105 DAS
T_1 = Control	0.66	1.01	3.88	11.62	17.0	23.12	302.7	104.1	79.5
T_2 = ST-TY(5 t/ha)	1.26	1.93	4.11	65.26	64.43	76.21	381.5	172.9	130.7
T_3 = ST-TY(4 t/ha)	2.54	2.07	4.84	47.95	43.99	51.24	416.5	175.9	139.8
T_4 = T_3+FYM (5 t/ha)	3.26	2.40	5.02	64.33	48.78	52.36	450.2	184.8	151.4
T_5 = T_3+Azot.+PSB	3.14	1.50	4.05	58.36	26.44	35.62	353.3	151.9	141.4
T_6 = T_4+Azot.+PSB	3.32	1.73	4.08	68.28	37.92	43.2	471.9	157.7	148.4
T_7 = FYM @ 5 t/ha	2.74	1.62	3.38	72.58	36.83	41.59	377.7	145.4	105.1
T_8 = T_7+Azot.+PSB	4.10	1.68	4.13	98.5	34.15	39.82	606.1	150.1	118.5
T_9 = RDF	1.73	1.40	1.49	65.13	29.81	42.01	389.7	157.1	129.0
T_{10} = FP	1.57	1.32	1.81	65.55	25.26	30.99	356.7	134.2	154.4
CD $_{(P=0.05)}$	0.19	0.2	0.37	4.53	3.10	2.49	14.4	11.1	7.82

Table 4.11: Effect of different treatments on soil population of Azotobacter and phosphate solubilizing microorganisms at different growth stages of jute

Treatment	Alkali Phosphatase (µg p-nitrophenol released/g oven dry soil/hr)			Azotobacter ($x10^4$ cfu/g oven dry soil)			Phosphate solubilizing microorganisms ($x10^4$ cfu/g oven dry soil)		
	35 DAS	70 DAS	105 DAS	35 DAS	70 DAS	105 DAS	35 DAS	70 DAS	105 DAS
T_1 = Control	181.6	104.6	50.2	5.42	8.7	10.5	0.88	1.13	4.02
T_2 = ST-TY(5 t/ha)	192.8	118.0	55.2	3.70	12.8	12.5	1.38	1.35	5.52
T_3 = ST-TY(4 t/ha)	219.5	159.9	75.2	4.99	10.3	8.5	1.45	1.43	5.69
T_4 = T_3+FYM (5 t/ha)	351.9	188.8	108.8	6.32	22.7	14	1.62	1.87	7.52
T_5 = T_3+Azot.+PSB	183.5	139.8	60.3	4.64	26.7	17.5	1.99	2.15	8.43
T_6 = T_4+Azot.+PSB	249.2	144.6	74.3	9.33	27.5	18.2	2.69	2.55	10.9
T_7 = FYM @ 5 t/ha	213.9	149.1	53.5	6.11	29.5	19.5	2.01	2.34	6.48
T_8 = T_7+Azot.+PSB	248.4	157.4	54.8	7.80	43.6	23.5	3.24	2.82	7.45
T_9 = RDF	217.3	149.0	56.9	5.81	18.7	20.1	1.49	1.54	6.03
T_{10} = FP	175.0	131.9	74.5	6.11	17.3	9.6	1.02	1.38	5.35
CD $_{(P=0.05)}$	10.5	8.85	4.63	0.4	1.37	1.33	0.63	0.45	0.94

4.2.3 Evaluation of promising jute varieties for higher nitrogen use efficiency

Field experiment was conducted at CRIJAF, Barrackpore during 2011 and 2012 to study the performance of six promising new *tossa* jute varieties over a wide range of N doses (0 – 160 kg N/ha) and to group them according to their N use efficiency. The experiment was conducted in a Factorial RBD with six varieties (JRO 524, JRO 204, JRO 128, JRO 8432, JRO 2003-H and S 19) and five nitrogen doses (no nitrogen, 40 kg N/ha, 80 kg N/ha, 120 kg N/ha and 160 kg N/ha) replicated four times. The crop was sown in 1st week of April during both the years and harvested at 120 days of crop age. The perusal of data for the year 2012 and two years pooled data revealed that the olitorius variety JRO 204 recorded significantly higher dry biomass while in 2011, olitorius varieties JRO 204, JRO 524, JRO 128 and JRO 8432 were statistically at par in this regard (Table 4.12). The dry biomass (2011, 2012 and pooled) increased significantly up to 160 kg N/ha level (Table 4.12).

Table 4.12: Dry matter accumulation in tossa jute as influenced by variety and nitrogen

Treatments	Dry biomass (q/ha)		
	2011	2012	Pool
Varieties			
JRO 524	107.7	143.1	125.4
JRO 204	109.4	151.8	130.6
JRO 128	108.7	140.2	124.4
JRO 8432	107.8	132.1	119.9
JBO 2003-H	94.8	122.9	108.9
S 19	93.0	108.9	100.9
CD $_{(P=0.05)}$	6.9	6.8	4.8
Nitrogen dose			
No nitrogen	78.2	83.7	80.94
40 Kg N/ha	93.3	116.8	105.0
80 kg N/ha	103.9	136.3	120.2
120 Kg N/ha	117.1	158.1	137.6
160 Kg N/ha	125.2	171.0	148.1
CD $_{(P=0.05)}$	6.4	6.2	4.4

Data on fibre yield of the six olitorius varieties pooled over 2011 and 2012 revealed that JRO 204 (27.0 q/ha), JRO 524 (26.8 q/ha) and JRO 8432 (26.6 q/ha) were statistically at par but recorded significantly higher fibre yield over the rest three varieties (JRO 128, JBO 2003-H and S 19) (Table 4.13). In 2012, fibre yield of JRO 204 (31.4 q/ha) and JRO 524 (30.6 q/ha) were statistically at par but significantly superior to that with JRO 8432 (29.3 q/ha). The fibre yield of jute varieties increased significantly with application of N up to 120 kg/ha level only during both the years of experimentation and also when the data was pooled (Table 4.13).

Table 4.13: Effect of variety and nitrogen on fibre yield of tossa jute

Treatments	Fibre yield (q/ha)		
	2011	2012	Pool
Varieties			
JRO 524	23.1	30.6	26.8
JRO 204	22.7	31.4	27.0
JRO 128	22.4	28.7	25.5
JRO 8432	23.5	29.3	26.6
JBO 2003-H	21.3	27.5	24.4
S 19	20.3	23.9	22.1
CD $_{(P=0.05)}$	0.8	1.2	0.9
Nitrogen dose			
No nitrogen	18.0	19.5	18.7
40 Kg N/ha	20.5	25.6	23.1
80 kg N/ha	22.8	30.4	26.8
120 kg N/ha	24.6	33.2	28.9
160 kg N/ha	25.0	34.2	29.6
CD $_{(P=0.05)}$	0.7	1.1	0.8

The nitrogen content of leaf, bark and wood of tossa jute varieties were analyzed. The leaf N content ranged from 3.18% in no nitrogen treatment (N0) to 3.75% in 120 kg N/ha (N120) and subsequently decreased to 3.73% in 160 kg N/ha (N160). Similarly N content ranged from 0.66% in N0 treatment to maximum 0.72% in N120

in bark and from 0.44% N0 treatment to maximum 0.58% in N120 in wood of jute, respectively. In 2012, maximum nitrogen use efficiency (NUE) was recorded in all the varieties at 40 kg N/ha level with maximum NUE recorded with JRO 128 (19.7 kg fibre / kg N) and minimum NUE recorded with JBO 2003-H (9.4 kg fibre / kg N). The NUE declined in all the varieties with further increase in N dose (Fig. 4.4). At higher N level (120 – 160 kg N/ha), JRO 128 and JRO 204 showed relatively higher NUE (10.1 – 12.6 kg fibre / kg N) as compared to other olitorius varieties *(Source: JA 5.5. Contributors: S. Mitra, M. Kumar, D.K. Kundu, and S.R. Singh).*

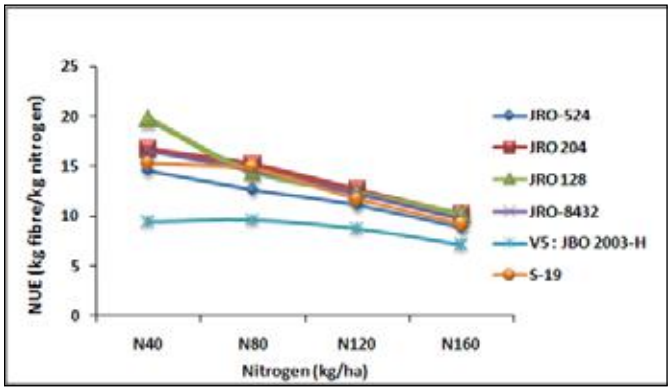


Fig. 4.4: Mean nitrogen use efficiency of *C. olitorius* varieties in 2012

4.2.4 Sunnhemp

4.2.4.1 Inoculum potential, symbiotic effectiveness and compatibility of *Bradyrhizobium* spp. with sunnhemp cultivars

Microscopic study of various isolates of *Bradyrhizobium* revealed that the isolated colonies were gram-negative, rod shaped, whitish pink in colour, elevated with glistering appearance. The morphological, cultural and biochemical characteristics showed different growth characteristics in their specific medium with different carbon sources. Xylose was the best source of carbon for most of the isolates followed by glucose and sucrose. On the basis of plant growth-promoting activities (PGPR), out of fourteen isolates, BRC-1, BRC-6, BRC-7, BRC-10 showed highest PGPR activities. Whereas BRC-7 showed highest ammonia, indole acetic acid (IAA), siderophore, HCN production and antibacterial activity followed by BRC-6, BRC-1, BRC-10 but except BRC-7 and BRC-10 no other isolates showed production of antibacterial activity (Table 4.14). The nodulation test was also conducted in control condition for confirmation of whether the isolated bacteria belong to genus *Bradyrhizobium,* due to *Bradyrhizobium spp*. is host specific in nature which causes infection and develops nodules only in respective host (sunnhemp). Seventeen isolates of *Bradyrhizobium* were isolated and identified. Out of which, seven promising isolates of *Bradyrhizobium* were tested for nodulation in control condition. Isolate BRC-7 recorded highest nodulation, fresh and dry weight of nodules, fresh and dry weight of root and shoot followed by BRC-6 and BRC-1 for sunnhemp cultivar SUIN-053. However, Isolates BRC-1 observed highest nodulation, fresh and dry weight of root in case of K-12 yellow variety of sunnhemp but highest fresh and dry weight of shoot recorded in BRC-6. Similarly, BRC-6 observed highest nodulation, fresh and dry weight of root and shoot followed by BRC-3 in case of HS-4 (Table 4.15). The control treatment could not produce single nodules in any of the sunnhemp variety. Therefore, Isolates, BRC-6, BRC-7 and BRC-1 were observed effective over other isolates of *Bradyrhizobium* in respect of nodulation, fresh and dry weight of sunnhemp *(Source: JC 6.3. Contributors: S.R. Singh, B. Majumdar and M.K. Tripathi).*

Table 4.14: Characterization of plant promoting rhizobacterial activities of *Bradyrhizobium* isolated from root nodule of sunnhemp

Bradyrhizobium isolates	IAA (µg/ml)	Ammonia production	Siderophore production	HCN production	Phosphate solubilization (µg/ml)	Seed germination (average length of root)
BRC-1	168	++	+	+	6.1	3.0 cm
BRC-2	104	++	+	++	4.8	2.5 cm
BRC-3	63	++	+	++	4.0	2.9 cm
BRC-4		-	-	-	-	-
BRC-5	46	+	-	+	3.1	2.5 cm
BRC-6	216	+	+	+	2.1	2.2 cm
BRC-7	232	++	+	++	4.6	2.4 cm
BRC-8	81	++	+	++	6.1	3.2 cm
BRC-9	65	++	+	++	4.8	3.05 cm
BRC-10	98	++	+	++	5.0	2.9 cm
BRC-11	-	++	+	++	7.0	3.0cm
BRC-12	79	++	+	++	5.0	2.9cm
BRC-13	88	++	+	++	7.4	3.2cm
BRC-14	53	+	+	+	1.9	2.7cm
BRC-15	19	+	+	++	3.3	2.2cm
BRC-16	128	++	+	++	6.8	3.23cm
BRC-17	-	-	-	-	-	-

Table 4.15: Effect of different isolates of Bradyrhizobium on nodulation, root and shoot weight of sunnhemp at controlled conditions

Bradyrhizobium isolates	Nodulation			Root (g/plant)		Shoot (g/plant)	
	No./plant	Fresh weight (mg/plant)	Dry weight (mg/plant)	Fresh	Dry	Fresh	Dry
Var. SUIN-053							
Control	-	-	-	0.054	0.042	0.89	0.25
BRC-1	4.2	1.78	0.31	0.205	0.119	1.93	1.04
BRC-2	2.5	1.88	0.12	0.139	0.076	1.55	0.87
BRC-3	1.0	0.33	0.02	0.124	0.074	1.12	0.74
BRC-4	-	-	-	0.052	0.043	0.91	0.32
BRC-5	-	-	-	0.059	0.048	1.09	0.66
BRC-6	8.3	13.37	0.72	0.233	0.062	2.18	1.36
BRC-7	8.8	28.65	0.88	0.248	0.069	2.72	1.58
$CD_{(P=0.05)}$				0.037	0.021	0.41	0.28
Var. K-12 yellow							
Control	-	-	-	0.078	0.025	0.71	0.20
BRC-1	3.5	11.70	2.18	0.213	0.120	1.19	0.59
BRC-2	1.3	0.90	0.08	0.091	0.038	1.10	0.66
BRC-3	2.5	0.44	0.01	0.136	0.060	2.02	0.79
BRC-4	-	-	-	0.069	0.030	0.77	0.22
BRC-5	-	-	-	0.075	0.079	1.09	0.66
BRC-6	1.8	10.44	0.10	0.206	0.102	1.94	0.85
BRC-7	2.3	2.73	1.07	0.103	0.029	1.31	0.60
$CD_{(P=0.05)}$				0.033	0.015	0.39	0.14
Var. HS-4							
Control	-	-	-	0.093	0.027	0.97	0.20
BRC-1	3.1	1.61	0.74	0.094	0.049	1.39	0.59
BRC-2	3.0	6.91	1.25	0.101	0.051	1.49	0.75
BRC-3	4.5	7.57	1.34	0.194	0.056	1.79	0.83
BRC-4	-	-	-	0.088	0.030	1.01	0.26
BRC-5	0.75	1.33	0.10	0.113	0.031	1.09	0.66
BRC-6	3.0	7.63	1.59	0.135	0.062	2.01	0.88
BRC-7	1.2	2.06	0.15	0.111	0.042	1.47	0.82
$CD_{(P=0.05)}$				0.031	0.011	0.04	0.16

5. Crop Husbandry

5.1. Jute

5.1.1. Productivity assessment and nutrient management for jute based cropping system

Perusal of data in Table 5.1 revealed that jute plant height was significantly lower in jute-rice-wheat (J-R-W) cropping sequence than other cropping sequences at 35 DAS. However, at later crop growth stages the difference was non-significant. Similarly, crop growth rate of jute was also lower in J-R-W cropping systems. Fertilizer application at 75% RDF and 100% RDF did not significantly affect the jute plant height except at 90 DAS. Growth rate of the crop was recorded higher in 100% RDF compared to 75% RDF and also in crop residue incorporation treatment (Fig. 5.1 and 5.2). Jute-rice-baby corn (J-R-C-Vj) system recorded the highest system productivity (219.1 q/ha) and production efficiency (60.03 kg/ha/day) followed by jute-rice-garden pea (J-R-Gp) (89.4 q/ha and 24.5 kg/ha/day) system. Fertilizer application and crop residue incorporation did not bring any significant increase in productivity of different cropping systems. There was non-significant difference in organic carbon content in soil among different cropping systems and crop residue management as it was the first year of experimentation *(Source: J A 5.6. Contributors: M. Kumar, A.K. Ghorai, S. Mitra and S.R. Singh).*

Table 5.1: Jute plant height, system productivity and production efficiency of different jute based cropping system under fertilizer and residue management

Treatments	Jute plant height (cm)				System productivity (q/ha)	Production efficiency (kg/ha/day)
	35 DAS	65 DAS	90 DAS	At harvest		
Cropping system						
R-R	------	-------	-------	---------	46.40	12.71
J-R-W	50	148	232	282	62.87	17.23
J-R-C-Vj	58	153	258	302	219.10	60.03
J-R-Gp	61	164	247	295	89.41	24.50
J-R-M¥-Mu	66	156	242	290	81.26	22.26
SEm ±	1.54	3.12	11.12	12.36	3.18	---
CD $_{(P=0.05)}$	5.32	NS	NS	NS	10.36	
Fertilizer application						
75% RDF	59	153	231	292	99.6	27.29
100% RDF	58	157.25	258.8	301	100.0	27.40
SEm±	1.48	2.26	6.74	8.56	2.9	---
CD $_{(P=0.05)}$	NS	NS	21.00	NS	NS	-----
Residue management						
No residue	58.71	155.5	246.2	295.6	99.6	27.31
Residue incorporation	58.75	155.0	243.7	298.4	100.0	27.38
SEm ±	0.89	2.14	2.79	2.44	1.41	
CD $_{(P=0.05)}$	NS	NS	NS	NS	NS	

J: Jute; R: Rice; W: Wheat; Gp: Garden pea; M: Mustard; Mu: Mung bean; C: Baby corn: Vj: Jute for vegetable purpose; ¥: Mustard was sown with zero tillage

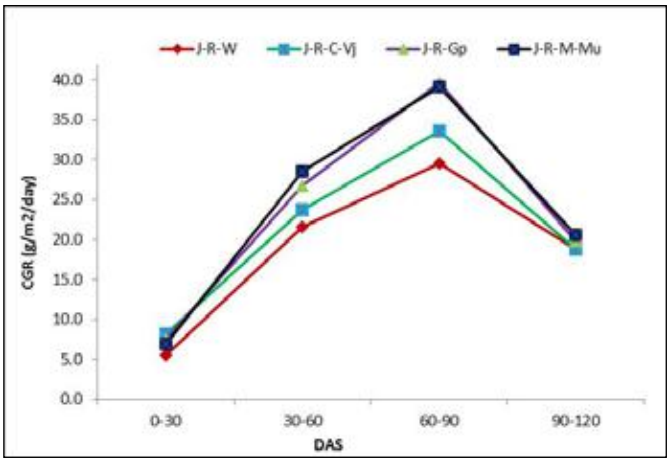


Fig. 5.1: Growth rate of jute in different cropping systems

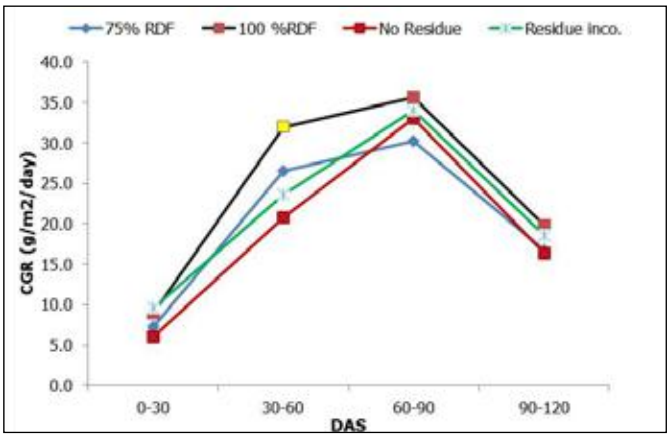


Fig. 5.2: Growth rate of jute under different fertilizer application and residue incorporation treatments.

5.1.2. Improving water productivity of jute and its retting under limited water in changing climatic scenario

Jute being primarily a rainfed crop (>85%), its national average yield is poor (22-23 q/ha) due to unassured moisture and nutrient supply during its growth period. In last decade, the average rainfall during 15th March to 15th June has reduced by 25-54%. Farmers are not in a position to supply adequate irrigation as the ground water is shrinking day by day. Therefore efforts were made to improve jute fibre productivity under limited irrigation (one only) and to ret jute fibre in low volume water.

Treatment effects of the following were studied: *Main plots*: Irrigation methods: i) One post sowing flood irrigation (7.5 cm), ii) One post sowing furrow irrigation (4-5 cm): (open furrow sowing: 7-10 cm). *Subplots*: Nutrient management: i) $N:P_2O_5:K_2O$ :: 60:30:30 ii) $N:P_2O_5:K_2O$ :: 60:30:30 + 30 kg elemental S iii) $N:P_2O_5:K_2O$ :: 60:30:30 + neem cake 150 kg/ha iv) $N:P_2O_5:K_2O$ :: 60:30:30 + Mung threshing waste 2 t/ha (after final weeding) and v) $N:P_2O_5:K_2O$ :: 80:40:40 kg/ha.

Under 33% deficit rainfall, open furrow sowing reduced post sowing irrigation requirement by about 40% and produced 2.4 q/ha more fibre (q/ha) over flatbed method sowing (18.16 q/ha) at fertilizer dose (kg/ha) N:P:K :: 60:30:30 (RDF). In flat bed method of sowing, under single irrigation i) application of elemental sulphur @ 30 kg/ha with RDF produced 2.88 q more jute fibre (21.04 q/ha) over RDF without sulphur. RDF (N:P:K :: 60:30:30) and addition of mung threshing waste @ 2 t/ha during sowing yielded 4 q more fibre/ha over RDF alone (Table 5.2).

Mortality rate of jute in ridge and furrow method was near 2% and that of flatbed was near 10%. Higher yield recorded in open furrow sowing was due to 11% more moisture retention in ridge furrow method of sowing.

In polyethylene lined micro tank (1.2 decimal and 4.5 feet depth) and in low volume of harvested rainwater (v/v:: 1:1) retting of jute (with natural retting agent e.g., retting tank soil, sunnhemp twig, molasses and ammonium sulphate) was completed within 18-20 days *(Source: JA 5.4. Contributors: A.K. Ghorai, H. Chowdhury, D.K. Kundu, B. Majumdar, M. Kumar and D. Barman).*

5.1.3. Jute seed cum fibre production

The objective of the experiment was to bring self-sufficiency in jute seed production in jute fibre growing states of the country where jute seed is primarily imported from other states (Maharashtra and Andhra Pradesh) of the country.

Jute fibre cum seed crops were sown at CRIJAF farm on three different dates starting from 1st week of May to 1st week of June in the different land situations to suit fibre cum seed production in fibre producing states. When sown on 15th June on upland (0-10 cm water) situation with good drainage facility, it produced 19.5 q fibre and

Table 5.2: Water Productivity of Jute under different methods of irrigation and nutrient levels

Main Plot (Method of irrigation)	Fiber yield (kg/ha)	Water use efficiency (kg/ha/mm)	Water productivity (l/kg fiber)
Flat Bed	24.25	3.12	3800.49
Ridge & furrow	25.84	2.53	3508.47
S.Em±	2.18	0.04	390.01
CD $_{(p=0.05)}$	NS	0.23	NS
Sub Plot (Nutrients levels)			
N:P:K::60:30:30	24.16	2.71	3840.95
N:P:K::60:30:30 +30 kg elemental S	26.88	3.01	3467.95
N:P:K::60:30:30 + 150 Neem cake/ha	23.31	2.61	3866.98
N:P:K::60:30:30 + Pulse waste 2t/ha	27.61	3.10	3276.20
N:P:K::80:40:40	23.26	2.70	3820.33
S.Em±	1.52	0.14	243.66
CD $_{(p=0.05)}$	NS	NS	NS
Interaction	NS	NS	NS

8.47 q jute seed/ha, respectively (Fig 5.3). When sown on 15th May in medium (0-30 cm water) land situation, the fibre yield was 16 q/ha and the seed yield was 8.41 q/ha. When sown on 7th June in medium low land situation (30-50 cm water), the fibre yield was only 12.4 q/ha and the seed yield was 4.76 q/ha only. The retting of this jute took long period due to low tempearture and it was 35 days approximately. Thus upland having drainage facility is better for jute seed production in jute fibre producing areas like 24-Parganas (N), West Bengal and sowing should be done in 1st week of June. This crop require 1-2 irrigations after monsoon and 20 kg more nitrogen to keep the reeds green for fibre extraction while the pods are matured *(Source: Expl. A2. Contributors: A.K. Ghorai, H. Chowdhury, D.K. Kundu, C.S. Kar and S.K. Sarkar).*

Fig. 5.3: Jute fibre-cum-seed crop sown in upland on 1st week of June

5.1.4. Use of jute fabrics in field crops

Extensive utilization of synthetics as packaging material has brought insecurity in jute sector which warrant immediate intervention. Utilization of woven and non-oven jute in agricultural field may strengthen survival of jute as commercial crop. The exploratory trials were thus conducted to find new avenues for jute fabrics utilization in agricultural field and crop diversification in rice field using woven and non-woven jute fabrics based soil columns. Potential of small jute packets for early seedling development of field and horticultural crops were also tested in the experiment.

Jute fabrics based soil columns of different dimensions (Fig 5.4, 20 to 45 cm height and 15-30 cm radius) were developed in rice field (*summer* and *kharif*) with puddled soil and FYM in four alternate layers. Desired vegetables and tuber crops were sown in soil columns at 45 days after rice transplanting. Proper aeration and moisture regime were maintained in the soil column through the crop growth period. The moisture per cent of soil (0-30 cm depth) of jute reinforced soil columns, ridges (30 cm base with and 15 cm height) and flat moist beds of the same field at a given time ranged from 13 to 23.5%, 23.3 to 25.8% and 22.0 to 25%, respectively. The oxygen diffusion rate of soils (at 15 cm depth) of jute reinforced soil columns, ridges (30 cm base with and 15 cm height) and flat moist beds of the same field at the same time were 280, 115 and 86.95 µg O_2/m^2/sec respectively. Crop

diversification in waterlogged rice field was possible using jute reinforced soil column of different dimensions (Fig 5.4). Cucurbits (e.g., sponge gourd, bottle gourd, red pumpkin, cucumber, bitter gourd, spine gourd etc), colocasia, brinjal, etc were found suitable to grow in jute based soil columns in summer rice (yield 5.4 t/ha) field avoiding anoxia. Different cucurbit yields varied from 55 to 150 q/ha, colocasia yielded 25 tonnes tuber/ha in eight months. Brinjal yield was 125 q/ha. Field and horticultural crop samplings were developed in small packets (Fig 5.5) and transplanted after rice in rabi season. Mustard, bitter gourd, rajmash and cucumber, yielded 21.25, 40.00, 40.00 and 35.8 q/ha, respectively *(Source: Expl. A1. Contributors: A.K. Ghorai, H. Chowdhury and D.K. Kundu).*

Jute fabric based soil columns

Gabion for support

Summer rice and vegetables

Young colocasia after rice

Kharif vegetable and rice

Amorphophallus spp. and summer rice

Fig 5.4: Woven jute fabrics based soil columns and vegetable cultivation in waterlogged rice field

Mustard grown from packet seedlings

Bitter gourd saplings raised in jute packets

Okra

Fig 5.5: Sapling development in small jute packets for transplanting after rice in jute-rice based cropping system

5.2. Sunnhemp

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

Field experiment was carried out to study the residual effect of sunnhemp green manuring grown before rice crop, on wheat in rice-wheat cropping system. Sunnhemp crop was grown as green manure after harvesting of wheat during May to June. The green manure crop was ploughed down and well incorporated into the soil at 60 days after sowing for decomposition at proper moisture before transplanting of rice crop. The 21 days old seedlings of rice variety NDR-359 was transplanted and grown with recommended package of practices. After harvest of rice crop, wheat was grown with recommended package of practices. The rice-wheat crop sequence is being repeated along with the green manuring crop to build up the organic matter in the soil *(Source: SNHA 1.6. Contributors: M.K. Tripathi and S.R. Singh).*

5.3. Sisal

5.3.1. Feasibility of growing annual intercrops in sisal plantation

The inter-row spacing of sisal in double row planting system is kept unutilized in sisal plantation. Common farmers do not get any economic return from the initial 3 years phase of such sisal plantation, which otherwise is remunerative in long run and environmentally safe. The inter-row space may be utilized by practising inter-cropping in double row planting system in sisal plantation. Therefore, a field experiment was conducted at Sisal Research Station (23.05°N, 84.23°E, and 256.03 m above MSL), Bamra, Dist: Sambalpur, Odisha in 2012-13 to find suitable legume intercrops for sisal plantation in the plateau region of India.

The treatments were, T1: Sisal (*Agave sisalana*); T2: Sisal + Cowpea (cv. VRCP 4 or Kashi Kanchan); T3: Sisal + Green gram (cv. Pant Mung 5); T4: Sisal + Black gram (cv. Pant Urd 31); T5: Sisal+ Mothbean/ Matki (cv. RMO 40); T6: Sisal + Pigeon pea (cv. ICPL 87 or Pragati).

Table 5.3: Characteristics of legume crop varieties grown with sisal

Crop	Variety	Characteristics
Cowpea	VRCP-4 (Kashi Kanchan)	Suitable for June-Aug sowing, first harvest 45-50 days, colour- green, length 10-11 inch
Green gram	Pant Mung 5	Days to maturity 60-65 days, suitable for all seasons, resistant to YMV, yield 12-15 q/ha
Black gram	Pant Urd 31	Days to maturity 75 days, suitable for kharif season, resistant to YMV, yield 10 q/ha
Moth bean	RMO 40	Days to maturity 60-64 days, first early variety, erect growth, suitable for low rainfall area.
Pigeon pea	ICPL 87 (Pragati)	Short statured (80-90 cm plant height), short duration (110 days), tolerant to fusarium wilt, 100 seed weight 8.6 g, seed yield 11.4 q/ha

Legume intercrops such as cowpea, moth bean, green gram, black gram and pigeon pea were grown in between the space of double rowed sisal plantation (Table 5.6, Fig. 5.6).

The sisal equivalent yield from the system was the highest in case of pigeon pea (723 kg/ha) followed by cowpea (349 kg/ha) and black gram (313 kg/ha) (Table 5.3, 5.4, 5.5 and 5.6). 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 and black gram *(Source: SLC 1.4. Contributors: Sitangshu Sarkar, D.K. Kundu, A.R. Saha and B. Majumdar).*

Cowpea as intercrop in sisal

Moth bean as intercrop in sisal

Fig. 5.6: Legume intercropping with sisal

5.3.2 Micro-irrigation and micronutrient management in sisal

An experiment in sisal was undertaken to increase water use efficiency along with better utilization of micronutrients. In the second year of the experiment, it was observed that micronutrient has significant effect on leaf length, number of leaf and fibre yield of sisal. Drip irrigation (discharge rate 4 l/hr) for 4 hrs at 2 weeks interval + soil application of zinc sulphate @ 20 kg/ha along with borax @ 15 kg/ha produced the longest sized leaf (82.30 cm) as compared to check (60.23 cm). Maximum number of harvested leaves (114400 leaves / ha) were recorded in the same treatment as compared to that (54266 leaves /ha) under no irrigation and no micronutrient treatment. The maximum fibre yield (0.693 t/ha) was also recorded under the said treatment *(Source: SLC 1.3. Contributors: D.K. Kundu, S. Sarkar and A.R. Saha).*

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

Treatment	Leaf length (cm)	Leaf number ('000)/ha	Weight of harvested leaf (t/ha)	Fibre yield (kg/ha)
Sisal + cowpea	87.3	51.30	8.64	259.6
Sisal + moth bean	88.2	49.17	7.88	255.2
Sisal + green gram	85.1	48.71	8.04	222.7
Sisal + black gram	87.4	47.89	8.11	250.2
Sisal + pigeon pea	92.4	45.08	9.95	302.5
Sisal (sole)	76.7	37.58	7.15	159.2
$CD_{(P=0.05)}$	6.50	6.29	1.64	56.25

Table 5.5: Growth and yield of legumes when grown as intercrops in double rowed sisal plantation

Treatment	Pod length (cm)	Seeds/pod	1000 seed weight (g)	Seed yield (g/m^2)
Sisal + cowpea	-	-	-	70.58*
Sisal + moth bean	-	-	-	-
Sisal + green gram	8.17	8.94	3.18	10.93
Sisal + black gram	3.98	6.06	3.08	11.45
Sisal + pigeon pea	5.36	4.44	7.96	68.44
Sisal (sole)	-	-	-	-

*Harvested as green vegetable having demand in local market

Table 5.6: Effect of legume intercrops on sisal equivalent yield in double rowed sisal plantation

Treatment	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	259.6	245.4	89.2	348.8
Sisal + moth bean	255.2	-	-	255.2
Sisal + green gram	222.7	74.2	72.3	295.0
Sisal + black gram	250.2	77.8	62.8	312.9
Sisal + pigeon pea	302.5	391.1	420.6	723.1
Sisal (sole)	159.2	-	-	159.2

6. Biotic and Abiotic Stresses

6.1. Biotic stress

6.1.1. Pest management

6.1.1.1. Jute

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

Age-specific life table and fecundity life table were constructed for the jute hairy caterpillar, *Spilosoma obliqua* Walker during 2012 cropping season as per the standard format using computerized programme. The early instars (up to third instar) were more vulnerable to the density dependent mortality factors. Two braconid larval parasitoids, *Meteorus spilosomae* Narendran & Rama and *Protapanteles obliquae* (Wilkinson) (Fig. 6.1 a & b) were the key mortality factors with the K-value of 0.2 whereas in late instars, mortality due to virus was more with 0.14 K-value. The generation survival was 0.39.

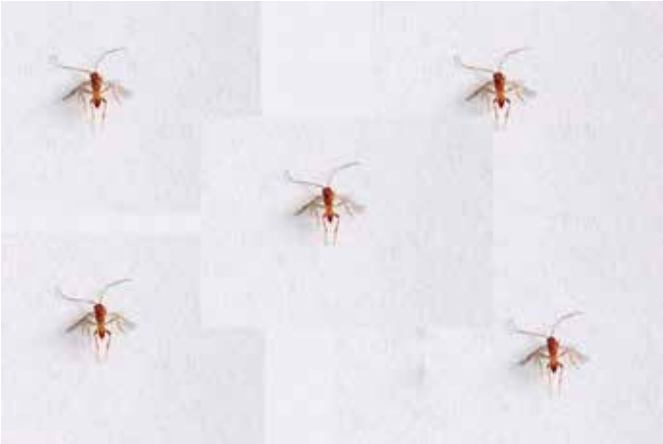


Fig. 6.1 a: *Meteorus spilosomae* Narendran & Rema

Fig. 6.1 b: *Protapanteles obliquae* (Wilkinson)

The population of *S. obliqua* has been predicted to be much higher in the ensuing generation as trend index was positive. This indicates the need of insecticidal intervention to manage this pest as the natural mortality factors were inadequate to suppress the increasing population of the pest in the jute ecosystem. The net reproductive rate (NRR) and intrinsic rate of increase (r_m) have been determined to be 162 female offsprings/ female/generation and 1.15 female offsprings/ female/ day, respectively. The mean generation time was 46 days and it is predicted that the population would double within a span of 6.0 days with the existing finite rate of increase of 3.16. Other growth indices including generation time (days) (T_c), capacity for increase (r_c), weekly multiplication rate (WMR) and corrected generation time (days) (T) were 47.87, 0.10, 2.12 and 48.04, respectively *(Source: JE 1.3. Contributors: K. Selvaraj, S. Satpathy and B.S. Gotyal).*

Bio-efficacy of new insecticides against jute hairy caterpillar, *S. obliqua* Walker

Leaf dip bioassay of new insecticides *viz.,* flubendiamide 480 EC, emamectin benzoate 5 SG, lamda cyhalothrin 5 EC and chlorantriliniprole 18.5 SC against third instar larvae of *S. obliqua* was conducted under laboratory condition. The larval mortality range varied from 23-100%, 20-100%, 23-100% and 40-100% in flubendiamide, emamectin benzoate, lamda cyhalothrin and chlorantriliniprole in various test concentrations. The LC_{50} values determined as 1 ppm for flubendiamide and lamda cyhalothrin and 2 ppm and 3 ppm for emamectin benzoate and chlorantraniliprole, respectively *(Source: JE 1.3. Contributors: K. Selvaraj, S. Satpathy and B.S. Gotyal).*

Determination of single- and multiple-pests-economic injury levels (EILs)

Yield-infestation relations were established through multiple regressions to determine the multiple pest economic injury levels (EILs) on JRO 204 jute variety at different crop growth stages during 2012 cropping season. The yellow mite (YM) damage varied from 18.72-

35.54 mite /cm^2 on second unfolded leaf at 35 DAS (Table 6.1). However, the peak YM population was at 45 DAS with 109.62 mite/cm^2. In case of Bihar hairy caterpillar (BHC) and semilooper (SL), the infestation ranged from 16.58-22.89% plant damage at 45 DAS (Table 6.2). However, the peak infestation (64.12%) was recorded at 75 DAS. With increase in pest infestation, fibre yield was reduced in various treatments as with lowest mite infestation (0.4-18.72 mite/cm^2) in (T_4) highest yield (34.01 q/ha) was recorded and combined infestation of yellow mite and lepidopteran pests, reduced the yield to maximum extent (24.55 q/ha). The crop protected with insecticide had significantly more yield than the unprotected crop. Highest yield was recorded with two spray of spiromesifen 240 SC at 36 DAS and 46 DAS against YM and profenophos 50 EC at 46 DAS and 56 DAS against lepidopteran pests. Two sprays for each were found to be optimum against YM and lepidopteran pests during 2012 cropping season.

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=32.58-0.338 (YM)-0.035 (BHC+SL), (R^2=0.62) at 55 days after sowing (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.

Based on control expenditure and market price of jute fibre, individual EIL for yellow mite and lepidopteran pests were 42 mites/cm^2 on second unfolded leaf and 3% plant damage respectively.

Further multiple regression was used to determine iso-loss points simultaneously increasing incidence of one pests and decreasing that of another. Based on iso-loss points, iso-loss equations were established through regressing incidence of one pest on another. The iso-loss equation for lepidopteran pests (%) was Y=41.884-3.135 (number of YM) and for YM (mites/cm^2) was Y=2.835-0.057 (lepidopteran pest-damage %). These equations were used to draw iso-loss curves which depicted various combinations of YM and BHC + SL infestation that resulted in economic damage, though individually each pest was below its respective EIL (Fig. 6.2). These curves can be used for monitoring combined incidence of YM and BHC + SL and timing pesticide application to prevent avoidable yield loss *(Source: JE 1.4. Contributors: K. Selvaraj and B.S. Gotyal).*

Table 6.1: Mean yellow mite population on jute variety JRO 204 in different treatments for yield-infestation relationships during 2012

Treatments	Insecticides application at different DAS		Yellow mite/cm^2 leaf					Mean Yield (q/ha)
	Spiromesifen	Profenophos	35 DAS	45 DAS	55 DAS	65 DAS	75 DAS	
T_1=Yellow mite (YM) incidence alone	-	46,56	35.54	109.62	46.54	1.09	1.38	25.50
T_2= Semilooper (SL) and Bihar hairy caterpillar (BHC) incidence alone	36,46	-	24.46	20.50	12.92	0.8	0.96	30.90
T_3=YM+ SL+BHC incidence (no spray)	-	-	22.20	55.82	52.67	12.42	0.44	24.55
T_4=Insect-free crop (completely protected)	36,46	46,56	18.72	6.34	0.40	0.26	0.34	34.01
SEm±	-	-	4.12	4.44	3.49	0.30	0.65	1.09
CD $_{(P=0.05)}$	-	-	12.71	41.77	10.77	0.92	2.05	3.37

Table 6.2: Mean lepidopteran pests infestation (%) on jute variety, JRO 204 in different treatments for yield-infestation relationships during 2012

Treatments	Insecticides application at different DAS		Plant damage (%)				Mean Yield (q/ha)
	Spiromesifen	Profenophos	45 DAS	55 DAS	65 DAS	75 DAS	
T_1=Yellow mite (YM) incidence alone	-	46,56	16.58 (23.96)*	10.29 (18.66)	9.08 (17.49)	0.00 (4.05)	25.50
T_2=Semilooper (SL) and Bihar hairy caterpillar (BHC) incidence alone	36,46	-	22.89 (28.50)	55.75 (48.33)	52.41 (46.38)	60.27 (51.65)	30.90
T_3=YM+ SL+BHC incidence (no spray)	-	-	18.58 (25.22)	37.54 (37.76)	22.38 (28.15)	64.12 (53.27)	24.55
T_4=Insect-free crop (completely protected)	36,46	46,56	21.01 (31.27)	9.70 (17.98)	3.49 (10.74)	2.62 (9.13)	34.01
SEm±	-	-	1.65	1.51	0.77	1.60	1.09
$CD_{(P=0.05)}$	-	-	5.11	4.67	2.40	4.95	3.37

*Figures in the parenthesis are arc-sine transformed values

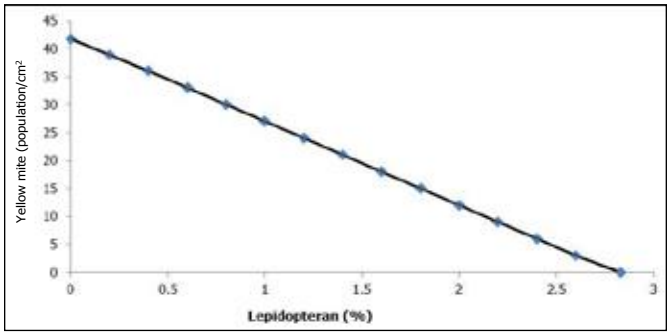


Fig. 6.2: The iso-loss line showing equal loss combination of combined infestation due to yellow mite (population/cm^2) and lepidopteran pests (plant damage %) at 55 DAS.

Identification of sources of resistance against jute insect pests

The evaluation of fifteen germplasm each of *capsularis* and *olitorius* along with cultivated varieties under natural field condition indicated the *capsularis* germplasm, CIN-512 and CEX-23 to be least infested by yellow mite (3.66 mites/cm^2 on second unfolded leaf). Germplasm lines with least infestation of stem weevil (2.14%), semilooper (31.9%) and Bihar hairy caterpillar (BHC) (2.61%) were CIN-13, CIN-001 and CIN-211 respectively. In case of *olitorius* germplasm, the least infestation of yellow mite, stem weevil, semilooper and BHC was observed on OIN-507, OIJ-192, OIN-431 and OIN-401 with infestation of 33.67 mites/cm^2 on second unfolded leaf, 7.14%, 36.33% and 0.71% plant damage respectively. Under glasshouse screening, least yellow mite population was noticed in OIN-457, OIN-403 and OIN-402 with infestation of 6.00, 7.5 and 7.5 mites/cm^2 on second unfolded leaf respectively. The lines, OIN-202, OIN-434 and OIN-252 were found to be more susceptible with maximum of 41.5, 35.00 and 33.5 mites/cm^2 on second unfolded leaf respectively *(Source: JE 1.2. Contributors: B.S. Gotyal and S. Satpathy).*

Feeding preference (Choice test) of Bihar hairy caterpillar *Spilosoma obliqua* on cultivated and wild jute species

The feeding preference of *S. obliqua* in choice test indicated significant non-preference for *Corchorus trilocularis* (0.33) and *C. tridens* (0.60) as compared to the cultivated species of jute, *C. olitorius* (cv. JRO 204)(19.3) while *C. pseudoolitorius* (18.00) had high degree of feeding preference over *C. olitorius* (cv. JRO 632) (2.00) (Fig. 6.3) *(Source: JE 1.2. Contributors: B.S. Gotyal and S. Satpathy).*

Antibiosis study on Bihar hairy caterpillar, *Spilosoma obliqua* Walker

The growth of 5-day old larvae indicated maximum antibiosis effect of *C. aestuans* on *S. obliqua*. At 13 days after feeding (DAF) significantly least larval survival was on *C. aestuans* (7.50%) followed by *C. tridens* (37.50%) while *C. olitorius*, *C. trilocularis* and *C. fascicularis*

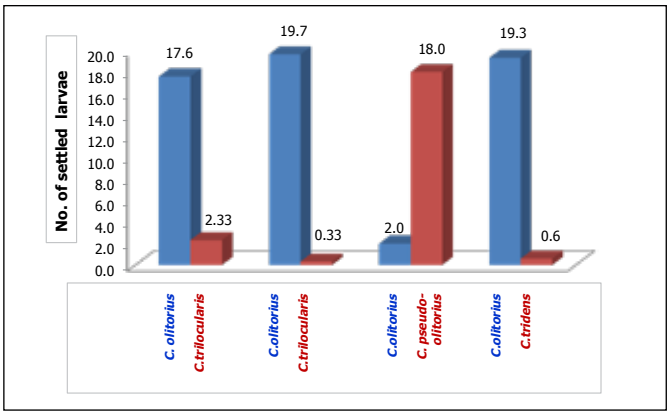


Fig 6.3 Feeding preference (Dual choice) of *Spilosoma obliqua* on different jute species

recorded more than 70% larval survival. Later on at 17 DAF the larvae completely failed to survive on *C. tridens* and *C. aestuans*. The pre-pupal larval survival (%) among the preferred hosts was lowest on *C. pseudo-olitorius* (45.00 %) and highest on *C. olitorius* (70.00 %) (Table 6.3) *(Source: JE 1.2. Contributors: B.S. Gotyal and S. Satpathy).*

Table 6.3: Effect of host plant on the larval survivability of *Spilosoma obliqua* at different days after feeding (DAF)

Host plants	Larval survival (%)			
	5 DAF	9 DAF	13 DAF	17 DAF
C. tridens	100 (90.00)	77.50 (62.14)*	37.50 (37.72)	00.00 (0.00)
C. trilocularis	100 (90.00)	82.50 (68.09)	72.50 (59.94)	67.50 (55.87)
C. pseudoolitorius	100 (90.00)	90.00 (71.57)	82.50 (65.84)	45.00 (42.05)
C. aestuans	100 (90.00)	37.50 (37.72)	7.50 (11.25)	00.00 (0.00)
C. fascicularis	100 (90.00)	97.50 (85.39)	77.50 (62.14)	70.00 (57.16)
C. olitorius (cv. JRO 204)	100 (90.00)	82.50 (65.46)	72.50 (59.19)	62.50 (46.50)
CD $_{(P=0.05)}$	NS	14.92	16.58	12.68

*Figures in the parenthesis are arc-sine transformed values.

Biochemical studies on wild and cultivated jute species

As part of the biochemical basis of resistance, the protein, phenol and peroxidase content in the wild and cultivated jute species with differential effect on biological parameters of BHC was estimated. Among the wild species, maximum phenol content (4.8 mg/g) was in *C. aestuans* compared to 2.0 mg/g and 2.5 mg/g in the *C. olitorius* (cv. JRO 204) and *C. capsularis* (cv. JRC 321) respectively (Fig. 6.4). The protein content in cultivated species, *C. olitorius* was more (26.2 µg/ml) compared to the wild jute species (7.66-10.15 mg/ml) except *C. trilocularis* (24.75 µg/ml) (Fig. 6.5). The total peroxidase content was very high in both *C. tridens* and *C. aestuans* (7.2 µg/ml) as compared to *C. capsularis* (5.8 µg/ml) and *C. olitorius* (4.1 µg/ml) (Fig. 6.5). The biochemical content was correlated with the biological parameters of BHC namely, larval survival and adult emergence. Phenol and peroxidase content showed negative effect on the biology of *S. obliqua.*

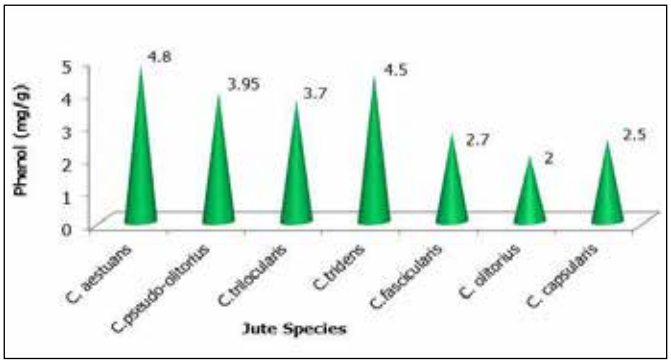


Fig 6.4: Phenol content in wild and cultivated species of jute

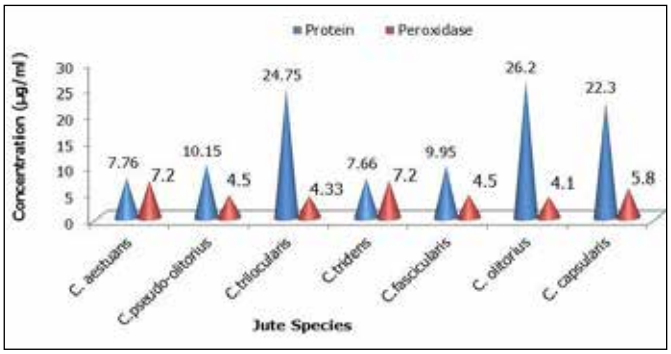


Fig 6.5: Protein and peroxidase content in wild and cultivated species of jute

Among the wild and cultivated jute species, *C. tridens* and *C. aestuans* did not support for the complete life cycle of BHC, this might be due to presence of secondary plant metabolites *(Source: JE 1.2. Contributors: B.S. Gotyal and S. Satpathy).*

Toxicity of plant essential oils on Bihar hairy caterpillar, *S. obliqua* Walker

Plant essential oils from citronella, mentha, *Lippia geminata* leaves were extracted by hydro-distillation in Clevenger apparatus. Turmeric oil was extracted from turmeric rhizome powder by hexane in Soxhlet apparatus. Turmeric powder residue was further extracted with benzene in the same apparatus, solvent was evaporated and residue was recrystallized from cold ethanol to collect curcumin mixtures (curcumin-I, II, III). Oils were dried over sodium sulphate bed. Bioassay of the essential oils against third instar larvae of Bihar hairy caterpillar, through leaf dip bioassay method was conducted under laboratory condition. Among the oils, Lippia oil recorded highest larval mortality (43.33% at 0.01%) of the insect followed by mentha (30% at 0.05%) and turmeric (26.66% at 0.05%) oils. The LC_{50} value of Lippia oil was calculated as 0.076% followed by 0.237% and 0.879% in mentha and turmeric oils, respectively (Table 6.4) *(Source: JC 6.4. Contributors: H. Chowdhury, S.K. Sarkar, R.K. De and K. Selvaraj).*

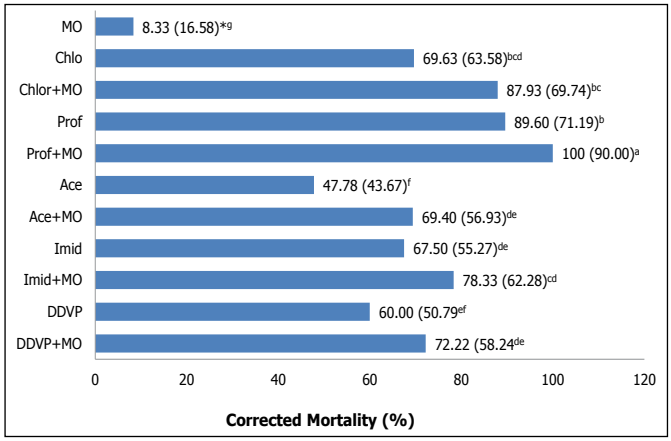
Table 6.4: LC_{50} value of plant essential oils on Bihar hairy caterpillar larvae

Plant oil	LC_{50} value(%)	Fiducial limit (%)	
		Lower	Upper
Citronella oil	2.865	2.523	3.286
Lippia oil	0.076	0.024	0.384
Mentha oil	0.237	0.010	2.222
Turmeric oil	0.879	0.272	5.013

6.1.1.2. Mesta

Synergistic effect of mineral oil with insecticides on mealybug of kenaf

The synergistic effect of agriculture-grade mineral oil (0.2%) was studied with the insecticides effective against mealybug to further enhance the toxicity. The use of mineral oil (0.2%) could enhance the toxicity through improving the mortality by 6% to 22% in different insecticides. Maximum mortality of 100% was recorded in case of profenophos 50 EC (0.035%) with addition of 0.2% mineral oil. The mortality in chlorpyriphos 20 EC (0.02%) + mineral oil was 87.93% which was at par with profenophos 50 EC (89.6%) and chlorpyriphos 20 EC (69.63%). Although maximum synergistic effect (22%) was recorded with acephate 75 SP (0.035%) but overall mortality was significantly less than chlorpyriphos 20 EC (0.02%) and profenophos 50 EC (0.035%) (Fig. 6.6).



MO - Mineral oil (0.2%), Chlor-Chlorpyriphos (0.02%), Prof - Profenophos (0.035%), Ace-Acephate (0.04%), Imid-Imidacloprid (0.003%), Dichlo-Dichlorovos (0.038%) *Figures in the parenthesis are arc-sine transformed values

Fig. 6.6: Synergistic effect of agriculture-grade mineral oil (0.2%) with the insecticides effective against mealy bug for enhancing the toxicity

Effect of seed treating chemicals on flea beetles of kenaf

The effect of neonicotinoid seed treating insecticide i.e imidacloprid 600 FS, thiamethoxam 70 WS and clothianidin 50 WDG against flea beetle of kenaf, *Nisotra orbiculata* indicated thiamethoxam 70 WS to be most effective against flea beetle. At 30 DAS, the mortality of flea beetle caused by all the seed treating chemicals was > 90% with maximum mortality in imidacloprid (100%) (Fig. 6.7). Later on the persistent toxicity was more with thiamethoxam causing 54% mortality at 75 DAS**.** Although initial toxicity was more in case of clothianidin and imidacloprid, the persistant toxicity of thiamethoxam continued till 83 DAS with 54% mortality of the flea beetles.

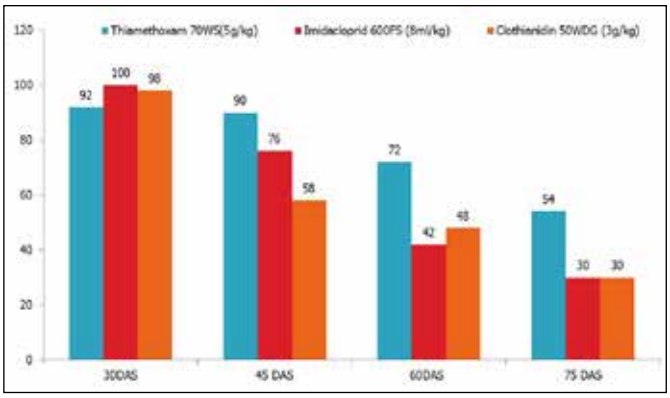


Fig. 6.7: Persistent effect of seed treating chemicals on mortality of flea beetle of kenaf

Combined effect of seed treatment and foliar spray of insecticide for management of mealy bug in Kenaf

The effect of seed treatment with thiamethoxam 70WS and imidacloprid 600 FS followed by foliar spray of profenophos 50 EC (0.1%) and chlorpyriphos 20EC (0.04%) at 35 and 55 DAS were evaluated for mealy bug management along with untreated check. Control of kenaf mealybug was much significant in the treatment with seed treatment of thiamethoxan 70 WS followed by foliar spray of profenophos 50 EC (0.1%) at 35 and 55 DAS which was manifested in significant increase in height (2.57 m) and plant dry weight (7.31 g) and reduction in damage grade (2.46) over the untreated control (Fig. 6.8) *(Source: JE 1.1. Contributors: S. Satpathy and B.S. Gotyal).*

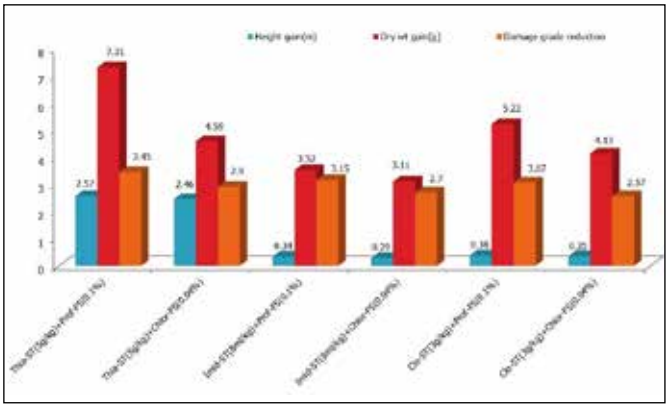


Fig. 6.8: Effect of seed treatment and foliar spray on improvement of plant height and dry weight and reduction in damage caused by mealybug in kenaf

6.1.1.3 Ramie

Report of new insect pests of ramie

Three insect pests of ramie *viz.,* leaf beetle, yellow coaster butterfly, black fungus beetle were observed to cause damage to the ramie crop and seeds (during storage). These insect pests were collected and identified through the insect identification facility at Division of Entomology of IARI, New Delhi. The identified insects were leaf beetle, *Pachenephorus bretinghami* Baly (Coleoptera: Chrysomelidae), yellow coaster butterfly, *Pareba vesta anamola* (Lepidoptera: Nymphalidae) and black fungus beetle, *Alphitobius piceus* Olivier (Coleoptera: Tenebrionidae).

Survey and surveillance of insect pest of ramie

The occurrence and seasonal incidence of important insect pest of ramie was recorded at RRS, Sorbhog throughout the year (Table 6.5). Among the insect pests *viz.,* Indian red admiral caterpillar, leaf beetle, leaf eating caterpillar, yellow coaster butterfly, leaf folder, black fungus beetle and termites have been observed as most important insect pest of ramie crop.

Table 6.5: Seasonal occurrence, incidence of ramie insect pest at RRS, Sorbhog

Insect Pest	Scientific Name	Period of occurrence	Damage (%)	Temp. (°C)
Indian red admiral caterpillar	*Vanessa indica* Herbst	Nov - Feb	2 - 8	10.0-25.0
Leaf folder	Not identified	Throughout the year	5 – 25	20.0-32.0
Yellow coaster butterfly	*Pareba vesta anamola*	Mar-Apr	2-10	16.0-30.0
Hairy caterpillar	*Spilosoma obliqua* Walker	Apr - May	2 - 5	19.0 – 32.0
Leaf beetle	*Pachenephorus bretinghami* Baly	May Aug	5 -30	25.0 -32.0
Termite	Not identified yet	Apr-Aug	5- 50	20.0-30.0

Screening of ramie germplasm against red admiral caterpillar

Observation on seasonal incidence of Indian red admiral caterpillar was recorded on 7 elite germplasm of ramie during 2nd week of December and January. The incidence of Indian red admiral caterpillar was highest in the month of January when the temperature was low i.e. 10^0 C. The incidence was in the range of 0.38% (R1416) to 3.75% (R67-34) in the month of December and 1.07% (R1416) to 6.62% (R67-34) in the month of January (Table 6.6). Among all the seven elite germplasm, R67-34 was most susceptible whereas R1414 (3.75%) was moderately susceptible *(Source: RB 1.0. Contributors: A.K. Sharma and S.P. Gawande.)*

Table 6.6: Infestation of Indian red admiral caterpillar in elite ramie germplasm

Germplasm	Plant infestation (%)	
	2nd week of Dec	2nd week of Jan
	Mean	Mean
R-1414	1.64 (7.31)*	3.74 (10.77)
R-1415	1.05 (5.84)*	2.62 (9.29)
R-1416	0.38 (3.52)*	1.07 (5.93)
R-1418	0.72 (4.83)*	1.85 (7.81)
R-52	1.11 (6.03)*	1.55 (7.10)
R-6734	3.12 (10.15)*	6.62 (14.86)
R-1411	0.57 (4.30)*	1.57 (7.183)
$CD_{(P=0.05)}$	1.294	2.59

**Figures in the parenthesis are arc-sine transformed values

6.1.2. Disease Management

6.1.2.1. Jute

Effect of fertilizers on the incidence of stem rot in jute

The effect of different doses of NPK fertilizers on the incidence of stem rot caused by *Macrophomina phaseolina* in jute (cv. JRO 8432) was studied under field conditions. The treatments comprised of different doses of NPK @ 40:30:30, 60:30:30, 80:30:30, 100:30:30, 120:30:30, 80:40:40 and 120:40:40 kg/ha. Application of high doses of nitrogenous fertilizer enhanced stem rot incidence. But higher doses of phosphatic and potassic fertilizers reduced the disease incidence. The highest incidence of stem rot (49.41%) was recorded in N: P: K @ 120:30:30 kg/ha, followed by 120:40:40 (42.64%), 100:30:30 (34.55%) and 80:30:30 (32.47%). The lowest incidence of 12.29% was noticed in check plot where no fertilizer was applied. With same nitrogen levels in the treatments N: P: K @ 120:30:30 and 120:40:40, higher P and K moderated the stem rot incidence (Fig 6.9) *(Source: JM 8.0. Contributors: R.K. De, C. Biswas and S.K. Sarkar).*

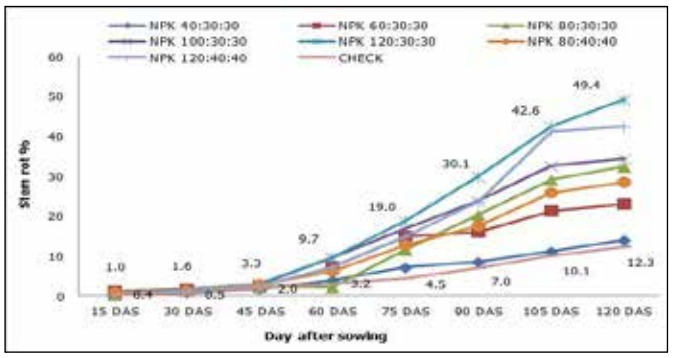


Fig. 6.9: Effect of NPK fertilizers on the incidence of stem rot of jute

Alternatives to conventional fungicides for managing jute stem rot

In order to find out alternatives to the conventional fungicides for the management of jute stem rot disease a field experiment was conducted on a susceptible variety, JRO 8432 to determine the efficacy of thiophanate methyl 70 WP, mancozeb 75 WP, tricyclazole 75 WP, tebuconazole 25.9 EC, hexaconazole 5 EC, copper oxychloride 50 WP and carbendazim 50 WP. The fungicides were applied as seed treatment followed by a foliar spraying at 45 DAS. Among the selected fungicides, carbendazim 50 WP and tebuconazole 25.9 EC were most effective with stem rot incidence of 30.68% as compared to 41.25% in untreated check. Tricyclazole 75 WP and hexaconazole 5 EC were also effective with incidence of 32%, whereas, thiophanate methyl 70 WP was least effective showing 40.58% stem rot incidence at 105 DAS (Table 6.7) *(Source: JM 8.0. Contributors: R.K. De, C. Biswas and S.K. Sarkar).*

Table 6. 7: Effect of different fungicides on the incidence of stem rot in jute

Treatments*	Mean stem rot (%)**				
	30 DAS	45 DAS	60 DAS	90 DAS	105 DAS
Thiophanate methyl 70 WP	0.34 (3.28)	1.63 (7.22)	3.50 (10.72)	16.56 (18.30)	40.58 (23.83)
Mancozeb 75 WP	0.25 (2.23)	3.76 (10.27)	8.11 (16.12)	23.59 (19.48)	38.08 (28.78)
Tricyclazole 75 WP	0.54 (3.88)	1.92 (7.33)	4.97 (11.57)	17.76 (15.45)	32.69 (24.92)
Tebuconazole 25.9 EC	0.57 (4.15)	2.02 (8.05)	4.66 (12.43)	17.40 (19.07)	30.31 (24.63)
Hexaconazole 5 EC	0.18 (1.94)	1.95 (7.86)	3.97 (11.19)	17.99 (20.81)	32.65 (25.10)
Copper oxychloride 50 WP	0.31 (2.59)	1.57 (7.20)	5.37 (13.39)	16.57 (18.79)	35.38 (23.92)
Carbendazim 50 WP	0.63 (4.39)	1.87 (7.610	3.89 (11.30)	14.20 (17.59)	30.68 (22.06)
Control	1.62 (7.07)	1.73 (7.41)	5.03 (12.83)	20.75 (18.06)	41.25 (27.03)
SEm±	1.53	2.13	2.55	2.80	2.69
$CD_{(P=0.05)}$	3.22	4.47	5.37	5.89	5.66

*Two applications: (1) seed treatment (0.1 % each) and (2) one foliar spraying (0.1%) at 30 DAS. **Figures in the parentheses represent arc-sin transformed values

Effect of propiconazole and tricyclazole on *Macrophomina phaseolina in vitro*

The efficacy of propiconazole 25 EC and tricyclazole 75 WP against *M. phaseolina* was tested *in vitro* using standard poison food technique with doses ranging from 0 to 1000 µg/ml. Propiconazole 25 EC was effective in reducing growth of *M. phaseolina*. Complete inhibition of growth was observed at concentration of 1 ppm onwards (Fig. 6.10 a & b). Tricyclazole 75 WP at 5 µg/ml inhibited growth of *M. phaseolina* by 50% only. Growth was checked completely at high concentration of 10000 µg/ml (Fig. 6. 11 a & b).

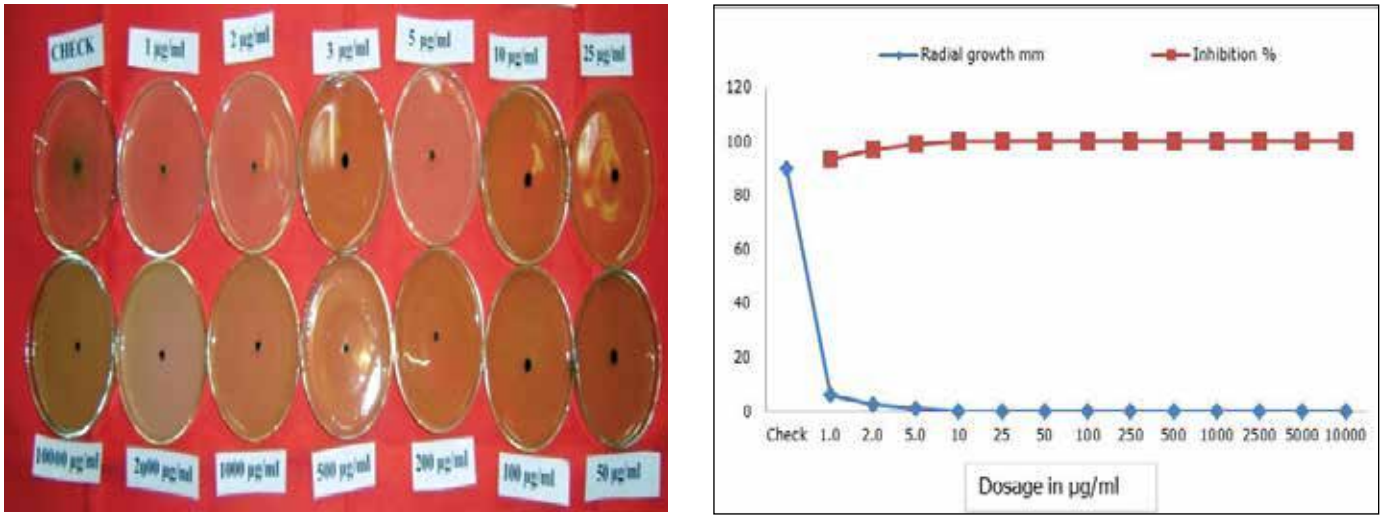


Fig. 6.10 a & b: Effect of propiconazole on *M. phaseolina in vitro*

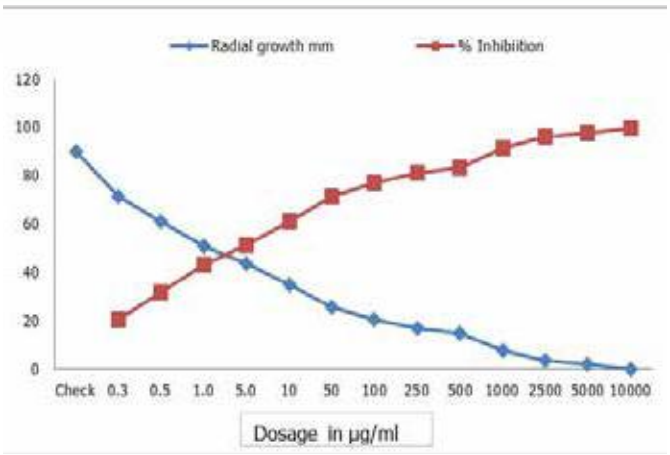
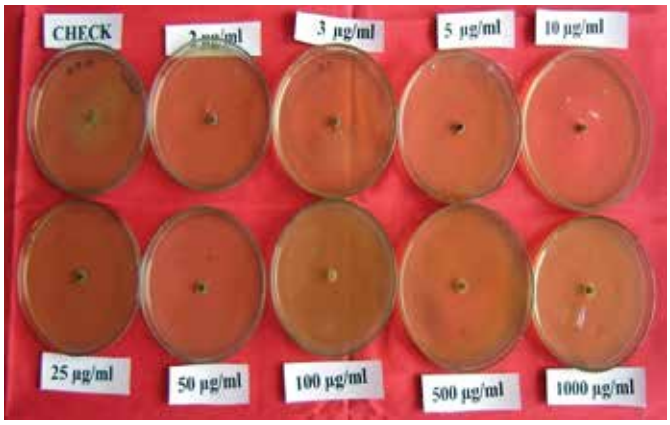


Fig. 6.11 a& b: Effect of tricyclazole on *M. phaseolina in vitro*

Effect of turmeric oil and curcumin mixture on *M. phaseolina in vitro*

Turmeric oil and curcumin mixture were tested *in vitro* using standard poison food technique with doses from 0 to 10000 µg/ml. Complete growth inhibition of the test fungus was observed with turmeric oil (10 µg/ml or above) (Fig. 6.12 a & b) and curcumin mixture (100 µg/ml or above) (Fig. 6.13 a & b) *(Source: JM 8.0. Contributors: R.K. De, C. Biswas and S.K. Sarkar).*



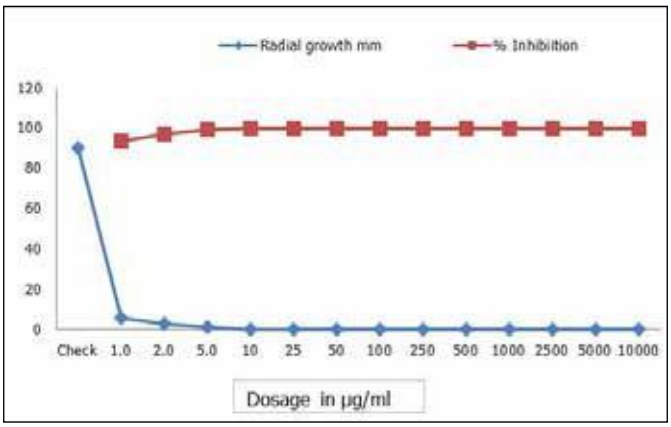
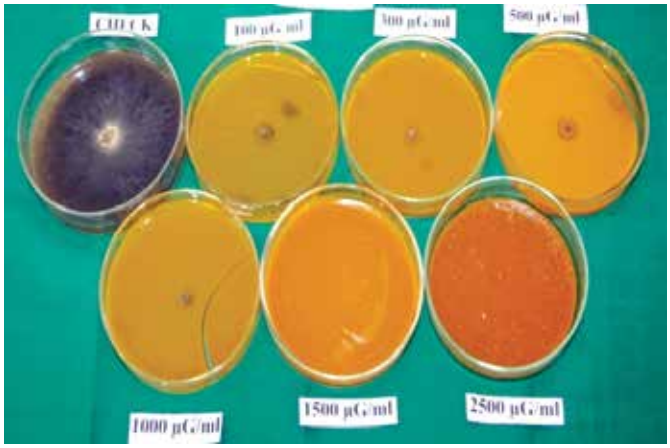


Fig.6.12 a & b: Effect of turmeric oil on *M. phaseolina in vitro*



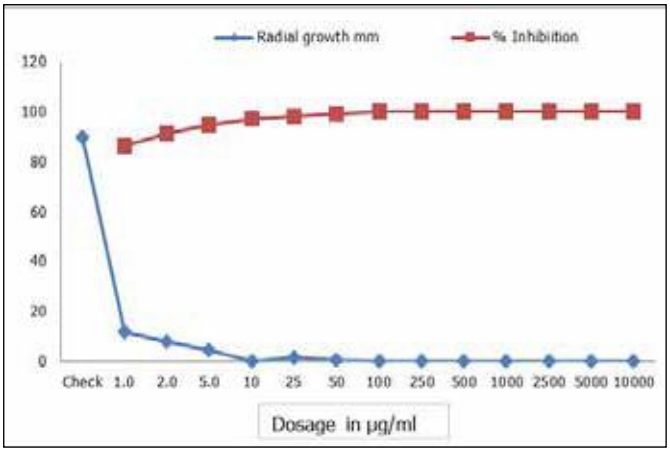


Fig. 6.13 a&b: Effect of curcumin mixture on *M. phaseolina in vitro*

Variability of *M. phaseolina* infecting jute

Five isolates of *M. phaseolina* were purified from diseased (jute stem rot) samples collected from five different places namely Barrackpore, Goaldah, Budbud, Bahraich and Bankura. These five isolates were inoculated through pot soils on two susceptible varieties of *Corchorus olitorius* (cv. JRO 8432) and *C. capsularis* (cv. JRC 412) and pathogenicity was tested. All the isolates were pathogenic and produced typical symptoms of jute stem rot and seedling blight. The isolates were re-isolated. Variation in growth pattern and colony characters of isolates of *M. phaseolina* was observed in potato dextrose agar medium (Fig. 6.14) *(Source: JM 8.3. Contributors: R.K. De and A.N. Tripathi).*

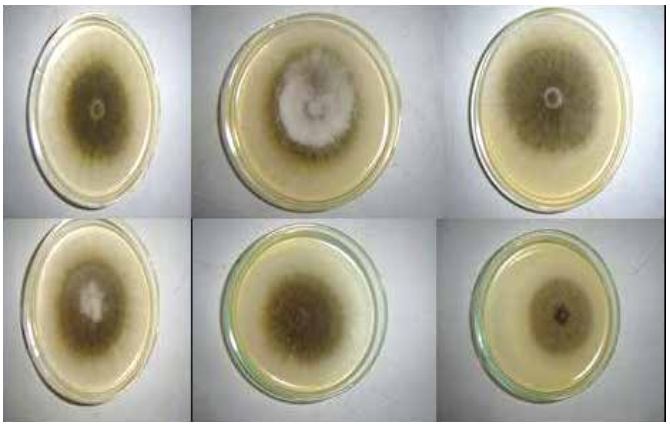


Fig. 6.14: Variation in growth pattern and colony characters of isolates of *M. phaseolina*

Designing and synthesis of *Beauveria bassiana*-specific EST primers

Four pairs of EST primers *viz*. CBB1F/R, CBB2F/R (coffee berry borer gene specific), HST1 F/R, HST2 F/R (heat stress tolerant gene specific) were designed and synthesized for specific detection of *B. bassiana*. For this mRNA was extracted from mycelial mat of different *B. bassiana* strains viz. ITCC 4796, 6063, 4512, 4644, 4925, 5408, 4705, 4563 and 5562 using RN easy mini kit (Qiagen). Three *B. bassiana*-specific SCAR primers *viz.* SCA14, SCA15 and SCB9 were used separately for cDNA synthesis. cDNA synthesis protocol was standardized**.** SCA15 showed successful amplification. However, no cDNA was developed with SCA14 and SCB9 primers. ITCC 4796, 6063, 4512, 4644, 4925 generated 410 bp amplicon, and ITCC 5408, 4705, 4563, 5562 generated 541 bp amplicon (Fig. 6.15).

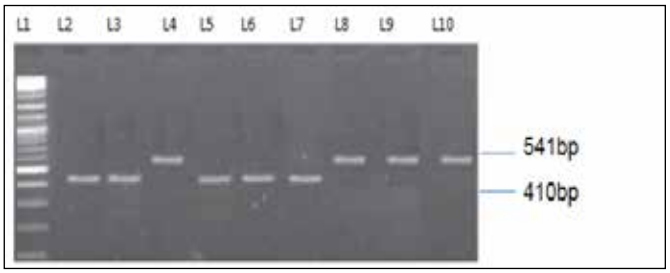


Fig. 6.15: Differential display reverse transcriptase PCR showed two different groups among nine *B. bassiana* strains, L1: ladder 100bp; L2: ITCC 4697, L3: ITCC 6063, L4:ITCC 5408, L5:ITCC 4644, L6: ITCC 4925, L7:ITCC 4512, L8:ITCC 4705, L9:ITCC 4563, L10:ITCC 5562

All the nine cDNA samples were sequenced. ITCC 4796, 6063, 4512, 4644, 4925 samples showed 100% identity with one another and ITCC 5408, 4705, 4563, 5562 showed 100% identity with each other and formed two different clusters. BLASTn analysis revealed that ITCC 4796, 6063, 4512, 4644 and 4925 had 100% identity with gene involved in the infection of coffee berry borer *Hypothenemus hampei* (Ferrai) by *B. bassiana* (Acc. No. GT 896079) and ITCC 5408, 4705, 4563, 5562 had 100% identity with heat stress tolerant gene (Acc.no HS040367). Four pairs of EST primers viz. CBB1F/R, CBB2F/R (coffee berry borer gene specific), HST1 F/R, HST2 F/R (heat stress tolerant gene specific) were designed from both clusters by using NCBI Primer BLAST software. Then eight new strains viz. ITCC 6551, 6645, 5409, 6869, 6726, 4668, 6552 and 6892 were used for testing the efficiency of designed EST primers. ITCC 6551, 6645, 5409, 6726, 4668 and 6869 strains of *B. bassiana* were amplified by using CBB1F/R and CBB2F/R primers (Fig. 6.16).

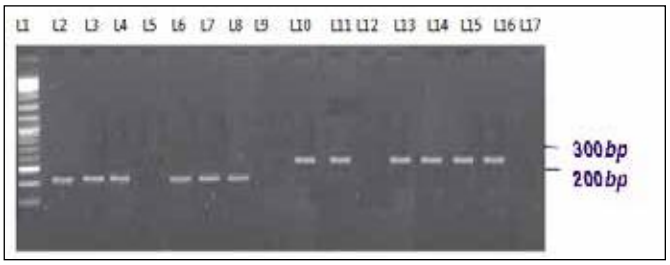


Fig. 6.16: Amplification of EST primers CBB1 and CBB2 by new sets of *B. bassiana* strains, L1: 100bp ladder, L2: ITCC 6551, L3: ITCC 6645, L4: ITCC 5409, L5: ITCC 6552, L7: ITCC 6869, L8: ITCC 6726, L9: ITCC 4668, L10:ITCC 4668, L11: ITCC 6551, L12: ITCC 6552, L13: ITCC 6869, L14: ITCC 4645, L15: ITCC 5409, L16: ITCC 6726, L17: ITCC 6892.

ITCC 4668, 6552, 6869 and 6892 were amplified by using HST1 F/R and HST2 F/R primer pairs (Fig. 6.17). ITCC 6869 and 4668 were amplified by using all the four primer pairs viz., CBB1F/R , CBB2F/R , HST1 F/R and HST2 F/R.

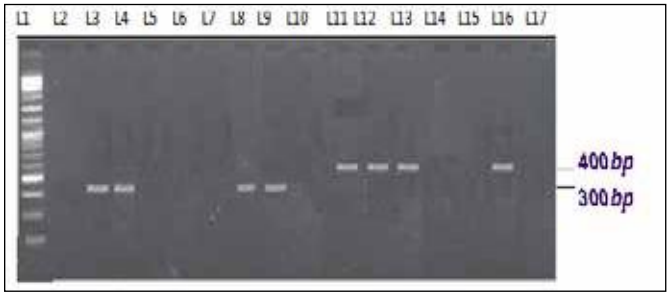


Fig. 6.17: Amplification of EST primers HST1 and HST2 by new sets of *B. bassiana* strains, L1: 100bp ladder, L2: ITCC 6551, L3: ITCC 4668, L4: ITCC 6552, L5: ITCC 6645, L6: ITCC 5409, L7: ITCC 6726, L8: ITCC 6892, L9: ITCC 6869, L10:ITCC 6551, L11: ITCC 4668, L12:ITCC 6552, L13:ITCC 6869, L14:ITCC 5409, L15:ITCC 6645, L16:ITCC 6892, L16:ITCC 6726.

Effect of endophytic *Beauveria bassiana* on pest and disease incidence in *tossa* jute under field condition

The seeds of *tossa* jute (cv. JRO 204) pre-soaked in conidial suspension of different *B. bassiana* isolates overnight were sown. Infestation of stem weevil and jute semilooper was 8.10% and 51.08% respectively in the control plots. In *B. bassiana* treated plots incidence of both the pests were lower (Table 6.8). The lowest incidence of stem weevil (2.50%) and semilooper (35.33%) was recorded in ITCC 6063 treated plot. Although as compared to the control the incidence of stem rot was lower in case of some *B. bassiana* isolates the results were not significant *(Source: JM 8.1. Contributors: C. Biswas, B.S. Gotyal and S. Satpathy).*

Effect of chemical elicitors on incidence of pests and diseases in jute

Seeds of JRO 8432 were treated with different chemical elicitors *viz*. chitosan @ 5.0%, salicylic acid @ 1.0 mM, indole acetic acid (IAA) @ 1.0 mM; beta amino butyric acid (BABA) @ 5 mM, di-potassium hydrogen phosphate (K_2HPO_4) @ 50 mM, calcium chloride ($CaCl_2$) @ 25mM and carbendazim @ 0.1% for 15 minutes. Foliar application of the above-said chemicals was made at 30 days after sowing. The effect of the treatments on infestation of stem weevil and semilooper was non-significant. Numerically least infestation (2.54%) of stem weevil and semilooper (38.75%) was recorded in salicylic acid treatment. Carbendazim, bêta amino butyric acid (BABA), salicylic acid and calcium chloride significantly reduced stem rot incidence to 1.73, 2.76, 3.39 and 4.35% respectively compared to 9.64% disease incidence in control (Table 6. 9).

Table 6.8: Effect of different *B. bassiana* isolates on incidence of jute pests under field condition

Treatment	Stem weevil infestation (%)	Semilooper infestation (%)	Stem rot incidence (%)
ITCC 4512	3.96	37.55	7.50
ITCC 4563	4.55	46.74	10.66
ITCC 5562	4.91	38.56	9.54
ITCC 6063	2.50	35.33	8.58
ITCC 4796	4.39	41.75	10.12
ITCC 5408	3.76	30.17	11.16
ITCC 4705	5.38	39.64	8.09
Control	8.10	51.08	9.45
$CD_{(P=0.05)}$	2.27	7.45	NS

Effect of chemical elicitors on enzymatic activity in treated jute plants

Jute seedlings on pot culture were sprayed with different chemical elicitors *viz*. chitosan @ 5.0%, salicylic acid @ 1.0 mM, indole acetic acid (IAA) @ 1.0 mM; beta amino butyric acid (BABA) @ 5 mM , di-potassium hydrogen phosphate (K_2HPO_4) @ 50 mM, calcium chloride ($CaCl_2$) @ 25 mM and carbendazim @ 0.1%. Three days after treatment, the activity of different enzymes *viz.*, polyphenol oxidase (PPO), L - phenyl alanine ammonia-lyase (PAL) and peroxidase were studied. The activity of PPO (µmoles/min/mg protein) was enhanced by all the treatments (Fig. 6.18). The high PPO activity was recorded in calcium chloride, carbendazim, IAA and chitosan treated plants. PAL activity (µmoles/min/mg protein) was increased by chitosan, carbendazim, BABA and IAA. Carbendazim, di-potasium-hydrogen phosphate, IAA and salicylic acid enhanced peroxidase

(µmoles/min/mg protein) activity (Fig. 6.19) *(Source: JM 8.2. Contributors: C. Biswas, B.S. Gotyal, S.K. Sarkar and H. Chowdhury).*

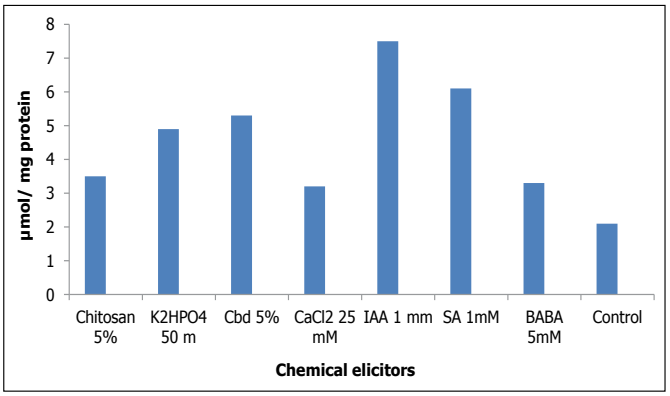


Fig. 6.18: Enhancement of L-phenylalanine ammonia-lyase activity by chemical elicitors

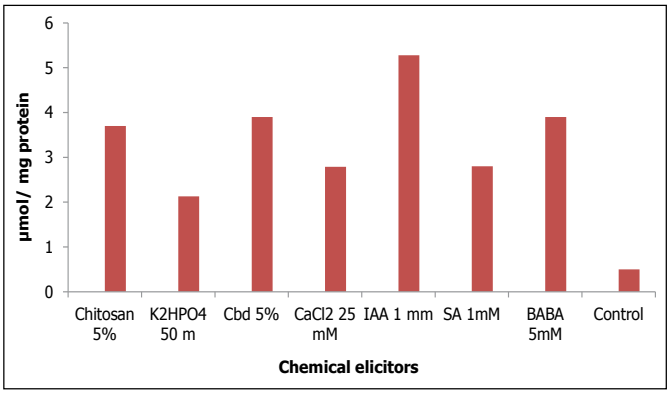


Fig.6.19: Enhancement of peroxidase activity by chemical elicitors

Effect of plant essential oils on *M. phaseolina* under *in vitro*

Bioassay of the chemicals against jute stem rot pathogen *M. phaseolina* was conducted under laboratory condition. Among the oils, turmeric oil recorded highest radial growth inhibition against *M. phaseolina* in poison food technique (PDA media). At 50 ppm dose it recorded about 40% growth inhibition of the fungus after 3 days of treatment. At higher dose of 100 ppm, both turmeric oil and citronella oil recorded similar growth inhibition (>50%) of the fungus whereas, mentha oil recorded only 20% growth inhibition (Fig. 6.20). LC_{50} values of the oils were recorded as 0.011%, 0.013%, 0.018% and 0.022% for turmeric oil, citronella oil, mentha oil and Lippia oil, respectively (Table 6.10) *(Source: JC 6.4. Contributors: H. Chowdhury, S.K. Sarkar, R.K. De and K. Selvaraj).*

Table 6.9: Effect of different chemical elicitors on incidence of jute pests under field condition

Treatment	Stem weevil infestation (%)	Jute semilooper infestation (%)	Stem rot incidence (%)
Chitosan @5%	3.18	44.26	6.56
Salicylic acid @ 1.0 mM	2.54	38.75	3.39
BABA @5 mM	3.32	44.47	2.76
IAA @1.0 mM	3.09	45.31	7.31
$CaCl_2$ @25 mM	2.96	40.41	4.35
K_2HPO_4 @50 mM	3.29	45.95	7.36
Carbendazim @ 0.1%	3.40	48.02	1.73
Control	3.96	49.64	9.64
$CD_{(P=0.05)}$	NS	NS	1.57

Table 6.10: Calculated LC_{50} and LC_{25} values of the essential oils against *M. phaseolina*

Plant oil	LC_{50} value (%)	Fiducial limit (%)		LC_{25} value (%)	Fiducial limit (%)	
		Lower	Upper		Lower	Upper
Citronel-la oil	0.013	0.012	0.014	0.009	0.008	0.009
Lippia oil	0.022	0.018	0.026	0.015	0.012	0.018
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

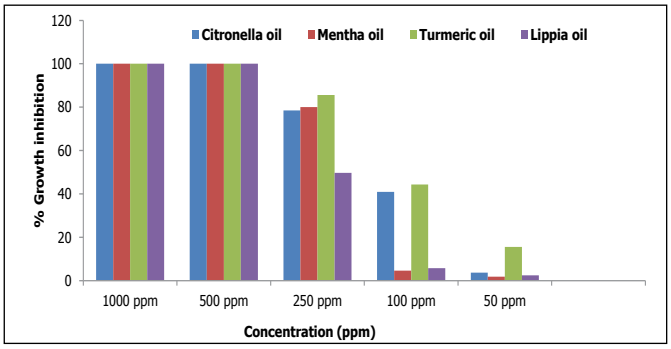


Fig. 6.20: Growth inhibition of *M. phaseolina* by the plant essential oils

6.1.2.2. Mesta

Effect of foliar spraying of biopesticides and insecticides on yellow vein mosaic disease in kenaf (*Hibiscus cannabinus*) variety HC 583

Various treatments comprised of foliar spraying of insecticides, like, thiamethoxam 25 WG (0.1 gm/lit) and imidacloprid 200 SL (0.25 ml/lit) and biopesticides, like, leaf extract of ramie (6 ml/lit), sisal (6 ml/lit), *Mirabilis jalapa* (6 ml/lit), neem (6 ml/lit) and bulb extract of garlic (6 ml/lit) on yellow vein mosaic disease of mesta. It was observed that foliar spraying of imidacloprid was most effective in reducing the MYMV followed by thiamethoxam. In case of imidacloprid, 73.8% MYMV was observed with 26.1% reduction over check and in thiamethoxam spraying, 77.3% MYMV was noticed with 22.7% reduction over check (Table 6.11). Among biopesticides, leaf extracts of neem and bulb extract of garlic decreased MYMV to 81.1 and 87.3% incidence and by 18.8 and 12.6% over check, respectively. Sisal leaf extract also reduced MYMV incidence by 15.1% in HC 583 over untreated check. Foliar spraying of leaf extracts of *Mirabilis jalapa* reduced incidence of MYMV by 10.6% over check *(Source: TMJ MM 1.6. Contributor: R.K. De).*

Table 6.11. Effect of foliar spraying of biopesticides and insecticides on yellow vein mosaic disease in kenaf (*H. cannabinus*) variety HC 583

Treatments	Dosage (ml/l)	Incidence of MYMV	Reduction over check (%)
Leaf extract of ramie	6.0	82.12	17.88
Leaf extract of sisal	6.0	84.84	15.16
Leaf extract of *Mirabilis jalapa*	6.0	89.31	10.69
Thiamethoxam	0.1 g	77.30	22.7
Imidacloprid	0.25	73.83	26.17
Leaf extract of neem	6.0	81.13	18.87
Extract of garlic	6.0	87.36	12.64
Check	-	100.00	-
SEm±	-	2.34	-
$CD_{(P=0.05)}$	-	6.51	-

6.1.2.3. Ramie

Survey on major diseases of ramie and screening of elite germplasm

Observation on occurrence and seasonal incidence of important diseases of ramie was carried out during 2012-13 at RRS, Sorbhog throughout the year (Table 6.12). The diseases such as *Cercospora* leaf spot, anthracnose leaf spot, *Sclerotium* rot, damping off and yellow mosaic were found to be the prominent diseases of ramie crop in the North Eastern conditions *(Source: RB Expl. 1 Contributor: S.P. Gawande).*

Table 6.12: Seasonal occurrence, incidence and epidemiology of diseases of ramie

Disease	Causal organism	Period of occurrence	Incidence (%)	Temp. (°C)
Cere-cospora leaf spot	*Cercospora boehremia*	Mar-Oct	5-30	20.0– 28.0
Anthrac-nose leaf spot	*Colle-totrichum gleosporides*	Nov- Mar	10 -60	12.0 – 26.0
Collar rot	*Sclerotium rolfsii*	Apr- Oct	5-20	22.0-27.0
Wilt	*Complex disease*	Apr-Jun	15-70	21.0 – 32.0
Damping off of seedling	*Rhizoctonia* spp.	Throughout year (seed nursery)	5- 20	20.0 -32.0
Yellow Mosaic	Virus	Oct-Mar	30-70	15.0-28.0
Cane rot	*Rhizoctonia bataticola*	Oct-Jan	10-100	10.0-25.0

Efficacy of different fungicides against foliar diseases of ramie

A field experiment was conducted to test the efficacy of 6 fungicides *viz.*, carbendazim 50 WP, mancozeb 75 WP, propiconazole 25 EC, difenoconazole 25 EC, carbendazim 12%+mancozeb (63%) 75 WP, and copper oxychloride against *Cercospora* and anthracnose leaf spot diseases in

ramie. Among all six fungicides tested, the similar trend was observed in first and second cutting taken in different seasons. In second cutting taken during December, the incidence of both *Cercospora* and anthracnose leaf spot was observed. Foliar application of propiconazole (3.27%) followed by difenoconazole (4.17%) were found effective over control (16.7%) in management of *Cercospora* leaf spot (Table 6.13). In case of anthracnose leaf spot, similar trend was observed. Application of fungicides also caused significant increase in strip weight, plant height, green weight and ultimately the fibre yield (Table 6.13) *(Source: RB Expl.-1. Contributor: S.P. Gawande).*

Table 6.13: Efficacy of different fungicides against foliar diseases and effect on growth parameters of ramie

Treatment	Incidence cercospora leaf spot (%)	Incidence Anthrac-nose leaf spot (%)	Green weight (Kg)	Strip weight (Kg)	Plant height (cm)	Dry fibre weight (q/ha.)
Carbendazim@ 0.25%	9.87 (18.27)*	5.50 (13.46)*	37.00	16.00	93.33	3.557
Mancozeb@ 0.25%	7.59 (15.81)*	4.73 (12.54)*	41.17	18.67	95.0 0	3.947
Propiconazole@ 0.1%	3.27 (10.40)*	2.51 (9.05) *	47.00	26.33	107.5	4.507
Difenconazole@ 0.1%	4.17 (11.78)*	4.24 (11.76) *	45.00	23.16	105.0	4.24
carbendazim 12%+mancozeb (63%) 75 WP@ 0.25%	7.44 (15.81)*	5.42 (13.40) *	36.00	18.33	88.33	3.337
COC @ 0.25%	11.05 (19.33)*	7.21 (15.39) *	32.67	17.66	88.33	3.143
Control	16.71 (24.12)*	11.21 (19.50) *	30.00	16.50	85.33	3.08
CD $_{(P=0.05)}$	2.667	3.435	4.402	3.089	14.503	0.509

*Figures in the parentheses represent arc-sine transformed values.

6.1.2.4. Sisal

Incidence of zebra disease and screening of sisal germplasm

Observations on incidence of zebra disease of sisal in 19 villages of Jharsugura, Sambalpur and Sundargarh district of Odisha were recorded following 0-5 rating scale and PDI was calculated. Disease incidence of 13.7 to 26.2% in *Agave sisalana* and 22.8 to 45.2% in Bamra Hybrid-1 were recorded. Out of 11 spp. tested under natural epiphytotic condition, two spp. (*A. cantala* and *A. ameniensis*) showed resistant reaction and three spp. (*A. miradorensis, A. aungustifolia, A. americana*) showed moderately resistant reaction and rest 6 spp. showed susceptible and highly susceptible reaction. Out of 58 germplasm tested under natural epiphytotic condition, 29 germplasm showed resistant reaction, 14 germplasm showed moderately resistant reaction and 15 germplasm showed susceptible to highly susceptible reaction *(Source: SLM 1.0 & 1.1. Contributors: A.K. Jha and R.K. De).*

6.1.4. Weed Management

6.1.4.1 Jute

Integrated weed management of jute with special reference to smother crops

Integrated approaches using interventions like smother /intercrops, mechanical weeding by CRIJAF-nail weeder, non-selective herbicide application mechanically by CRIJAF herbicide applicator, new herbicide molecules and hand weeding were evaluated to reduce the cost of weeding and enhance the fibre productivity in a sustainable manner (Table 6.14). The experiment was

conducted with twelve treatments with combination of different weed control tactics. Jute crop (cv. JRO 204) was harvested at 120 days after sowing. Pulse crops of small and bold grain varieties resistant to MYMV (mung bean yellow mosaic virus) were harvested at 55-90 DAS. Green gram cultivars (e.g., Pant moong 4, Pant moong 5, Local mung and RMG-62) was found as effective smother crops (Fig 6.21a) in between jute rows (1:1, 30-35 cm spacing) and yielded 24-27.3 q fibre/ha with 7-8.75 q green gram/ha (Table 6.15: Fig. 6.21b).

Table 6.14: Details about the treatment for weed management

Treatment	Ratio	Spacing (R to R) (cm)
Jute + green gram (cv.Pant mung 4 + Butachlor @1kg +1HW*	1:1	30
Jute + Pant mung 5+ Butachlor @1kg +1HW	1:1	35
Jute + Mug local+ Butachlor @1kg +1HW;	1:1	30
Jute + Pant mung 5 + Butachlor @1kg	1:1	35
Herbicide brush (Glyphosate 1.23 kg)+1HW	sole	25
Jute+ RMG-62 (Quizalofop ethyl 45 g +1HW	1:1	30
Nail weeder twice +1HW	Sole	25
Open furrow sowing + Butachlor@1kg +1HW	Sole	25
Butachlor 1kg+Glyphosate 0.8 kg +1HW	Sole	25
Two hand weeding	Sole	25
Jute + Okra (cv. Shakti) +2HW and four irrigations	2:1	25
Control	Sole	25

*HW: Hand weeding

The jute fibre equivalent yield ranged from 42-47 q/ha which was very much higher over manual weeding twice (32.56 q/ha) using only one post sowing irrigation under 33% deficit rainfall. Sowing in open furrow in ridge furrows system reduced the irrigation requirement and weed population up to 50% and yielded 30.79 q fibre/ha (Fig. 6.21c). Use of nail weeder followed by one hand weeding effectively controlled weeds in jute and yielded 33.55 q fibre/ha. In broadcast jute, synchronous line arrangement, weeding and thinning was possible using CRIJAF-nail weeder (5-21 DAS) and herbicide applicator (Fig. 6.21d). With four irrigation jute and okra intercropping (2:1) yielded 60 q/ha tender okra and 42 q fibre/ha and a fibre equivalent yield of 72 q/ha (Fig 6.21e). In line sown jute, application of butachlor @1kg/ha (pre-emergence) and glyphosate @ 0.8 kg/ha (20 DAS) effectively controlled composite weed flora including *Trainthema* spp. (Fig. 6.21f). Quizalofop ethyl 10 EC (38 g/ha) and propaquizafop 10 EC (120 g/ha) were found promising grass weed killer in jute. Pretilachlor 50 EC @ 0.9 kg/ha controlled wide range of weeds in jute *(Source: JA 5.3 Contributors: A.K. Ghorai, M. Kumar, B. Majumdar, H. Chowdhury and D.K. Kundu).*

Fig. 6.21a: Weed suppression in jute by pulses by intercrops

Fig. 6.21b: Intercropping of jute with mung

Fig. 6.21c: Scanty weeds in jute crop essential by open furrow sowing in ridge and furrow method

Fig. 6.21d: Simultaneous weeding, thinning and line arrangement in broad cast jute by CRIJAF - Nail weeder

Table 6.15: Jute fibre yield under different weed control treatments

Treatment	Fibre yield & equivalent fibre yield (q/ha)	Pulse yield (kg/ha)	Rice (cv. Satabdi) yield (q/ha, dry transplanted)
Jute + PM-4 + Butachlor @1kg +1HW (30 cm)	27.39 (46.6)	770	38.72
Jute + PM-5 + Butachlor @1kg +1HW (35 cm)	23.95 (40.0)	812	38.88
Jute + Mung local + Butachlor @1kg +1HW (30 cm)	25.24 (46.2)	700	39.50
Jute + PM-5 +Butachlor @1kg + 1HW (35 cm)	25.27 (46)	875	40.09
Jute+RMG-62, Butachlor @1kg +1HW (25cm)	24.6 (42.3)	739	33.20
Nail weeder twice +1HW (25 cm)	33.5	--	39.46
Open furrow sowing + Butachlor @1kg +1HW (25cm)	30.79	--	35.46
Butachlor @1kg +Glyphosate 0.8 kg SL+1HW (25 cm)	37.35	--	41.51
Two hand weeding (25 cm)	32.56	--	40.65
Jute+ Okra (cv. Shakti) +2HW	42.0 (72)	6000	38.17
Control (25 cm)	16.68	---	36.85
SEm±	1.33	---	2.55
CD $_{(P=0.05)}$	3.93	---	NS

*HW: Hand weeding

Jute fibre equivalent yield: Jute Fibre Rs.2000/q, Pulse: Rs 35/kg (MSP), Rs 45/kg (small grain).

6.1.4.2. Ramie

Mechano-chemical weed management in ramie

Mechano-chemical technique for the effective and less expensive weed management in ramie crop even during rainy season was developed at RRS, Sorbhog, Assam. Use of tractor - drawn weeder for weed and crop residue removal in the inter - row space either for growing crop or after harvesting followed by spraying of 0.125 to 0.25% paraquat (non-selective herbicide) for annual weeds in newly planted crop (<one year old) or 0.125 to 0.25 % glyphosate (non-selective herbicide) for perennial

Fig.6.21e: JRO-204 + Okra (Cv. Shakti) (2:1)

Fig. 6.21f: Composite weed control including *Trianthema* spp by Glyphosate 41 SL at 25 DAE

weeds (*Saccharum* type) using tractor mounted sprayer. Depending upon nature and population of weeds, the herbicide dose (paraquat and glyphosate) varied from 0.125 to 0.25%. Incorporation of weed and crop residues in the field itself maintains the fertility of the soil.

6.2. Abiotic Stresses

Drought management of jute and mesta under deficit rainfall condition

Validation of observed drought management strategies were carried out both at experimental fields i.e. CRIJAF, Barrackpore; ARS, Amadalavalasa, Andhra Pradesh and in farmers' fields (West Bengal and Andhra Pradesh) to identify suitable agronomic management practices to recover better fibre yield from jute and mesta crop under deficit rainfall situation. In addition to this, efforts were also made to identify suitable insurance crop to mitigate the drought stress. The national jute fibre yield is around 22-23 q/ha and that of mesta is around 11-14 q/ha under rainfed situation. At CRIJAF Research Farm the following observations were obtained under limited irrigation and rainfed condition.

Three promising drought management technologies were validated in selected farmers fields in Beldanga, Murshidabad, and Swarupnagar, 24-Parganas (N) in West Bengal. During the present study period (2012-13) there was severe drought stress across (33% deficit) West Bengal during the entire jute growing season and there was acute shortage of water for jute retting. For weed control, butachlor 5G was used @ 1kg ai/ha as pre-emergence herbicide. Present study on drought management revealed that i) N:P:K::60:30:30 and elemental sulphur @ 30 kg/ha yielded 26 q jute fibre/ha (available sulphur <20 kg/ha) with one post sowing irrigation ii) N:P:K::60:30:30 and one post sowing irrigation yielded only 20-21 q jute fibre/ha iii) N:P:K::80:40:40 with one post-sowing irrigation yielded only 23.37 q jute fibre/ha iv) Green gram (cv. Pant mung 5) cultivation preceding jute (which produced 975 kg pulses ahead of jute and added around 2 tonnes pulse waste/ha) and yielded 25.5 q fibre /ha using N:P:K::60:30:30 and one pre sowing irrigation which may be recomended.

At ARS, ANGRAU, Amadalavalasa effect of treatment was N:P:K::60:30:30 and elemental sulphur @ 30kg/ha yielded 24.6 q mesta fibre/ha in rainfed condition, N:P:K::60:30:30/ha yielded 12.0 q mesta fibre/ha, open furrow sowing with N:P:K::60:30:30 produced 14 q fibre/ha, while under control N:P:K::40:20:20, yield was only 7 q/ha *(Source: MM 1.5. Contributor: A.K. Ghorai)*

Determination of water productivity of tossa jute genotypes under deficit moisture stress condition

Soil moisture characteristics curves (SMCC) (Fig 6.22) were developed for jute growing soils of Barrackpore (silty clay loam), Kendrapara (clay loam) and Bankura (sandy loam for jute seed production) regions. Scrutiny of the SMCCs revealed that moisture retention pattern of

these three types of soils is similar. In general, between 3 and 15 bar, 5% more moisture retention capacity was found in Kendrapara soil than at Barrackpore soil which also retained 5% more moisture than the soil of Bankura. The bulk density measured in the silty clay loam soil of CRIJAF-North Farm during the jute growing period was found between 1.2 Mgm^{-3} and 1.4 Mgm^{-3}. Root zone soil moisture content during early growth period of jute, reduced from 15% to 5% in one month period (from 16th April to 16th May, 2012) which leads to jute plant mortality.

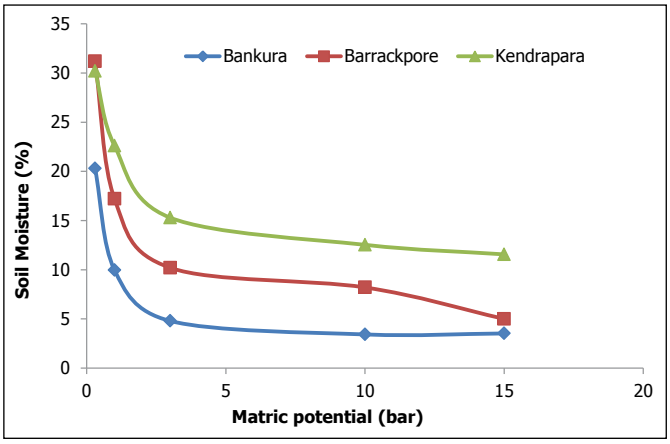


Fig. 6.22: Soil moisture characteristics curves of different types of soils

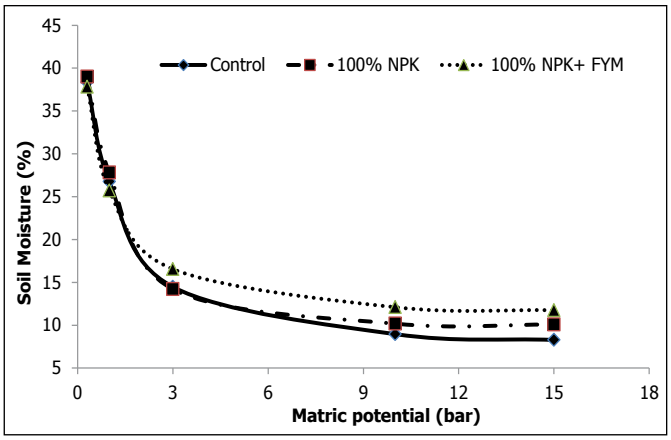


Fig. 6.23: Soil moisture characteristics curve under long term treatment

Comparing this decreasing pattern of root zone soil moisture with SMCC revealed that 5% moisture content retained at 15 bar matric potential which is the temporary wilting point. Therefore, this may be inferred that 15 bar (1500 kPa) matric potential is the temporary wilting point for jute crop in the similar line of most of the agricultural crops.

Scrutiny of Fig 6.23 revealed that at 300 kPa (3bar), 1000 kPa (10bar) and 1500 kPa (15 bar) tension, 100% NPK+FYM treated plot retained 15%, 35% and 42% more moisture than control plot (without NPK+FYM application), respectively *(Source: JC 6.5, Contributors: D. Barman, D.K. Kundu, A.K. Ghorai and S. Mitra).*

7. Farm Mechanization and Post Harvest Technology

7.1. Farm mechanization

7.1.1. Development of power operated jute ribboner

The objective of the project was to design and develop of a power operated machine to extract green ribbon keeping stick of jute plants intact and with capacity equivalent to about 50 kg dry jute fibre per hour. The project was initiated on 20th February, 2009, funded by the Jute Corporation of India under Jute Technology Mission MM-III. A portable, low power and low cost machine suitable for operating in field condition was targeted. The working principle has been envisaged earlier (through testing of developed various experimental set up), i.e. first opening of green ribbon at the tip of jute plant and then pulling of opened ribbon to separate entire stick of the jute plant. The earlier developed experimental model (Fig. 7.1) based on the above mentioned working principle had a mechanism of pulling of green ribbon with the canvass belt conveyor system which failed to pull green ribbon of about 10 jute plants at a time.

Subsequent improvement in the operation of pulling of ribbon with the metallic platform conveyor system (Fig. 7.2) was found to be the proper mechanism for pulling green ribbon without slippage of about 10 jute plants. In this system, specially made metallic platform conveyor was fitted with the two parallel chains and mounted on the sprocket for its movement through motor power. Conveyor platform is made up of metal strips bolted on both sides with the specially made metal cap which mounted on each link of the chain and these metal strips moves freely along with the chain. The ribbon is held rigidly in between the two narrowly spaced metallic platform conveyor and the ribbon moves along with the conveyor without slippage in a given direction with the desired force required for pulling the ribbon. Thus, pulling of ribbon at a uniform speed enables the stick to eject from the jute canes freely. But, the mechanical operation of the metallic platform conveyor was found constrained due to un-proper jointing of metal cap (on which platform metal strips are bolted) with the chain link. Since the metal cap could not be made an integral part of the chain link, its smooth operation was affected considerably.

The merging of separate metal cap with the chain link in-order to make it an integral part of the chain was found to be the essential requirement for elimination of the operational constraint to obtain smooth mechanical operation of metallic platform conveyor. The chain (size, 3/4" pitch) link having horizontal wing on both sides provided with a hole for bolting platform metal strips was designed and fabricated; and found its working on the sprocket driven system satisfactory. Thus the specially made chain (Fig. 7.3) having arrangement for fixing metal strips on it to form metallic conveyor platform was found to be the proper mechanism for obtaining smooth operation of conveyor for the desired pulling and carrying of green ribbon. The design and fabrication work was undertaken to develop a prototype model of Power Operated Jute Ribboner machine (powered by 3 HP motor) consisting improved metallic conveyor system for delivering green ribbon of capacity equivalent to about 50 kg dry jute fibre per hour *(Source: JTMAE 1.0. Contributors: U.N. Borkar and R.K. Naik).*

Fig. 7.1: Jute ribboner

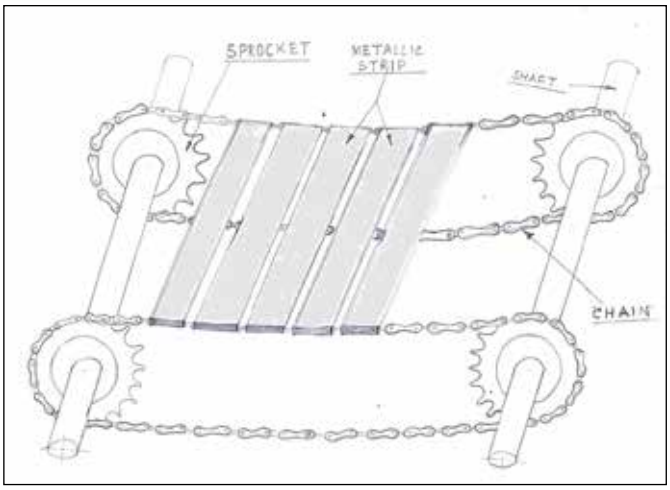


Fig. 7.2 : Schematic diagram of metallic platform conveyor

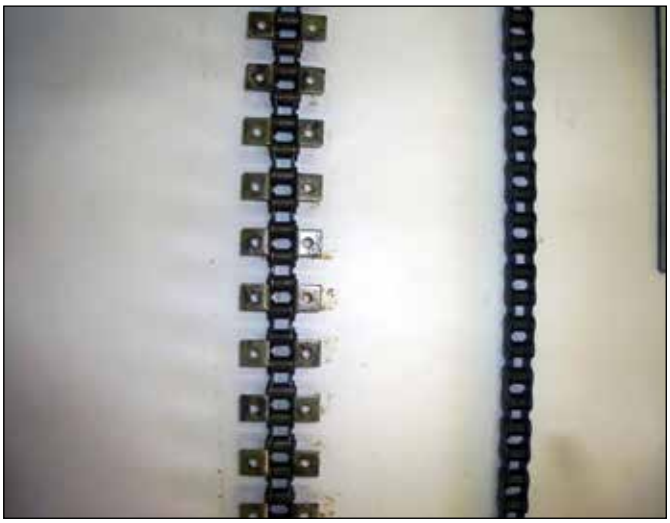


Fig. 7.3 : Chain for conveyor system

7.2. Post Harvest Technology

7.2.1. Improvement of fibre quality through microbial, enzymatic and chemical retting in jute

Seventy large scale retting trials on jute and mesta were carried out using talc-based formulation of microbial consortium in Baharaich district of Uttar Pradesh and Srikakulam district of Andhra Pradesh. The jute retting in Baharaich district was completed in 9 and 15 days respectively with and without microbial formulation in the month of October and the treated fibre had strength of 27.3 g/tex compared to 23.2 g/tex under conventional method. The mesta retting was completed in 13 to 15 days under *in-situ* retting with microbial formulation compared to 25 days required under conventional method of retting, thereby reducing the retting period by 10 to 12 days during the month of November and December (Fig 7.4). The farmers of Srikakulam district got additional price of Rs 4/kg fibre for the improvement in colour, lusture and strength of the treated fibre. A spore suspension of microbial consortium was also developed and the spore form was viable in the range of 6 x 10^7 per gram of powder up to 120 days *(Source: TMJ MM 1.7. Contributors: B. Majumdar, A.R. Saha and H. Chowdhury).*

Fig 7.4: Mesta retting with microbial formulation, extraction and monitoring of fibre in Srikakulam district of Andhra Pradesh

7.2.2. Large scale production of CRIJAF jute retting consortium for demonstration

More than 900 packets of talc-based formulation were prepared and supplied for large scale retting trials in different parts of the country. Two hundred five (205) large scale retting demonstrations with newly developed talc-based formulation were carried out in different jute growing districts viz. Hooghly, Nadia, North 24 Parganas, Malda and Murshidabad of West Bengal (Fig. 7.5 to 7.9). Retting with microbial formulation was completed between 12 to 15 days compared to 18 to 22 days under conventional method in all the districts (Table 7.1). There was improvement in fibre colour, lusture and strength. The fibre strength ranged between 23.1 to 31.6 g/tex in various districts and mean fibre strength for all the district were more than 25.0 g/tex. Farmers got higher price for their quality fibre @ Rs 200 to 300/q extra over traditionally produced fibre *(Source: JCI Project. Contributors: B. Majumdar and S.R. Singh).*

Fig. 7.5: Distribution of CRIJAF microbial formulation for retting to farming community

Fig. 7.6: Application of microbial formulation for retting

Table 7.1: Effect of microbial formulation for retting on retting duration and fibre strength

District & state	No. of demonstrations	Retting duration (days)	Fibre strength (g/tex)	Retting duration under traditional method (days)
Hooghly, West Bengal	44	9-14 (11.6)*	23.1-30.1 (26.2)*	15-19 (18.2)*
North 24 Parganas, West Bengal	79	10-17 (13.4)	23.9-28.8 (25.2)	17-21 (19.5)
Nadia, West Bengal	57	11-19 (14.6)	23.3-31.6 (25.7)	21-23 (22)
Murshidabad, West Bengal	05	13-14 (13.6)	24.0-29.0 (25.4)	16-21 (18.6)
Malda, West Bengal	20	12-14 (12.7)	23.5-26.1 (24.6)	17-22 (19.5)

*Figures in parentheses are means

Fig 7.7: Farmer putting soil filled old cement bags on jute bundles after application of microbial formulation

Fig 7.8: Drying of jute fibre treated with microbial formulation

7.2.3. Improved degumming technology for ramie

Molecular characterization of two pectinolytic alkalophilic bacteria (previously characterized by BIOLOG) was carried out through 16s rDNA sequencing process. Two specific primers, the forward primer 515F, 8F and the reverse primer 1381R, 519R were used to sequence rDNA of the isolates, respectively.

Fig 7.9: Golden coloured fibre obtained with microbial formulation

The degumming efficiency of the consortium made from two alkalophilic isolates was determined at different environmental temperatures under medium (5 kg fibre) and large scale (10-15 kg fibre) degumming trial of freshly decorticated ramie fibre and it was observed that the degumming was completed within 2 to 3 days at 34-39°C (weight loss 22-32% on dry weight basis) while the completion of degumming process took 4 to 5 days when the ambient temperature varied between 27°C and 31°C (weight loss 15.5-21% on dry weight basis). The same degumming liquor could be successfully recycled twice for the next degumming process.

The consortium was formulated with talc powder and the enzymatic study revealed that the pectate lyase activity of the powder formulation was maintained as compared to the strains itself.

Six new neutral pectinolytic strains were isolated from agricultural soil collected from the ramie compost peat of CRIJAF (pectin enriched by papaya) and better pectinolytic activity was observed in two strains *(Source: TMJ MM 1.3. Contributor: S. Mitra).*

8. Jute Informatics

JAF expert, a web-based client-server application was developed by CRIJAF with knowledge related to diagnosis and management of stresses and inputs in jute cultivation (Fig. 8.1). It was developed using ASP .Net as graphic user interface (GUI), C# for programming language and SQL Server as its back-end database management tool (Fig. 8.2). Information was acquired from up-to-date published refereed sources, technical bulletins, manuals for advisers and other workers in jute and from the domain experts of CRIJAF, Barrackpore. 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. In this application object oriented methodology and heuristic method were followed. For diagnosis of different stress factors (weeds, insect-pests, diseases, and drought) rule-based methods were applied. The structure of rules for identifying particular module use textual as well as pictorial formats in the form of conditions. These conditions are connected through the logical operators. The user will be prompted to select the particular module that was fed with related rules corresponding to stress factors.

The system contains two domains, namely, fibre production and seed production. The modules under fibre production domain are land preparation and seed sowing, varietal information, nutrient management, weed management, water management, insect-pest diagnosis and management, disease diagnosis and management, retting, farm machineries and tools, extension programmes, uses of fibre, stick and leaf, fibre quality, expense and income ready-reckoner. Using land preparation and seed sowing module user will get details on soil preparation, ditches, broad-bed and furrow method to overcome waterlogging.

Specific variety search based on sowing time, yield and resistance to pre-mature flowering along with their description would help the user to take right decision. Nutrients are another main part of the crop cultivation. Ready-reckoner on soil test based requirement of N, P and K is provided. Weed management module includes herbarium, identification of weeds and their management in different situations. Water management module contains data on crops under drought and waterlogging situations. Retting module guides the user in jute retting by the use of natural inoculum and talc-based microbial formulation. In former retting process, micro pond preparation, water harvesting, fibre extraction and proper utilization of spaces in and around micro pond are described. Extension module depicts how new technologies are carried to the farmers through extension programmes and how to assess its impact.

In identification phase of weeds, insect-pests and diseases, system generates multiple choice options in textual and pictorial format. Thus the system prompts the user to guided information, based on their selection. This user-system interaction steps are displayed through the 'Question & Answer Session' *(Source: TMJ MM 1.8. Contributor: A.K. Chakraborty).*

Fig. 8.1. Home page of JAF expert

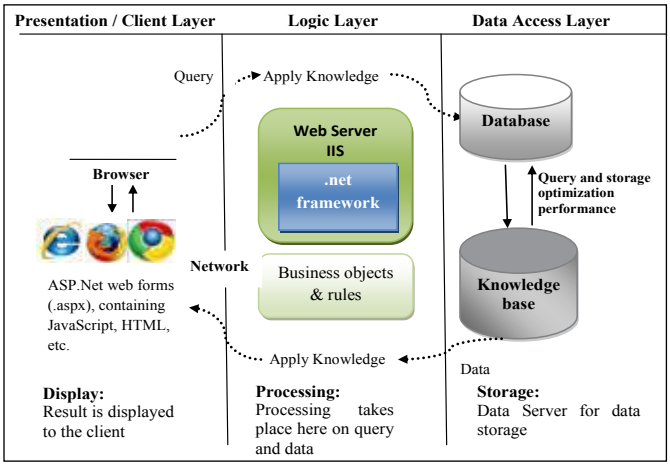


Fig. 8.2. Data flow between layers in JAF expert

9. Technology Assessment and Transfer

9.1. Technology assessment and transfer

9.1.1. Frontline demonstration on jute

Frontline demonstrations on improved production technologies of jute as well as sisal were organized in villages of Nadia, North 24-Parganas, Malda, Murshidabad and Hooghly districts of West Bengal and Sambalpur district of Odisha in collaboration with Directorate of Jute Development, Ministry of Agriculture, Government of India under Mini Mission-II (MM-II) of Jute Technology Mission programme. Altogether, 252 demonstrations covering 59.68 ha on jute were conducted in above districts. The programme was conducted through Agricultural Extension Section, CRIJAF at five extension centres and two villages in Burdwan district monitored by KVK, Budbud (Table 9.1). Similarly, 11 demonstrations on sisal covering 5 ha were laid out at Bamra (Sambalpur) under the supervision of Sisal Research Station, Bamra.

Table 9.1: Area covered (ha) under each component of Frontline demonstration programme on jute and sisal during 2012-13

Name of Village	No. of farmers	Improved varieties	Herbicidal weed control	Balanced fertilizer use	Multi row seed drill	Total
Gopalpur	47	2.0	3.0	1.0	7.0	12.00
Gauribati	45	2.0	6.0	-	3.0	11.00
Debkundu	41	1.0	7.9	1.1	-	10.00
Khairtala	32	0.78	3.3	0.9	3.2	8.18
Goaldah	22	1.0	3.0	-	3.0	7.00
Bhasapur	28	3.4	-	-	-	3.4
Jurjuti Bajpara	37	7.1	-	-	-	7.1
Bamra (sisal)	11	-	-	5	-	5.00
Total	263	17.28	23.2	8.0	16.2	64.68

9.1.1.1. Varietal evaluation

The *olitorius* jute varieties viz. JRO 204 (Suren), JBO 2003 H (Ira), CO 58 (Sourav) and JBO 1 (Sudhangsu) along with check JRO 524 (Navin) were demonstrated for yield performance in the farmers' field in 17.28 ha area across the villages (Table 9.2). The highest fibre yield of jute irrespective of the locations was obtained from the variety JRO 204 (31.34 q/ha) followed by JBO 2003 H (28.49 q/ha) CO 58 (27.23 q/ha) and JBO 1(25.37 q/ha). Highest net return per hectare was obtained from JRO 204 (Rs 25,412/ha) followed by JBO 2003 H (Rs 25,267/ha) CO 58 (Rs 21,055/ha) and JBO 1 (Rs 17, 773/). On an average cost of cultivation per hectare was Rs 51, 813/. Check variety (JRO 524) yielded 26.67 q/ha fibre giving a net return of Rs 11, 529 against Rs 54, 669 cost of cultivation. Regarding benefit-cost ratio, JRO 204 (1.49) gave maximum benefit (Table 9.2) followed by JBO 2003 H (1.48), CO 58 (1.40) and JBO 1(1.34).

Table 9.2: Economics of jute cultivation

Variety	Fibre yield (q/ ha)	Cost of cultivation (Rs/ ha)	Gross return** (Rs/ ha)	Net return (Rs/ ha)	B:C ratio
JRO 204 (Suren)	31.14	51,813	77,225	25,412	1.49
JBO 2003 H (Ira)	28.49	51,813	77,080	25,267	1.48
CO 58 (Sourav)	27.23	51,813	72,868	21,055	1.40
JBO 1 (Sudhangsu)	25.37	51,813	69,586	17,773	1.34
JRO 524 (Navin)*	26.67	54,669	66,199	11,529	1.21

*Check variety, **Price of jute fibre and jute stick was Rs 1,800-2,500/q and Rs 100-400/q, respectively

9.1.1.2. Chemical weed control

In order to reduce cost of weeding and increase profitability of jute cultivation, the demonstration on post-emergence herbicide namely, quizalofop ethyl @ 1.5 ml/l of water was laid in the farmer's field under 23.20 ha across the locations. Applications of the herbicide resulted in reduction of cost of human labour for weeding operations by Rs 7463 – 9198 / ha over the farmer's practice (Table 9.3). Maximum net return over farmers' practice was obtained at Debkundu (Rs 13, 867/ ha) due to moderate price of jute (Rs 2250/ha) as well as higher jute stick price (Rs 400/q).

Table 9.3: Economics of jute cultivation using post- emergence herbicide (Rs/ha)

Location/Particulars	IC	HLC	TCC	FY (q/ha)	GR	NR	B:C
Gopalpur	11,413	35,671	47,084	29.23	63,721	16,637	1.35
Farmer's practice	8,483	44,719	53,202	26.83	58,448	5,246	1.09
Goaldah	13,132	43,122	56,254	33.00	81,840	25,586	1.45
Farmer's practice	8,587	52,320	60,907	30.42	75,194	14,287	1.23
Debkundu	10,523	41,505	52,228	28.08	80,028	27,800	1.53
Farmer's practice	8,948	48,968	57,916	25.21	71,849	13,933	1.24
Gauribati	11,272	39,872	51,144	28.60	77,935	26,791	1.52
Farmer's practice	8,613	48,376	56,989	26.87	73,221	16,232	1.28
Khairtala	9,243	29,605	38,848	29.50	57,425	18,577	1.47
Farmer's practice	7,068	37,261	44,329	26.81	52,280	7,951	1.17

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

9.1.1.3. Line sowing

A demonstration on manual four row seed drill was conducted in an area of 16.20 ha across the villages. It helped in reducing the cost of human labour in jute cultivation by Rs 1,624-6,852/ ha over the farmer's practice (Table 9.4). Maximum difference in net return over farmers' practice was recorded at Gopalpur (Rs 9,924/ha).

Table 9.4: Economics of jute cultivation under line sowing method (Rs/ha)

Location/Particulars	IC	HLC	TCC	FY (q/ha)	GR	NR	B:C
Gopalpur	9,200	41,815	51,015	30.36	66,185	15,170	1.29
Farmer's practice	8,483	44,719	53,202	26.83	58,448	5,246	1.09
Goaldah	11,456	50,696	62,152	33.42	82,882	20,730	1.33
Farmer's practice	8,587	52,320	60,907	30.42	75,194	14,287	1.23
Gauribati	8,909	44,259	53,168	27.06	73,739	20,571	1.38
Farmer's practice	8,613	48,376	56,989	26.87	73,221	16,232	1.28
Khairtala	6,761	34,409	41,170	27.82	54,243	13,073	1.31
Farmer's practice	7,068	37,261	44,329	26.81	52,280	7,951	1.17

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

9.1.1.4. Balanced fertilizer application

Frontline demonstration on soil-test based fertilizer application in jute was conducted in an area of 8 hectare across the villages. Soil-test based fertilizer application could save cost of input by Rs 973– 2,850 per ha (Table 9.5) over farmer's practice. Maximum difference in net return over farmers practice was at Debkundu (Rs 11,534/ha)

Table 9.5: Economics of jute cultivation under soil test based fertilization (Rs/ha)

Location/Particulars	IC	HLC	TCC	FY (q/ha)	GR	NR	B:C
Gopalpur	9,456	43,780	53,236	27.30	59,514	6,278	1.11
Farmer's practice	8,483	44,719	53,202	26.83	58,448	5,246	1.09
Debkundu	11,798	41,470	53,268	27.50	78,735	25,467	1.47
Farmer's practice	8,948	48,968	57,916	25.21	71,849	13,933	1.24
Khairtala	8,171	34,094	42,265	27.43	53,489	11,224	1.26
Farmer's practice	7,068	37,261	44,329	26.81	52,280	7,951	1.17

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

Sisal is a perennial leaf fibre plant (3-10 years) grown in plateau region of India, in which farmers generally do not apply fertilizer. However, reports are available that sisal responds well to fertilizer application. A demonstration on balanced fertilizer application in sisal (*Agave sisalana* and Bamra hybrid-1) at Bamra in 5 hectare showed that incurring an expenditure of Rs 3,422/ha could give additional return of Rs 7,568-9,978/ha (Table 9.6).

Table 9.6: Economics of sisal cultivation under balanced fertilizer application (Rs/ha)

Particulars of sisal type	IC	HLC	TCC	FY (q/ha)	GR	NR	B:C
Balance fertilizer							
Agave sisalana	8,022	11,835	19,857	6.1	36,600	16,743	2.18
Bamra hybrid-1	8,022	11,835	19,857	6.7	40,200	20,343	1.97
Farmer's practice							
Agave sisalana	3,600	8,835	12,435	3.6	21,600	9,165	1.73
Bamra hybrid-1	3,600	8,835	12,435	3.8	22,800	10,365	1.83

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

9.1.1.5. Farmer's feedback

Farmers were satisfied with the performance of technological interventions implemented on their fields. They were convinced with the performance of four row seed drill, balanced fertilizer application and weed management through post-emergence herbicide. It helped in reducing the labour requirement for inter cultural operations. Result of balanced application of fertilizer in sisal motivated the farmers to follow the practice in next season.

9.1.1.6. Constraints

Hail storm damaged the jute crop badly resulting poor return in comparison to previous years particularly at Gopalpur extension centre. Wide variation of labour rate (Rs 100-200/man day) at various stages of operations as well as fluctuating market price of jute fibre (Rs 1,800-2,500/q) was observed at extension centres. Farmers also reported the problem of non- availability of quality seed in the market, paucity of labour at crucial time,

non-availability of water for retting and high labour cost. Rising price of fertilizer has also become a major concern for farmers *(Source: JEXA 4.7. Contibutors: Shailesh Kumar, U.N. Borkar, S. Sarkar, S.K. Jha 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, two major jute based cropping sequences under irrigated condition were assessed. Altogether, 60 demonstrations were conducted at the farmers' fields during the year (2012-13). Size of the plots were 400 sq. m. for each trial at five extension centres viz. Gopalpur, Goaldah, Manikchak, Debkundu and Gauribati from Nadia, North 24-Parganas, Malda, Murshidabad, and Hooghly districts of West Bengal, respectively.

The demonstrations were conducted to evaluate the performance of two major jute-based multiple cropping sequences, viz. Jute–Paddy –Mustard (North 24-Parganas and Hooghly) and Jute–Paddy–Wheat (Murshidabad, Malda and Nadia). The demonstrated varieties were jute (cv. JRO-524), paddy (cv. IET- 4094), wheat (cv. UP-262) and mustard (cv. B-9). The crop-wise demonstrations were of 60 trials on jute as first crop and 60 trials on *kharif* paddy as second crop and 24 trials on mustard and 36 trials on wheat, as the third crop. Crop management and protection practices were followed as per the requirement. Centre-wise evaluations of the cropping sequences have been done and are presented in Table 9.7.

Table 9.7: Location specific yield and benefit cost analysis of the jute based cropping sequence (2012-13)

Name of the extension centre	Cropping Sequences	No. of demonstrations	Yield (q/ha)	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B : C ratio	Rank
Goaldah	Jute	12	33.18	57940	82314	24374	1.42	I
	Paddy	12	34.04	38397	58846	20449	1.53	
	Mustard	12	17.23	31906	52683	20778	1.65	
	Total			128243	193843	65601	1.51	
Gauribati	Jute	12	28.53	52743	77745	25002	1.47	II
	Paddy	12	24.45	34602	42892	8290	1.24	
	Mustard	12	08.90	26360	28600	2240	1.08	
	Total			113705	149237	35532	1.31	
Gopalpur	Jute	12	28.40	49938	58340	9002	1.17	IV
	Paddy	12	35.88	53874	75324	21450	1.40	
	Wheat	12	36.83	41630	50641	9012	1.22	
	Total			145442	184305	39464	1.27	
Debkundu	Jute	12	26.93	58950	76750	17800	1.30	III
	Paddy	12	35.62	53917	59656	5739	1.11	
	Wheat	12	41.46	51504	75503	23978	1.47	
	Total			164371	211909	47517	1.29	
Manikchak	Jute	12	26.31	43578	51358	7780	1.18	V
	Paddy	12	36.70	65708	79635	13927	1.21	
	Wheat	12	38.33	50291	61085	10793	1.21	
	Total			159577	192078	32500	1.20	

A quick look of the Table 9.7 reveals that jute–paddy–mustard fared better at Goaldah (Swarupnagar), North 24-Parganas than Gauribati (Tarakeswar), Hooghly district. Similarly, the performance of jute-paddy-wheat is better at Debkundu (Beldanga), Murshidabad district than Gopalpur(Karimpur) of Nadia and Manikchak(Manikchak) of Malda district. Furthermore, overall performance of each cropping sequence, irrespective of locations (Table 9.8), it is revealed that jute-paddy-mustard (1.42) is better than jute-paddy-wheat (1.25) with higher benefit cost ratio, higher net return and lower total cost of cultivation *(Source: JEXA 4.8. Contributors: S.K. Jha, Shamna A, Shailesh Kumar and S. Sarkar).*

Table 9.8: Overall evaluation of cost benefit analysis of the jute based cropping sequence (2012-13)

Cropping Sequences	Yield (q/ha)	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B : C ratio	Rank
Jute Paddy Mustard	30.86 29.25 13.07	55342 36500 29133	80030 50869 40642	24688 14370 11509	1.45 1.39 1.40	I
Total		120975	171541	50567	1.42	
Jute Paddy Wheat	27.21 36.07 38.87	50822 57833 47808	62149 71538 62410	11527 13705 14602	1.22 1.24 1.31	II
Total		156463	196097	39834	1.25	

9.3. Jute cultivation: An analysis on research - farmers - industry linkage

9.3.1. Farmers' opinion on impact of improved jute production

Opinion of farmers on improved jute production technologies disseminated to them over the last three decades was analysed as part of the study on research, farmers and industry linkage. Study was conducted at four extension centres of CRIJAF, Barrackpore. Thirty farmers from each centre of Gauribati (Hooghly), Goaldah (North 24 Parganas), Debkundu (Murshidabad) and Gopalpur (Nadia) were selected randomly for the study which constituted a total sample size of 120 farmers.

The respondents were asked to list the technologies related to improved jute fibre production and profitability that they came to know in last few decades. The listed technologies were again given to the respondents to report on the impact of the technology on production and profitability. The scores given to each technology by all the farmers were added to obtain the total score for that particular technology. The results revealed (Table 9.9) that the technology cv. JRO 204 was given the highest score followed by four row seed drill, line sowing, and weed management using quizalofop ethyl etc. The technology JRO 524 had long term impact on production and profitability from jute cultivation. The result also proves that most of the technologies which had higher impact on their jute fibre production and profitability were received during last five years.

Table 9.9: Scores given by farmers on impact of the technology on production and profitability

Period	Technologies transferred	Score	Rank
2005-2010	Four row seed drill	540	2
	Line sowing	490	3
	JRO 204	580	1
	Weed management using quizalofop ethyl	320	5
1995-2005	Nutrient management	260	6
	Single row seed drill	95	7
1975	JRO 524	408	4

9.3.2. Constraint analysis of farmers and industry on jute fibre production procurement, processing and marketing

The list of constraints collected from farmers during the preliminary study period was given to them again for ranking purpose. These ranks were further quantified, by calculating rank based quotients (Sabaratnam, 2002) for

each constraint listed. The constraint lack of organized market scored first (RBQ 92.15) followed by high cost of labour (90.76), middle-man (89.65), lack of knowledge about fibre grades (80.20), non-availability of labour (79.9), water crisis during sowing (67.7) etc.

A study was conducted on constraints faced by industry in order to assess the actual problems faced by jute sector as a whole. The listed constraints by the industries were further ranked by them and Rank Based Quotients were calculated. The results indicated that (Table 8.10) lack of availability of labour (99.0) scored highest followed by labour cost (86.0), competition from synthetic products (68.0), lack of demand (63.0), middle-man (57.0) and lack of availability of quality fibre (54.0).

Table 9.10: Ranking of the constraints listed by jute mills

Constraint	RBQ	Rank
Labour availability	0.99	1
Labour cost	0.86	2
Sufficient fibre availability	0.22	15
Fibre quality not up to the mark (lack of fine fibre)	0.54	7
Less storage facility	0.22	14
Competition from other similar synthetic products	0.68	3
Lack of latest machineries	0.55	6
Middle-man	0.57	5
Demand constraint	0.63	4
Dominance of single product-sacking	0.48	10
Dominance of domestic consumption	0.39	13
Non exploitation of export market potential	0.45	11
Absence of institutionalized marketing effort	0.53	8
Lack of awareness of jute in developed nations	0.49	9
Lack of process and quality controls	0.43	12

9.3.3. Assessment of views of industries on jute fibre production and procurement

Industries views on jute fibre production and procurement was assessed. The results showed that 86.5% of the jute mills are of the opinion that retting method to be improved so that no part of the fibre goes as wastage. Most of the mill representatives (78.5%) had opined that there should be more participation from state government. Other prominent views were on non-availability of quality fibres (77.0%), lack of clarity in fibre grading (69%), requirement of high yielding varieties (69%) and readiness to procure jute from farmers' group directly (66.6%).

9.3.4. Linkage model for enhancing the performance of jute sector

The linkage between research, farmers and industry was analyzed by assessing the feedback collected from the research stations, farmers and industry and a new model is suggested for the better performance of the jute sector (Fig. 9.1). The existing linkage analysis revealed that there is a wide gap between research, farmers and industry. The technologies from research station had been disseminated only to few villages in and around each extension centre. To bridge this gap the effective collaboration and functioning of state level extension systems in dissemination of technologies is suggested.

The linkage between farmers and industries is mainly through middlemen. Because of this existing linkage farmers get poor price to the product irrespective of the quality. Lack of better price for better fibre quality restrain farmers from adopting new technologies demonstrated by the research institute. The relation between farmers and industries can be improved by avoiding the middle man and by forming Farmers Interest Groups (FIG) or Commodity Interest Groups (CIG). These groups can be trained on grading of fibres and can be an effective link between farmers and industry. Most of the jute mills also accepted to procure jute from such groups provided they are well trained on grading and supported by government.

The linkage between research and industry is very scanty. The relation is limited to processing technology related information. A strong linkage where both fibre qualities and processing technology related information or feedback sharing is very much required for overall growth of the jute sector *(Source: JEXA 4.9. Contributors: Shamna, A. Jha, S.K. and S. Sarkar).*

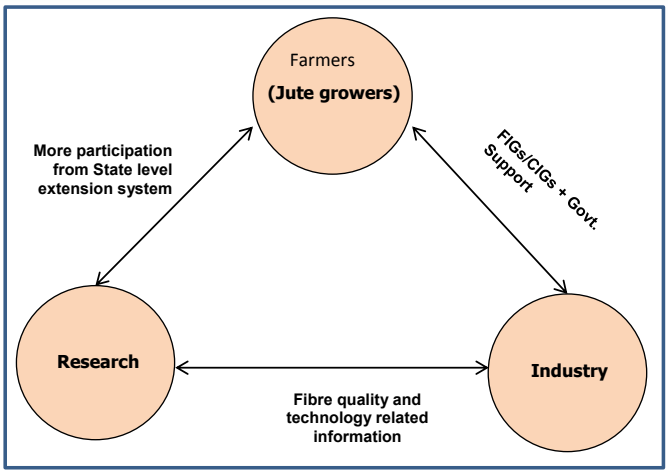


Fig 9.1: Linkage model for enhancing the performance of jute sector

9.4. Assessment of jute production technologies under deficit rainfall condition

Drought like situation due to climate change is adversely affecting the livelihood of majority of jute and allied fibre growers of West Bengal. Three drought management technologies for jute production (agronomic interventions developed by CRIJAF, Barrackpore) were demonstrated and assessed at farmer's field under deficit rainfall in Nadia and Murshidabad district of West Bengal (comprising of more than 40 farmers) in term of profitability, simplicity and compatibility with production system. Rainfall during early crop growth *i.e.* mid-March to mid-June was deficit by 40-50%.

Farmers practice comprised of sowing jute seed @ 6-8 kg/ha with NPK 60:30:30 (Recommended Dose of Fertilizer *i.e.* RDF) and Butachlor @1kg *a.i.*/ha as pre- emergence herbicide yielded 21.06 q/ha jute fibre.

Incorporation of additional 30 kg elemental sulphur per hectare yielded 15.57% more over farmer's practice. Application of augmented nutrition (N:P:K:@80:40:40) recorded 13.58 % more yield (24.92 q/ha) over farmer's practice. Green gram (cv. Pant Moong 5) cultivation preceding jute (which adds around 2 tonnes pulse waste/ha) produced 386 kg more jute fibre/ha (18.32%) than farmer practice. In monetary term it gave additional return of Rs 8,000/ha. This method produced 24.92 q/ha jute fibre and 5-6 q/ha pulse grain.

Additional expenditure for augmented nutrition (Rs 1,200/ha) and supplemented nutrition (Rs 1,800/ha) generated extra income of Rs 3,800/ha and Rs 6,560/ha respectively. Farmers reported that these practice were cheap and simple.

One day training programmes were conducted each at Tokipur and Debkundu villages of Murshidabad district to upgrade the skill of farmers (172 in nos.) in drought management techniques *(Source: JEXA 5.0. Contributors: Shailesh Kumar and A.K. Ghorai).*

10. Tribal Sub Plan (TSP)

The TSP activities were carried out on jute, ramie and sisal with an objective to bring more area under ramie and sisal cultivation of these fibre crops in tribal areas and to uplift the socio-economic conditions of the tribal people. The TSP activities on jute were focused in Bankura, Purulia and Nadia districts of West Bengal. Lakhimpur, Dhemaji and Sonitpur districts of Assam were selected for ramie, while Jharsuguda and Sambalpur districts of Odisha were the major area selected for conducting the TSP programmes on sisal. The major activities under TSP were generation and distribution of planting materials, expansion of crop area, transfer of technology and human resource development.

10.1 TSP on jute

i) Soil test and targeted yield based fertilizer application in jute based cropping system

Front line demonstration on soil test and targeted yield based fertilizer application in mustard under jute-rice-mustard cropping sequence was conducted in selected farmers' field of Bankura, Purulia and Nadia districts in West Bengal (Fig. 10.1). Targeted yield equation of mustard (B-9) developed by CRIJAF was used for application of fertilizers to achieve the targeted yield (10 q/ha). In this programme, 111 tribal farmers had participated and mustard was sown in 24.8 ha area out of which proper crop stand was observed in 21.9 ha area. Average grain yields of mustard due to application of fertilizers as per soil test and targeted yield were superior over the yield recorded by using farmers' practice (Table 10.1). The highest grain yield (7.03 q/ha), response ratio (2.04 kg/kg) and net return (Rs 6165/ha) were recorded in Bharatpur village followed by Majharpara village (5.58 q/ha). Similarly, at Haringhata, Nadia, lentil plots receiving fertilizer based on soil test value recorded higher yield, net return and B:C ratio as compared to those under the farmers' practice (20:40:20 kg N, P_2O_5 and K_2O/ha) (Table 10.2).

Table. 10.1: Effect of soil test and targeted yield based fertilizer application on yield and net return of mustard in rainfed condition of Bankura district

Name of village	No. of farmers	Total area (ha)	Targeted grain yield (q/ha)	Yield (q/ha) under		Response ratio (kg/ kg NPK)	Profit due to fertilizer (Rs/ha)
				Farmers' practice	Additional yield over FP		
Hanumanhir GP-Nakaijuri Block-Onda	10	2.13	6.30	3.48	2.94	1.77	5045
SareshKanali GP-Nakaijuri Block-Onda	35	10.8	5.97	3.19	2.79	1.69	4607
Daldali GP-Nakaijuri Block-Onda	15	2.40	5.71	3.14	2.59	1.60	4038
Majharpra GP-Chingani Block-Onda	15	3.73	6.58	3.44	3.26	1.99	6055
Bharatpur GP-Susunia Block-Chhatna	14	2.40	7.03	3.69	3.33	2.04	6165
Bamundia GP-Lachmanpur Block-Gangajalghati	22	3.33	6.27	3.83	2.42	1.50	3443

Table 10.2: Effect of soil test and targeted yield based fertilizer application on yield, net return and B: C ratio of lentil in rainfed condition of Nadia district

Farmers' name	Fertilizers applied as per ST-TY (kg/ha)			Yield under ST-TY based treatment (q/ha)		Yield under farmers' practice treatment (q/ha)		Net return (Rs/ha)
	N	P	K	Grain	Straw	Grain	Straw	
Lipa Soren	20	43	28	8.96	12.4	5.34	6.32	4497
Bhuta Soren	16	42	21	11.23	13.7	7.23	8.79	11131
Chanda Hembram	23	43	19	9.76	12.2	5.05	6.24	6700
Budirai Soren	27	43	34	10.56	12.9	6.59	7.97	8937
Jagai Hansda	27	43	35	9.98	10.9	6.89	6.85	7216
Bimal Murmu	27	43	30	11.87	14.1	7.76	8.95	12732
Average				10.73	13.0	6.81	7.85	8536

Fig. 10.1: Field view of FLD on mustard (jute-rice-mustard sequence) under TSP of STCR in Bankura district of West Bengal

ii) Seed production in jute

Under this programme, 6.83 q of jute seed of improved varieties like JRO 8432 (4.37 q), JRO 524 (0.20 q) and JRO 128 (2.26 q) were supplied free of cost to the tribal farmers of Bankura and Purulia districts for quality jute seed production in those areas. Altogether 96 tribal farmers were identified in these two districts for production of seed of jute, rice, mustard, etc. after discussion with individual farmers. A meeting was conducted on 23.03.2012 at Tara village in Purulia district to motivate the tribal farmers for jute seed production and 96 knapsack sprayers and 26 CRIJAF Nail Weeders were distributed among the farmers for better intercultural operation and plant protection in the seed crops (Fig. 10.2 & 10.3).

Fig. 10.2: Director CRIJAF is distributing sprayer to the tribal farmers at Tara village in Purulia district of West Bengal

Fig. 10.3: CRIJAF scientists together with the Agril. Asst. of Manbazar block, Purulia, West Bengal visiting the tribal farmers fields

10.2 TSP on sisal

Generation and distribution of planting materials: During 2012-13, 81,272 healthy suckers of sisal were distributed among the tribal farmers under TSP which had been planted to 20.32 ha area.

Area expansion of sisal: Thirty one tribal farmers were identified in Sambalpur and Jharsuguda districts of Odisha under TSP programme for sisal plantation in 20.36 ha area (Fig. 10.4 & 10.5).

Transfer of technology: The improved production technology of sisal had been demonstrated to these farmers through Farmers' Training Programme arranged at Sisal Research Station, Bamra. The planting was made in double-row planting geometry accommodating 4300(±200) suckers/ha.

Human resource development: An awareness campaign and farmers' training programme was conducted under the TSP which created an overwhelming response among the tribal farmers of this region. Training programme on '*Improved production technology of sisal cultivation*' was organized during 25-28 July, 2012 at Sisal Research Station, Bamra. Thirty tribal farmers from different villages of Jharsuguda and Sambalpur districts participated in the programme.

Fig. 10.4: Sisal plantation under TSP in farmers' fields at (i) Tapagunja and (ii) Khokhopada villages of Odisha

Fig.10.5: ADG (CC) and Director (CS), ICAR visiting TSP site in Odisha with Director, CRIJAF

10.3 TSP on Ramie

Generation and distribution of planting materials: During 2012-13, planting materials of ramie were supplied to Assam Ramie Fibre Cultivation Cooperative Ltd. which had been planted to 26.0 ha area in farmers' field.

Area expansion of ramie: About 26.0 ha of farmers' land was planted with ramie in Lakhimpur, Dhemaji and Sonitpur districts of Assam and West Siang district of Arunachal Pradesh (Fig. 10.6 & 10.7).

Transfer of technology: The new areas under ramie cultivation in farmers' field were planted with alternate

planting material of ramie (plantlets, stem cutting, etc.) which reduced the requirement of rhizome as well as the cost of cultivation significantly. The planting was made in ridge and furrow system which protected the emerging small plants from rotting during the high rainfall periods. Both these technologies have been well accepted by the farmers.

Fig. 10.6: ICAR officials visiting TSP site at Lakhimpur, Assam

Fig. 10.7: Ramie plantation developed in farmers' field at Lakhimpur, Assam under TSP

Publication: Two training manuals viz., "Rami Ki Vaigyanik Kheti evam Iska Mahetwa" (in Hindi) and "Improved production technology of ramie" (in English) were published covering various aspects of ramie cultivation and its benefits for wide circulation among the various stakeholders of ramie.

11. AINP on Jute and Allied Fibres

All India Network Project on Jute and Allied Fibres functions through 9 SAUs and an ICAR institute-based centre with its Head Quarter at CRIJAF, Barrackpore. During the year 2012-13, a total of 58 projects were executed on jute (*C. capsularis* and *C. olitorius*), mesta (*H. cannabinnus* and *H. sabdariffa*), sunnhemp (*Crotalaria juncea*), ramie (*Boehmeria nivea*), sisal (*Agave* sp.) and flax (*Linnum usitatissimum*) pertaining to crop improvement, crop production and crop protection aspects.

11.1. Crop Improvement

As many as 25 projects comprising of 133 trials were evaluated on jute and allied fibre crops at different AINP centres under crop improvement programme. Twelve projects for jute, eight for mesta, three for sunnhemp and one each for flax and ramie were evaluated which includes germplasm evaluation, national hybridization programme, Initial Evaluation Trials (IETs), Advance Varietal Trials (AVTs)-I, Advance Varietal Trials (AVTs)-II and adaptive trials at different centres.

11.1.1. Varieties released

Four varieties *viz.,* JROM 1 (Pradip) of *tossa* jute, JRCM2 (Partho) of white jute, JBM 81 (Shakti) of kenaf and SUIN 037 (Ankur) of sunnhemp were released and notified by the Central Variety Release Committee for their commercial cultivation in the country vide Gazette of India No. S.O. 312 (E), dated 01. 02. 2013.

11.1.2. Varieties identified for release

Three varieties, one each of white jute, JRC-9057 (Ishani), JRKM-9-1 (Satyen) of kenaf and R-1411 (Hazarika) of ramie were identified for release by the Central Variety Release Committee in 27th Annual Workshop of All India Network Project on Jute and Allied Fibres held at CRIJAF, Barrackpore during 10-11th February, 2013.

11.1.3. Germplasm Evaluation

11.1.3.1. Jute

Fifty accessions each in *tossa* and white jute and 48 accessions in roselle were evaluated at different locations during 2012-13.

C. capsularis: Average fibre yield (g/plant) over six locations was recorded to be 6.90±0.82 g/plant with a range of 5.00 (CIN-113) to 8.89 (CEX-03) g/plant. Three genotypes, CEX-03, CIN-069 and CEX-36 outperformed better check JRC 212 (8.11 g/plant).

C. olitorius: Average fibre yield over the three locations was recorded to be 10.34±1.55 g/plant with a range of 7.63 to 13.28 g/plant. Only one genotype OEX-35 (13.28 g/plant) outperformed better check JRO 8432 (13.21 g/plant) for fibre yield.

11.1.3.2. Mesta

H. sabdariffa: Two accessions, AR-19 and AR-67 (14.86 g/plant) exceeded the fibre yield over the best check variety AMV 5 (14.81 g/plant).

11.1.4. National Hybridization Programme

C. capsularis: Thirty F_2 progenies were evaluated at five locations. F_2 populations from Kalyani centre performed best with a mean of 9.84 g/plant. Population from cross combination CIN-117 X CEX-048 performed best with a mean of 8.62 g/plant over locations. Twenty-five F_8 populations were evaluated at Kalyani centre. Population from cross combination (CIN–149× UPC–94) exhibited highest fibre yield (14.6 g/plant).

C. olitorius: Twelve F_7 populations grown at Kalyani centre exhibited higher fibre yield than mean (9.90 g/plant). Population from cross combinations TJ-40 × JRO 524 and CO-51 × OIJ-100/TAN/NY/018C performed best (fibre yield 11.40 g/plant).

11.1.5. Evaluation of elite entries in IET and AVTs

Tossa jute (*C. olitorius*)

IET: KRO-4 turned out to be the best performing entry and recorded 34.23 q/ha fibre yield followed by KRO-5 (33.32 q/ha) and BCCO-6 (32.97 q/ha).

AVT I: Check variety JRO 8432 was found to be the best performer with fibre yield 28.83 q/ha followed by KRO-2 (27.66 q/ha) and JROK 7 (26.38 q/ha).

AVT II: JROG-1 turned out to be the best performing entry with 25.78 q/ha of average fibre yield closely followed by

JRO 524 (24.90 q/ha).

Adaptive Trial: Test entry JROM-9-1 (Fibre yield 35.73 q/ha) surpassed best check JRO 8432 over five locations by 9.75% yield advantage.

White jute (*C. capsularis*)

IET: Test entry BCCC-2 was the best performer with fibre yield 32.25 q/ha followed by NCJ-28-14 (29.54 q/ha), JRCJ-3 (29.36 q/ha) and JRCJ-4 (29.34 q/ha).

AVT I: Test entry NCJ-28-10 ranked first with fibre yield 26.23 q/ha followed by NDJC-2011 (25.95 q/ha).

AVT II: Based on pool analysis over locations and years mean (grand mean), test entry NCJ-28-1 (27.05 q/ha) was the best among all entries.

Adaptive Trial: Entry JRC-9057 with an average fibre yield 31.23 q/ha outyielded national check JRC 698 by 12.29 % based on evaluation at 7 locations in four states (UP, Odisha, WB and Bihar)

Kenaf (*H. cannabinus*)

IET: Check variety AMC 108 (33.38 q/ha) was found to be the best performer among all entries. Test entries JRK-2011-3 (31.29 q/ha) and JRK-2011-2 (31.23 q/ha) outyielded another check variety HC 583 (30.88 q/ha).

AVT I: Test entry JBMP-2 (26.81 q/ha) performed better than both the check varieties AMC 108 (25.19 q/ha) and HC 583 (24.60 q/ha).

AVT II: Five entries namely JBM-G-4 (27.39 q/ha), JBM-G-5 (26.69 q/ha), JBM-G-2 (26.54 q/ha), JBM-G-1 (25.80 q/ha) and JBM-G-3 (25.01 q/ha) out yielded better check variety HC 583 (24.56 q/ha).

11.1.6. Adaptive Trial: Test entry JRKM-9-1 with an average fibre yield of 30.22 q/ha outyielded best check variety AMC 108 by 13.61% based on two locations trial in West Bengal.

Roselle (*H. sabdariffa*)

IET: AHS-230 turned out to be the best performing entry and recorded 29.95 q/ha fibre yield compared to superior check HS 4288 (27.24 q/ha).

AVT I: Test entry JBRP-01 was found to be the best performer with 27.74 q/ha followed by AHS-216 which recorded 25.84 q/ha fibre yield.

AVT II: CRIJAF R-2 was found to be the best performer with 25.89 q/ha mean yield followed by CRIJAF R-5 and CRIJAF R-8 which recorded fibre yield of 25.81 q/ha and 25.51 q/ha, respectively.

Sunnhemp (*C. juncea*)

IET: Test entry SUIN-3 (12.16 q/ha) identified as the best performer over both the check varieties SH 4 (11.13 q/ha) and K 12 Yellow (11.07 q/ha).

AVT I: Two test entries SUIN-63 (9.17 q/ha) and SUIN 62 (8.96 q/ha) performed better than best check SUIN 53 (8.94 q/ha).

AVT II: Entry JRJ-610 (9.51 q/ha) performed better than the best check SH 4 (9.00 q/ha) followed by test entry JRJ-611 (8.91 q/ha) and check K 12 Yellow (8.76 q/ha)

Flax (*L. usitatissimum*)

AVT II: Test entry JRF-2 exhibited maximum plant height (126.4 cm) followed by JRF-1 (126.2 cm) while JRF-2 was best performer for fibre yield (14.2 q/ha).

Ramie (*B. nivea*)

Adaptive Trial: The entry R-1411 exhibited maximum dry fibre yield (17.16 q/ha/year), green weight (600.22 q/ha/year) and stick (cane) weight (317.87 q/ha/year).

11.1.7. Fibre quality

Tossa jute

IET: The entire fibre samples of Kalyani centre varied from TD_4 to TD_6 grade. Fibres were fine in nature.

AVT-I: Fibre samples of Kendrapara, Kalyani and Barrackpore centre ranged from TD_4 to TD_5 grade whereas samples of Rahuri placed in between TD_5 to TD_6 grade.

AVT-II: At Rahuri and Kendrapara centre fibre samples were weak in nature and placed in TD_5 to TD_6 grade. The entire fibre of Kalyani and Barrackpore centres were placed in TD_4 grade except BCCO-2.

White jute

IET: Fibre samples of Rahuri were placed in W_5 grade

except test entry BCCC-2. Fibres were very fine in nature.

AVT I: Fibre grades of Rahuri centre ranged between W_5 to W_6, Kalyani W_4 to W_6 and Barrackpore W_4 to W_5. Tenacity values were in weak group. All the entries were very fine in nature.

AVT II: Fibre samples of Kendrapara and Barrackpore were placed in W_4 to W_5 grade whereas samples of Kalyani centre graded in between W_4 to W_6.

Roselle

AVT I: Fibre samples of Kendrapara and Barrackpore centres were graded in between M_3 to M_4.

AVT II: Fibre strength for all the fibre samples of Kendrapara and Barrackpore centres were average to weak in nature and graded in between M_3 to M_4.

Kenaf

IET: At Rahuri, fibre tenacity value showed fairly good for all the entries. Fineness ranged from very fine to fine and graded in between M_3 to M_4.

AVT I: Fibre grades were of M_4 grade except JBMP-3 entry at Rahuri and M-3 at Kendrapara.

AVT II: Fibre samples of Rahuri were graded in between M_4 to M_5 with tenacity average to weak group but very fine in nature. Fibre samples of Kendrapara graded within M_3 to M_4.

Sunnhemp

IET: None of the entries showed better tenacity than check at both Barrackpore and Kalyani centres.

AVT I: All the entries at Barrackpore showed weak tenacity except SUIN-67 whereas very weak fibre tenacity of samples at Kayani centre observed.

AVT II: All the entries showed very weak fibre tenacity value at both Barrackpore and Kalyani centres.

11.2. Crop Production

During 2012-13, total 17 research projects comprising of 56 trials were evaluated on jute and allied fibre crops at different AINP centres under crop production programme. The new *C. olitorius* genotype JROM-9-1 recorded significantly higher fibre yield over check varieties at Barrackpore, Kalyani 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 *C. capsularis* genotypes under adaptive trial recorded any significant increase in fibre yield over the check variety at both Cooch Behar and Nagaon centres. Fibre yield of *capsularis* genotypes increased significantly upto 80 kg N + 17.5 kg P + 33.3 kg K/ha level at Cooch Behar and upto 100 kg N: 21.8 Kg P: 41.7 kg K/ha level at Nagaon centre, respectively.

Among the two roselle genotypes under adaptive trial, AHS 161 recorded significantly higher plant height, basal diameter and fibre yield over the check varieties HS 4288 and AMV 5 at Amadalavalasa centre only and the fibre yield of AHS 161 increased significantly up to fertilizer dose of NPK @ 80 : 17.5 : 33.3 kg/ha level. The new kenaf genotype JRKM-9-1 under adaptive trial recorded significantly higher basal diameter and fibre yield over both the check varieties AMC 108 and HC 583 at Kendrapara.

The targeted yield of jute fibre (4.0 t/ha) was achieved with (+) 3.05% yield deviation in Kalyani centre only but targeted yield of rice grain could not be achieved at both Kalyani and Bahraich centres. However, higher fibre and grain yield of rice were obtained with the treatment where fertilizer was applied as per soil test values and targeted yield equations. The highest N, P and K uptake was recorded with 100% NPK on ST-TY+ organic manure. Application of fertilizers on ST-TY basis significantly increased the nutrient uptake over RDF. Under integrated nutrient management based on initial soil test values and targeted yield equation in acidic soils showed that targeted yield of jute fibre was achieved in both the centres with ±10% yield deviations. However, targeted yield of rice could not be achieved at any centre. Highest grain yield of rice was found in the treatment where fertilizers applied on the basis of soil test and targeted yield. Application of 150% NPK on ST-TY with and without FYM and lime recorded low grain yield of rice at both the centre of Cooch Behar and Kendrapara. Targeted yield (3.5 t/ha) of mesta fibre could not be achieved with ±10% yield

deviations. However, significantly higher yield of mesta fibre was obtained under the treatments where fertilizers were applied on soil test value and targeted yield basis over RDF. Highest fibre yield of mesta (2.65 t/ha) was recorded at Amdalavalsa centre under 150% NPK on ST-TY +50% LR treatment followed by 150% NPK on ST-TY +50% LR +FYM.

The results of weed control experiments revealed that application of butachlor 5G @ 1.5 kg a.i or pretilachlor @ 1.0 kg a.i/ha (in case of assured irrigation) gave better weed control in jute and may be recommended for south Bengal condition while application of butachlor 50% EC @ 1.0 - 1.5 kg a.i. /ha (within 24 hrs of rain or irrigation) followed by one hand weeding may be recommended for north Bengal region as it gave higher fibre yield of jute along with better weed control. Similarly, pre-emergence application of butachlor 50% EC @ 1.5 kg a.i./ha under rainfed or irrigated condition or pretilachlor 50% EC @ 1.0 kg a.i./ha with irrigation followed by one hand weeding may be recommended for weed management in Nagaon region. At Kendrapara and Bahraich, the highest fibre yield of jute and better weed control were observed with application of quizalofop ethyl @ 60 g a.i /ha at 15 DAE + one hand weeding at 15-20 days after herbicide application and this may be recommended for both the regions. In mesta, post emergence application of of quizalofop ethyl @ 60 g a.i /ha at 15 DAE followed by one hand weeding at 15-20 days after herbicide application recorded better weed control at Aduthurai, while pre-emergence application of butachlor 50 EC @ 1.5 kg /ha or butachlor 5G @ 1.5 kg /ha followed by one hand weeding showed better performance and may be recommended.

At Kalyani, sowing of jute seed crop between 7th and 21st August with 45 cm x 15 cm spacing and topping at 45 DAS was suitable for higher seed yield. Sowing of seed jute on 15th June with 60 cm x 15 cm and topping at 45 DAS recorded significantly higher seed yield of the crop at Bahraich. At Kendrapara, maximum jute seed yield (4.8 q/ha) was achieved when the crop was grown with a spacing of 45 cm x 15 cm and topping was done at 45 DAS. At Nagaon, sowing of jute seed crop with a spacing of 45 cm x 10 cm or 45 cm x 15 cm and topping at 45 DAS recorded significantly higher seed yield and yield attributing characters of the crop while at Rahuri, maximum seed yield of jute was observed when crop was sown on 7th July with a spacing of 60 cm x 15 cm and topping was done at 45 DAS.

The results of drought management experiment revealed that maximum fibre yield of jute was observed with T_6 treatment (sowing time 30th March to 3rd week of April with one irrigation + 80 kg N+18 kg P+33 kg K/ha + bunding all around plot) at Kalyani and Kendrapara while in mesta, rainfed sowing along with NPK @ 60:13:25 kg/ha + S @ 30 kg/ha recorded highest fibre yield of roselle.

Newly developed talc based microbial formulation of CRIJAF for retting performed very well in various AINP centres located at different agro-climatic regions. Jute & mesta retting was completed in 8 to 13 days and 14 to 21 days, respectively with and without microbial formulation and there was reduction in retting period by 5 to 9 days when jute and mesta was treated with microbial formulation along with improvement in fibre quality compared to control. The strength of treated fibre ranged between 26.9 to 30.6 g/tex compared to 22.6 to 28.4 g/tex recorded in control.

Strip cropping of jute with green gram (9:9) particularly with Pant Mung 5 cultivar recorded higher system productivity, net return and B:C ratio at Barrackpore, Kalyani, Bahraich and Kendrapara centres.

The mesta variety MT 150 recorded maximum dry biomass and the dry matter increased significantly upto 160 kg N/ha level at Bamra, Odisha.

The sowing of mesta crop on 15th May with spacing of 60 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 and topping at 45 DAS recorded significantly higher seed yield of mesta at Amadalavalasa.

Higher seed yield of sunnhemp was achieved at Pratapgarh when the crop was sown up to 6th August with a spacing of 30 cm x 10 cm and topping was done at

30 DAS. At Rahuri, sowing of seed crop of sunnhemp on 22nd July with spacing of 30 cm x 10 cm or 30 cm x 20 cm and topping at 30 DAS recorded significantly higher seed yield. Maximum seed yield of sunnhemp was observed at Aduthurai when the crop was sown on 15th May with 45 cm x 10 cm spacing and topping at 45 DAS.

The results of INM experiment revealed that the recommended fertilizer dose of ramie at Barrackpore may be increased from 30:6.6:12.5 (NPK, kg/ha) to 45:10:19 (NPK, kg/ha), 25% of which can be substituted by FYM or ramie compost without sacrificing the fibre yield of the crop.

Higher productivity of sisal may be achieved through application of N, P and K @ 60:13:50 kg/ha along with sisal waste @ 20 t/ha at Bamra (Odisha) or through combined application of NPK @ 60:13:50 (kg/ha) and poultry manure @ 4 t/ha at Amadalavalasa, Andhra Pradesh.

Optimum sowing time of flax at Coochbehar ranged from 9th Novemeber to 19th November while at Pratapgarh, sowing of flax on 30th October with 15 cm row-row spacing recorded significantly higher fibre yield of the crop.

11.3. Crop Protection

During 2012-13, total 16 projects comprising of 37 trials were conducted in jute and allied fibre crops at different AINP centres under crop protection programme. Survey and surveillance of insect pests and diseases of jute, mesta and ramie were carried out in different centres. In jute semilooper, Bihar hairy caterpillar, yellow mite and stem weevil were the most common insect pests whereas in case of mesta, infestation of jassid, aphid, whitefly, mealybug and semilooper prevalent. Infestation of indigo caterpillar (11.36%) and grey weevil (23.84%) was specific to Nagaon and Barrackpore respectively. The yellow mite infestation was more consistent across the centres with maximum infestation of 10.12, 16.40, 38.36 and 115.39 mite population/cm^2 on second unfolded leaf at Cooch Behar, Katihar, Nagaon and Barrackpore, respectively coinciding at 40 DAS to 75 DAS during last week of May to Mid-June. Maximum infestation of Bihar hairy caterpillar was noticed at Barrackpore (60.40%) followed by Nagaon (44.38%) and Katihar (16.40 %) occurred at 75 DAS to 103 DAS during July.

Jute semilooper infestation was observed at Katihar, Cooch Behar, Nagaon and Barrackpore. The period of semilooper infestation was from first week of June to second fortnight of July with maximum 60.00%, 11.00%, 42.36% and 88.80% plant damage, respectively from 65 DAS to 119 DAS. Stem weevil infestation was noticed in all the centres except Cooch Behar and Bahraich. At Katihar, Nagaon and Barrackpore the maximum stem weevil infestation was from second fortnight of June to first week of July with 8.80%, 18.62% and 49.00% plant damage at 55 DAS to 102 DAS.

The infestation of mealybug at Nagaon and Barrackpore was from second week of June to first week of August with 2.86% and 15.00% plant damage respectively, during 80 DAS to 105 DAS. Its infestation was very mild at Katihar. In general, yellow mite, indigo caterpillar and stem weevil were more prevalent during the early crop growth period whereas Bihar hairy caterpillar, semilooper and mealybug were active during the later part of the crop period.

For the first time in jute, *Helicoverpa armigera* was recorded to damage *tossa* jute in two locations of North-24 Parganas causing defoliation and cutting of terminal part of the stem with 33% infestation in the month of May-June 2012. Indian red admiral caterpillar and Chinese rose beetle were recorded on ramie in Assam.

In mesta, maximum infestation of jassid, aphid, whitefly and mealybug was 3.54%, 22.84%, 3.28% and 3.18% respectively, during the July whereas the semilooper damage peaked (4.90%) in October at Amadalavalasa.

Stem rot, root rot, anthracnose and mosaic disease were common in jute whereas foot and stem rot, leaf spot and phytoplasma diseases were most common in mesta. The incidence of leaf mosaic of white jute was very specific at Katihar and Bahraich with 6.50% and 77.00% incidence respectively. Seedling blight incidence was restricted to Nagaon (3.20%). Maximum incidence of anthracnose

was after 100 DAS in August to the extent of 29.3% and 38.00% at Nagaon and Bahraich respectively. The stem rot incidence increased during the later part with maximum incidence of 8.00%, 8.93% and 11.70% at Nagaon, Cooch Behar and Katihar respectively. Severity of root rot was maximum at Nagaon (18.40%) and Katihar (16.10%). In mesta, foot and stem rot was most prevalent disease, the incidence was maximum (31.00%) in August at Amadalavalasa.

In the screening of *olitorious* germplasms against root knot nematode, two lines (OIJ 012 and OIJ 08) were highly resistant at Bahraich. Nine lines (OIJ 013, OIJ 201, OIN 1062, OEX 34, OIJ 025, OIJ 201, OIJ 911, OIJ 971, and OIJ 1001) were moderately resistant at Cooch Behar and Kendrapara.

Among the *tossa* jute (*C. olitorius*) germplasms, the accessions, OIN 730, OIJ 013, OIJ 201 and OIN 882 were least susceptible to yellow mite while 9 lines namely OIN 648, OIN 700, OIN 730, OIN 762, OIN 939, OIN 1000, OIN 1018, OIN 1060 and OEX 35 were completely free from stem weevil infestation. The germplasm with relatively less susceptibility to Bihar hairy caterpillar were OIN 702 and OIJ 059. In Nagaon, the *white* jute germplasms, CIN 330, CIN 301, CIJ 156 and CIJ 143 were least infested with yellow mite. Three lines CIN 498, CIN 494 and CIN 075 were resistant to stem weevil.

The *tossa* jute accessions, OIN 590 and OIN 1001 were resistant to both stem rot and root rot with less than 1% disease incidence at Kendrapara, In case of white jute, the root rot and stem rot tolerant lines were CIJ 067 and CIN 494.

Among the roselle germplasms, two lines i.e. AR 19 and AS 80-7 were resistant and another 7 lines was moderately resistant in reaction against mealybug. Two moderately susceptible lines against foot and stem rot were AS-80-19 and AS 81-5.

On the basis of disease incidence in the elite germplasms across the centres, OIN 270 line was least susceptible to stem rot (11.49%). Other lines with less susceptibility were OEX 027, OIN 853 and OIN 651. The relative incidence of the disease at Sorbhog (hot spot for disease incidence among the centres) indicated OIN 853, OIN 154 and OEX 027 to be less susceptible to stem rot.

Effect of crop management on stem rot control at Barrackpore indicated that incidence of stem rot was significantly less (5.8%) in 30th March sown crop with 30:60:60 NPK dose. Fibre yield was significantly higher (31.1q/ha) in 30th March sown crop than 15th March sown crop (25.7 q/ha). At Cooch Behar, early sowing (13thApril), with 60:30:30 NPK and integrated management (seed treatment with *Trichoderma viride* @ 10g/kg seed + butachlor @ 2 kg a.i/ha as pre-emergence + spraying of carbendazim @ 0.1% + spraying of endosulfan @ 0.15%) reduced disease incidence and increased the fibre yield to the maximum extent.

For disease free seed production of jute at Barrackpore sowing in mid-August recorded the least seed infection by *M. phaseolina* (1.9%). Spraying of 0.1% carbendazim at pod setting as well as pod maturation stage reduced the seed infection by 30-35% and seed discolouration by 4-24%. Maximum seed yield of 13.0 q/ha was obtained in mid-August sown crop. At Bahraich, mid-June sown crop performed better in respect of seed infection, discolouration as well as seed yield. Application of carbendazim reduced seed infection, discolouration and improved the seed yield. Similarly at Katihar also mid-June sown crop as well as application of fungicide performed better.

In ecofriendly management of major pests and diseases of jute, the treatment consisting of NPK @ 60:30:30+ seed treatment with carbendazim @ 2 g/kg + dicofol 18.5 EC @ 0.45% at 45 DAS and profenophos 50 EC @ 0.1% at 65 DAS favoured the plant height, reduced the insect pests and diseases and maximized the yield. At Cooch Behar, biofertilizer, biocontrol agent and biopesticides based organic production system performed at par with inorganic based treatments with highest B:C ratio.

The effect of sowing time and insecticides on insect pests of jute indicated that at Barrackpore initially till 37 DAS, the crop sown on 15th April harbored significantly more mite than the later sown crop. However, after 45 DAS the mite infestation in the late sown crop was significantly

more than the early sown crop. Similar trend was observed in Cooch Behar, Katihar and Kendrapara also. At Barrackpore, the fibre yield of earlier sown (15th April) crop with foliar spray of abamectin 1.8 EC (0.0015%) at 30 DAS and 45 DAS resulted in significantly higher fibre yield (35.89 q/ha). At Nagaon, the treatment effect on mite was non-significant.

The foliar spray of profenophos 50 EC @ 0.10% at 77 DAS and 87 DAS was most effective on semilooper and Bihar hairy caterpillar with significantly less plant damage. The fibre yield of early sown crop (21st April) was more (22.50 q/ha) than the late sown crop (20.67 q/ha). Similar trend was also observed at Kendrapara and Katihar. At Cooch Behar, significantly less mite infestation and more fibre yield of jute was recorded in fenazaquin 10 EC (0.015%) treatment. At Kendrapara, also the crop protected with fenazaquin and profenophos reduced mite and semilooper infestation significantly with maximum yield (31.4 q/ha). At Katihar, the best treatment against the sucking and lepidopteran pests with maximum fibre yield (27.14 q/ha) was abamectin 1.8 EC (0.015%) followed by lamda cyhalothrin 5 EC (0.003%).

In AVT-I, KRO 2 (*C. olitorius*) and JRC J-2 (*C. capsularis)* were least infested with mite and stem weevil respectively. Entries NOJ 27-4046 and JROK 1002 were best against stem and root rot resistance among the AVT-II trials of *C. olitorius*. The *capsularis* jute (AVT-II) entries, UBC 1 and NCJ 28-1 were significantly less infested with stem weevil and semilooper, respectively.

Fig. 11.1: Hon'ble DDG (CS), Prof. S. K. Datta inaugurating the 27th Annual Workshop of AINP on J&AF at CRIJAF, Barrackpore

The AVT-I roselle entry, JBRP 02 was superior in terms of foot and stem rot disease resistance.

Fig. 11.2: Inaugural address by Hon'ble DDG (CS), ICAR

Fig. 11.3: Inaugural address by Hon'ble ADG (CC), ICAR

Fig. 11.4: Welcome address by Prof. B. S. Mahapatra, Director, CRIJAF, Barrackpore

Fig. 11.5: Presentation of research achievements by Dr. S. Satpathy, In-Charge, AINP on J&AF

12. Krishi Vigyan Kendra

12.1. On Farm Trials

KVK Burdwan, during 2012-13 designed and implemented various programmes for farmers, farm women and rural youths which includes On Farm Testing (OFT) of various technologies for finding out location specificity, Front Line Demonstration (FLD) of established technologies, training of farmers, farm women, rural youths and extension workers etc., besides conducting other extension activities like exposure visits, field day, method demonstration etc.

Seven On Farm Trials were conducted by KVK to popularize different recommended technologies by farmers in different villages of the district. The salient findings of these OFTs were given below:

- OFT on performance of different varieties of jute under rainfed and medium upland situation of Burdwan district highlighted that JRO 204 and JRO 128 are to be promoted in the district as both have high return of 31.15 q/ha and 30.25 q/ha respectively.
- A study on performance of SRI under different modes of nutrition in medium upland soils of Burdwan indicated that there was nearly 32% increase in SRI with 100% inorganic nutrition while the respective increment for SRI with 75% inorganic + 25% organic nutrition was 36% over FP although both being statistically at par.
- Another study on varietal trial of tomato showed that most of the tomato growers in the study area used locally available cultivar (JK Deshi) which had low bearing habits and yield. Introduction of hybrids like Abinash 3 and Abhilash gave better results than the conventional ones. Abhilash was the best in terms of yield as well as production economy.
- Evaluation of poultry breed under backyard farming indicated that there was no significant ($p<0.05$) difference in number of egg production between Vanaraja and RIR breeds but weight of egg of RIR breed was significantly higher. The fighting habit of Vanaraja breed helps to adopt in free range farming situation in comparison to RIR. The Vanaraja breed of poultry are more capable to search feed in free range system.
- Evaluation of performance of different pig breeds in Burdwan under low input system concluded that White Yorkshire breed was more remunerative (B:C ratio of 1.59) as compared to Ghungroo and litter size at birth was significantly higher in ghungroo pig under low input system.
- OFT on IMC showed stocking optimum density of fish resulted in significantly higher productivity as compared to FP. However the practice of 15000 nos. per ha of fingerling resulted in significant differences in productivity. Therefore the OFT was also aimed at showing the farmers that they can stock the OFT stocking density i.e., 15000/ha.
- A study on kitchen garden indicated that diversified vegetables (cucurbits, brinjal, chilli, tomato, okra, bean and GLV) + mannuring + fertilizers had highest gross return of Rs 117000/ha/yr.

12.2. Front line demonstrations

A total of 114 FLDs were conducted on crop jute, rice, lentil, tissue cultured banana, mango, guava, ricebean, oat, berseem and IFS (Fig. 12.1). The salient findings of these FLDs are in Table 12.1.

Fig. 12.1: Demonstration of protected cultivation

Table 12.1: Details of FLDs conducted for various crops/entreprise

Crop/ Enterprise (Nos.)	Demonstration	Findings
Jute (65) JRO 204	Improved variety	22% increase in yield was recorded in JRO 204 (28.9 q/ha) compared to local check (23.7 q/ha).
Paddy (5)	SRI	33% increase in yield was recorded through SRI. Yield through SRI was 68.2 q/ha and that of farmers practice was 51.2 q/ha
Lentil (7) WBL 81	Improved variety	The yield of WBL 81 was 8.15 q/ha which is 2.5 % more than that of check having 6.65 q/ha
Tissue culture banana (7)	Production technology	TCB ensures better returns with high cost benefit ratio (3.10) within a short period of time and area compared to local variety. Best performance was observed when tissue culture banana was intercropped with vegetable.
Mango (8) var. Langra, Himsagar	Crop diversification	Result awaited
Guava (7) L 49	Crop diversification	Result awaited
Rice bean (fodder) (5) Bidhan 1	Improved production technology	25.64 % increase in yield was recorded.
Oat (fodder) (5) Kent	Improved production technology	13.9 % increase in yield was recorded
Berseem (fodder) (5) Wardan	Improved production technology	19.8% yield of Berseem increased using improved production technology.

12.3. Trainings

Various training programmes on diversified topic in agriculture, horticulture, animal science, fishery, plant protection, agricultural extension and home science were conducted by KVK to disseminate various improved technologies.

Practicing farmers and farm women: Sixty seven courses were conducted with 1800 benificiaries (Fig. 12.2)

Extension functionaries: Eight courses involving 195 extension personnel were conducted.

Rural youth: Six courses benefiting 180 rural youths.

Vocational training: Vocational trainings on preparation of kantha stitch, green house cultivation of high value vegetables and broiler farming was also conducted benefiting 360 rural youths (Fig. 12.3).

Sponsored Training: Six sponsored training were also conducted by KVK benefiting 341 farmers and farm women.

Fig. 12.2: Training on feed grinder

Fig. 12.3: Vocational Training on Kantha Stitch

12.4. Other Extension Activities

- Celebration of important days (Republic Day, Independence Day, World Vet. Day, World Food Day,

National Nutrition Day). Around 320 farmers, farm women and extension functionaries participated in it.

- 6 field days were conducted benefiting 230 farmers.
- 20 film shows were shown to farmers on various topics
- 3 Method Demonstrations were conducted on jute fibre extractor, cono weeder and castration which was attended by 105 farmers
- 52 diagnostic visit and 2 exposure visit.
- 12 animal health camp covering 700 farm families
- 25 agro mobile clinic reaching 800 farmers.

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

- Certified Paddy seed (MTU 7029) : 200 q
- Vegetables like tomato (*Abhilash, Avinash 3)*, brinjal (*Muktokeshi)* and cauliflower (*hybrid)* seedlings: 70,000 nos.

12.6. Seed Village Programme

Paddy seed production of 1100 q (MTU 7029, MTU 1010, Swarna Sub-1)) was done in 23 ha in three villages, *viz. Atpara, Sillaghat and Jharul* of Burdwan district in participatory mode.

12.7. Linkages

KVK BudBud is linked with different organization including ATMA (Fig. 12.4), RKVY, MGNREGA, NABARD, state line department and two universities viz., BCKV, Mohanpur, Nadia, West Bengal and Vishwa Bharati, Shantiniketan, West Bengal for conducting trainings, demonstrations, trials, workshops, projects and other activities.

Fig. 12.4: ATMA Katihar Visit by Farmers

13. Human Resource Development

13.1. Workshops/Meetings/Events

CRIJAF, Barrackpore

- Review Meeting and Monitoring of FLD was held at Central Research Institute for Jute and Allied Fibres, Barrackpore on 2nd April, 2012.
- Farmers' Awareness Camp on Improved Jute Production Technologies was organized at Manikchak, Malda on 10th April, 2012.
- Institute Research Council (IRC) meeting was held at Central Research Institute for Jute and Allied Fibres, Barrackpore on 3-4th April, 2012.
- Awareness camp on Improved Methods of Jute Retting was organized by CRIJAF at Manikchak, Malda on 23rd May, 2012.
- Institute Management Committee (IMC) Meeting was held at Central Research Institute for Jute and Allied Fibres on 29th May, 2012.
- Farmers' Day was held at Central Research Institute for Jute and Allied Fibres, Barrackpore, West Bengal on 30th June, 2012.
- Hindi Pakhwada was celebrated at Central Research Institute for Jute and Allied Fibres, Barrackpore from 14-28th September, 2012.
- Quinquennial Review Team (QRT) meeting was held at Central Research Institute for Jute and Allied Fibres on 25-27th April, 2012.
- Vigilance Awareness Week was celebrated at Central Research Institute for Jute and Allied Fibres, Barrackpore from 29th October to 3rd November, 2012.
- Quinquennial Review Team (QRT)-industry-scientists interactive meeting held during 16-17th November, 2012.
- 27th Annual Workshop of AINP on Jute and Allied Fibres was organized at Central Research Institute for Jute and Allied Fibres, Barrackpore from 10-11th February, 2013.
- Research Advisory Committee (RAC) meeting was held at Central Research Institute for Jute and Allied Fibres, Barrackpore during 7-8th March, 2013.

CSRSJAF, Budbud

- Quinquennial Review Team (QRT) meeting was held at Central Seed Research Station for Jute and Allied Fibres (CSRSJAF), Budbud on 26th April, 2012.
- Training-cum-awareness programme was conducted at CSRSJAF, Budbud regarding PPV&FR Act on 4th May, 2012.
- Training-cum-awareness programme was conducted on "Seed day" at Central Seed Research Station for Jute and Allied Fibres (CSRSJAF), Budbud on 22nd November, 2012

ShRS, Pratapgarh

- Quinquennial Review Team (QRT) meeting was held at Sunnhemp Research Station (ShRS) on June 4, 2012.
- Training-cum-awareness programme on Seed was organized at Sunnhemp Research Station (ShRS), Pratapgarh on 8th November, 2012.

RRS, Sorbhog

- Quinquennial Review Team (QRT) meeting was held at Ramie Research Station (RRS) on 25th May, 2012.
- Vigilance Awareness Week was celebrated at Ramie Research Station (RRS) Sorbhog, Assam from 29th October to 3rd November, 2012.
- Hindi (Rajbhasha) Week and Bhasan and Agricultural Knowledge Partiyogita was organized at Ramie Research Station (RRS), Sorbhog, Assam during 14-20th September, 2012.

SRS, Bamra

- Quinquennial Review Team (QRT) meeting was held at Sisal Research Station (SRS), Bamra on 13th May, 2012.
- Training on Improved Production Technology of Sisal Cultivation under TSP programme was conducted at Sisal Research Station (SRS) from 25-27th July, 2012.

13.2. Training imparted by CRIJAF

Name of the training	Place and Date	No. of participants
Improved Jute Production Technologies for Officers and Extension Personnel	CRIJAF, Barrackpore, 16-17th April, & 15th May, 2012	27
Improved Production Technology of Jute in Rainfed Condition for Farmers	Tokipur and Debkundu, Beldanga, 25-26th July, 2012	172
Improved Jute Production Technologies for Farmers	Manikchak, Malda, 9th August, 2012	25
Improved Jute Retting for Farmers	Gopalpur, Nadia, 25th August, 2012	50
Improved Production Technologies for Fibre and Seed Production of Jute and Mesta	CRIJAF, Barrackpore, 22th February, 2013	50
Field Extension Training for ARS Trainees	CRIJAF, Barrackpore, 24th February - 14th March, 2013	06
Soil Test & Targeted Yield Based Fertilizer Management for Enhancing Crop Productivity	CRIJAF, Barrackpore, 25 -27th February, 2013	22
Production Technology of Fibre Crops and their Marketing Management	CRIJAF, Barrackpore, 16 - 20th March, 2013	16

13.3.Participation in Agricultural Exhibition and Kisan Melas

Event	Place and Date
Science and Technology Exhibition	Palta, North 24 Parganas, 11-14th April, 2012
Global Conference on "Horticulture For Food, Nutrition and Livelihood Security"	OUA&T, Bhubaneswar, 28-31st May, 2012
Third International Agronomy Congress on " Agriculture Diversification, Climate Change Management and Livelihoods"	IARI, New Delhi , 26-31st November, 2012
"Kalyani Utsav"	Kalyani , 23-29th December, 2012
Joy Chandi Paryatan Utsav	Purulia, 29-31st December, 2012
Onda Block Krishi Mela	Bankura, 27-28th January, 2013
XI Agricultural Science Congress	OUA&T, Bhubaneswar, 7-9th February, 2013
Eastern Zone Regional Agricultural Fair and Agritech Krishi Mela	Ranchi, 22-24th February, 2013
Rashtriya Kisan Mela	Katihar, 17-18th March, 2013

13.4. Training undergone by the scientist and staff members of CRIJAF

Name of the training	Place and date	Name of the participant/s
Three Months FOCARS Mandatory Professional Attachment Training	NBPGR, New Delhi 3rd March-3rd June, 2012	Dr. A.N. Tripathi, Scientist
Three Months FOCARS Mandatory Professional Attachment Training	NBAII, Bangalore 3rd March-5th June, 2012	Dr. V. Ramesh Babu, Scientist
Three Months FOCARS Mandatory Professional Attachment Training	IARI, New Delhi 26th March-26th June, 2012	Dr. Amarpreet Singh, Scientist

Three Months FOCARS Mandatory Professional Attachment Training	DRR, Hyderabad 6th March-13th June, 2012	Mr. Anil Kumar, Scientist
Refresher Course of Directly Recruited Principal and Senior Scientists on Agricultural Research Management	NAARM, Hyderabad 5-18th June, 2012	Dr. A.K. Sharma, Sr. Scientist
Training Programme on Data Analysis Using SAS	NIRJAFT, Kolkata 25th February-2ndMarch, 2013	Dr. A. N. Tripathi, Dr. Amarpreet Singh, Dr. Asim Chakravarthy, Dr. V. Ramesh Babu

13.5 Participation of scientists in seminar/symposia

Seminar/Conferences/Symposia/Trainings	Place and Date	Participant/s
National Conference on "Livelihood and Environmental Security through Resource Conservation in Eastern Region of India"	OUAT, Bhubaneswar 5-7th April, 2012	Dr. D. K. Kundu Dr. D. Barman
XX Biennial Workshop of AICRP on Weed Control and Biennial Conference of Indian Society of Weed Science on "Weed Threat to Agriculture, Biodiversity and Environment"	KAU, Thrissur, Kerala 17-20th April, 2012	Dr. A. K. Ghorai Dr. M. Kumar
National Seminar on "Information Technology Mediated and Technology Driven Agricultural Development"	BAU, Ranchi 20-21th June, 2012	Dr. S. K. Jha
National Symposium on "Plant Microbe Interactions and Crop Health Management"	Visva Bharati, Sriniketan 6-7th October, 2012	Dr. R. K. De Dr. C. Biswas Dr. A. N. Tripathi
National Symposium on "Eco-Friendly Approaches to Pest Management for Sustainable Agriculture"	OUAT, Bhubaneswar 24-25th November, 2012	Dr. S. Satpathy Dr. K. Selvaraj
Third International Agronomy Congress on "Agriculture Diversification, Climate Change Management and Livelihoods"	IARI, New Delhi 26-30th November, 2012	Dr. B. S. Mahapatra Dr. S. R. Singh Dr. S. K. Pandey Dr. M. Kumar
International Conference on "Plant Health Management for Food Security"	NIPHM, Hyderabad 28-30th November, 2012	Dr. V. Ramesh Babu
National symposium on "Biotic and Abiotic Stresses in Plants Under Changing Climate Scenario"	UBKV, Coochbehar 29- 30th November, 2012	Dr. R. K. De Dr. A. N. Tripathi
National seminar on "Developments in Soil Science-2012"&"77th Annual Convention of Indian Society of Soil Science"	PAU, Ludhiana 3-6th December, 2012	Dr. A. R. Saha Dr. B. Majumdar
National Symposium on "Blending Conventional and Modern Plant Pathology for Sustainable Agriculture"	IIHR, Bangalore 4-6th December, 2012	Dr. R. K. De Dr. A. N. Tripathi
International Symposium on "Food Security Dilemma: Plant Health and Climate Change Issues"	BCKV, Kalyani 7-9th December, 2012	Dr. D. K. Kundu Dr. S. Sarkar Dr. P. Satya Dr. C. Biswas Dr. B. S. Gotyal
National Seminar on "Emerging Challenges and Paradigm for Sustainable Agri-Rural Development"	Solan, Himachal Pradesh 18-20th December, 2012	Dr. Shailesh Kumar
International Conference on "Extension Education in the Perspective of Advances in Natural Resource Management in Agriculture"	RAU, Bikaner 19-21th December, 2012	Dr. S.K. Jha

National Seminar on "Jute and Allied Fibres in Changing Times: Issues and Strategies"	NIRJAFT, Kolkata 3-5th January, 2013	All Scientists of CRIJAF
Fifth International Symposium on "Human Health Effects of Fruits and Vegetables"	UAS, Dharwad, Karnataka 7-11th January, 2013	Dr. C. S. Kar
International Conference on "Agriculture and Climate Change"	TERI, New Delhi 29-30th January, 2013	Dr. S.B. Choudhary Dr.H.K. Sharma
International Conference on "Bio-resource and Stress Management"	Science City, Kolkata 6-9th February, 2013	15 Scientists of CRIJAF
27th Annual Workshop of AINP on "Jute and Allied Fibres"	CRIJAF, Kolkata 10-11th February, 2013	All Scientists of CRIJAF
15th Indian Agricultural Scientists and Farmers Congress on "Agriculture and Global Climate Change"	Biovade Institute of Agriculture and Technology, Allahabad, 22-24th February, 2013	Dr. M. K. Tripathi
National Symposium on "In Quest of A Second Green Revolution"	University of Calcutta, Kolkata, 26-28th February, 2013	Dr. S. Sarkar
ARRW Golden Jubilee International Symposium on"Sustainable Rice Production and Livelihood Security : Challenges and Opportunities"	CRRI, Cuttack, 2-5th March, 2013	Dr. A. K. Ghorai

14. Awards and Recognition

- Dr. Debabrata Sarkar, Principal Scientist (Biotechnology), Division of Crop Improvement has been elected as a Fellow of the National Academy of Agricultural Sciences (NAAS) in 2013, for his significant contribution towards potato and jute biotechnology.
- Dr. M. K. Tripathi, Sr. Scientist (Agronomy) was awarded with Fellow of Bioved Research Institute of Agriculture and Technology (BRIAT) for outstanding contribution in the field of Agronomy on the occasion of 15th Indian Agricultural Scientists and Farmers Congress on Agriculture and Global Climate Change at Vigyan Parishad, University of Allahabad, India during 22-24th, February 2013.
- Dr. C. Biswas, P. Dey, Dr. S. Satpathy, and Dr. B. S. Mahapatra, were awarded the Best Poster Award under the category Biotic stress and management for poster on "Differential display of mRNA reveals variation among Begomo-viruses infecting jute (*Corchorus capsularis*, *C. olitorius*) and mesta (*Hibiscus sabdariffa*, *H. cannabinus*)" in the International Conference on Bio-resource and Stress Management, held at Science City, Kolkata, West Bengal, India, during 6-9th, February, 2013.
- Dr. A. Bera, Dr. C. S. Kar, Dr. P. Satya, Dr. Mukesh Kumar, Dr. H. R. Bhandari, and Dr. B. S. Mahapatra were awarded the Best Poster Award on "Effect of growth regulators on seed yield and seed quality parameters of *tossa* jute (*Corchorus olitorius* L.)" in the International Conference on Bio-resource and Stress Management, held at Science City, Kolkata, West Bengal, India, during 6-9th, February, 2013.
- Dr. M. K. Tripathi, Sr. Scientist (Agronomy) was awarded with Fellow of Hind Agri-horticultural Society (FHAS) for outstanding contribution in the field of Agronomy in the Seventh Annual General Body Meeting held at head office, Hind Agri-Horticultural Society, Muzaffarnagar, India on 16th December, 2012.
- Dr. B S. Gotyal, Dr. S. Satpathy and Dr. K. Selvaraj were awarded the Best Poster Award for the paper "Mechanism of resistance of wild jute to Bihar hairy caterpillar, *Spilosoma obliqua* Walker (Lepidoptera: Arctiidae)" in International Symposium on "Food Security Dilemma: Plant Health and Climate Change Issues held at BCKV, Kalyani, West Bengal, India during 7-9th, December, 2012.
- Dr. Sitangshu Sarkar, Sr. Scientist (Agronomy) was awarded "CWSS Fellow" for the Year 2012 by the Crop and Weed Science Society in the 8th Annual Conference of the Society at Bidhan Chandra Krishi Viswavidyalaya on 29th June 2012.
- Dr. Hombe Gowda H.C., Dr. Praveen Jakhar, Dr. D. Barman and Dr. M. Madhu were awarded the Best poster Award for the paper "Alley cropping system for higher productivity and natural resource conservation in shifting cultivated degraded lands of Eastern Ghats". National Conference on Livelihood and Environmental Security through Resource Conservation in Eastern Region of India (LESRC-2012) organized by Indian Association of Soil and Water Conservationists, Dehradun at Bhubaneswar, Odisha during 5-7th April, 2012.
- Three progressive farmers under KVK, Burdwan have been awarded for innovative contributions towards development of agriculture. Sri Tapan Nandi of Memari, Burdwan and Sri Sudhir Mandal of Kanksa have been felicitated with 'MAHINDRA SAMRIDDHI SAMMAN 2013" as 'BEST INNOVATIVE FARMER' from West Bengal for their originalities in developing organic farming system and modifications in SRI technology for wider adaptability, respectively. Sk. Soyeb Hossain of Galsi-I has received 'BEST FARMER' award from Department of Agriculture, Govt. of West Bengal for his endeavours in developing a fish-poultry-duck-crop integrated farming system.

15. Research Projects

Table 15.1: List of 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, P. Satya, S. B. Choudhary* and *Anil Kumar*	1997-Long term	1,2
JB 8.3	Development of high yielding and disease resistant varieties in tossa jute (*Corchorus olitorius*) with quality fibre. *C S. Kar, S.K. Sarkar* and *A.K. Ghorai*	2008-13	5
JB 8.4	Breeding for higher fibre yield and quality in *Corchorus capsularis* *J. Mitra* and *C. S Kar*	2009-13	4
JBT 4.1	Biotechnology for Jute and Allied Fibres Improvement *D. Sarkar* and *P. Satya*	2010-15	23
JB 8.5	Development of improved genotypes of mesta resistant to biotic stress with enhanced fibre yield and quality *S.K. Pandey, P. Satya, H.K. Sharma, S. Satpathy* and *R.K. De*	2010-15	7,9
JB 8.6	Assessment of genetic diversity and development of a core collection in *C. olitorius* *P. Satya, D. Sarkar* and *C.S. Kar*	2010-14	3
JB 8.7	Investigations on possibilities of cultivated and wild species hybridization in jute and mesta for germplasm base broadening *P. Satya, J. Mitra, S.K. Pandey* and *S.B. Choudhary*	2010-14	3,7,10
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	6
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 *P. Satya*	2010-13	9
JB 9.1	Improvement of fibre yield in tossa jute through heterosis breeding *Anil Kumar, C. S. Kar* and *J. Mitra*	2011-15	7
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 *Hem Raj Bhandari*	2012-15	6
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 *H.K. Sharma*	2012-17	26
Crop Protection			
JE 1.1	Integrated management of kenaf pests with special reference to mealybug *S. Satpathy* and *B.S. Gotyal*	2009-14	48

JE 1.3	Ecology and management of jute hairy caterpillar, *Spilosoma obliqua* Walker *K. Selvaraj, S. Satpathy* and *B. S. Gotyal*	2011-13	43
JE 1.4	Determination of single and multiple pests economic injury levels in jute *K. Selvaraj* and *B. S. Gotyal*	2012-14	44
JM 8.0.	Management of stem rot disease of jute *R. K. De, Chinmay Biswas* and *S.K. Sarkar*	2009-13	49,51
JE 1.2	Identifying the sources and mechanism of resistance against major pests of jute *B.S. Gotyal* and *S. Satpathy*	2010-13	45,46,47
JM 8.1	Studies on *Beauveria bassiana* for managing jute pests and diseases *Chinmay Biswas, S. Satpathy* and *B.S. Gotyal*	2010-13	53
JM 8.2	Studies on induction of resistance against jute pests and diseases by chemical elicitors *Chinmay Biswas, B.S. Gotyal, S.K. Sarkar* and *H. Chowdhury*	2010-13	54
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	52
Crop Production			
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* and *A. R. Saha*	2011-15	42
JA 5.3	Integrated weed management of jute with special reference to smother crops *A.K. Ghorai, Mukesh Kumar, B. Majumdar, H. Chowdhury* and *D. K. Kundu*	2011-13	57
JA 5.4	Improving water productivity of jute and its retting under limited water in changing climatic scenario *A.K. Ghorai, H. Chowdhury, D. K. Kundu, B. Majumdar, Mukesh Kumar* and *D. Barman*	2011-13	38
JA 5.6	Assessment of productivity and nutrient management for selected jute-based cropping system *M. Kumar, A.K. Ghorai, S. Mitra* and *S. R. Singh*	2011-16	37
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, A.R. Saha, B. Majumdar, A.K. Ghorai, S. R. Singh, B.S. Mahapatra* and *Sonali Paul Mazumdar*	2001-Long term	27
JA 5.5	Evaluation of promising jute varieties for higher nitrogen use efficiency *S. Mitra, M. Kumar, D. K. Kundu,* and *S. R. Singh*	2011-13	35
JC 5.6	Soil test and resource based integrated plant nutrient supply system for sustainable agriculture (AICRP) *S.R. Singh, B. Majumdar* and *A.R. Saha*	2005-06 (Continuing)	25,28,30
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 *S.R. Singh, B. Majumdar* and *A.R. Saha*	2010-14	31
JC 6.3	Inoculum potential, symbiotic effectiveness and compatibility of *Bradyrhizobium* spp. with sunnhemp cultivars *S.R. Singh, B. Majumdar* and *M.K. Tripathi*	2010-14	35

JC 6.4	Studies on combined efficacy of plant extracts with synthetic insecticides and fungicides against pest and diseases of jute and mesta *H. Chowdhury, S.K. Sarkar, R.K. De* and *K. Selvaraj*	2012-16	47,54
JC 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	60
Expl. A1	Use of jute fabrics in field crops *A.K.Ghorai, H. Chowdhury* and *D.K. Kundu*	2011-13	40
Expl. A2	Jute seed cum fibre production in jute fibre growing belt *A.K.Ghorai, H. Chowdhury, D.K. Kundu , C.S. Kar* and *S.K. Sarkar*	2011-13	39
Expl. A3	Assessment of nutrient management options in jute seed crop *Amarpreet Singh*	2012-13	21
Expl. A4	Assessment of planting methods and nutrient management options in jute seed crop *Amarpreet Singh*	2012-13	20
Agricultural Extension			
JEXA 4.7	Frontline demonstrations on jute under Mini Mission-II of Jute Technology Mission *Shailesh Kumar, U.N. Borkar, Shamna A., S. Sarkar* and *S.K.Jha*	2006-13	69
JEXA 4.8	Assessment of jute based multiple cropping sequences in farmers' fields of major jute growing districts of West Bengal *S.K.Jha, A. Shamna, Shailesh Kumar* and *S.Sarkar*	2009-14	70
JEXA 4.9	Jute cultivation - an analysis on research, farmer and industry linkage *A. Shamna, S. Sarkar* and *S.K.Jha*	2010-13	71
JEXA 5.0	Assessment of jute production technologies under deficit rainfall in changing climate scenario *Shailesh Kumar* and *A. K. Ghorai*	2010-13	72
All India Network Project on Jute and Allied Fibres			
AINP	All India Network Project on Jute and Allied Fibres *S. Satpathy, S. Mitra* and *S. K. Pandey*	Long Term	77
Sunnhemp Research Station, Pratapgarh, U.P.			
SNHA 1.6	Residual effect of sunnhemp on wheat in rice-wheat cropping system *M. K. Tripathi* and *S. R. Singh*	2010-14	40
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	2,15
SNHB 1.9	Population improvement of sunnhemp for fibre yield *B. Chaudhary, S. K. Pandey* and *M. K. Tripathi*	2011-16	-
Ramie Research Station, Sorbhog, Assam			
RB 1.0	Collection, maintenance and evaluation of ramie germplasm *A. K. Sharma* and *S.P. Gawande*	Long Term	10,11,12,49
RB 2.3	Genetic improvement for yield, fiber quality and wider adaptability in ramie through induced mutations *A.K. Sharma* and *S.P. Gawande*	2010-13	13

RB Expl.1	Efficacy of different fungicides against foliar diseases of ramie *S.P. Gawande*	2011-13	55,56
Sisal Research Station, Bamra, Odisha			
SLC 1.4	Feasibility of growing annual intercrops in sisal plantation in plateau region of India *S. Sarkar, D. K. Kundu, A. R. Saha* and *B. Majumdar*	2011-13	41
SLM 1.0	Studies on disease distribution, intensity and identification of sources of resistance against *Phytophthora* spp. causing zebra disease of sisal (*Agave sisalana*) *Ajit Kr. Jha, S. Sarkar* and *R.K.De*	2012-14	56
SLM 1.1	Bio-intensive management of zebra disease of sisal (*Agave sisalana*) *Ajit Kr. Jha, S. Sarkar, R.K. De* and *B. Majumdar*	2012-16	56
Central Seed Research Station For Jute And Allied Fibres, Budbud, West Bengal			
JAFSP 2.2	Enhancement of seed yield of tossa jute through application of plant growth regulators *A. Bera*	2009-13	20
Krishi Vigyan Kendra, Budbud, Burdwan		Long Term	84

Table 15.2: List of externally funded projects

Project No.	Project Title & Principal Investigator/Nodal officer	Duration	Results cited in the page No.
MSP	Seed production in agricultural crops and fisheries *C. S. Kar*	2006-2007 (Continuing)	18
BSP 1.0 AI-CRP-NSP (crop)	Breeder seed production of jute, mesta and sunnhemp *C.S. Kar*	Long Term	16
DAC	Protection of jute varieties and DUS testing *J. Mitra*	2002-13	7
DBT-ATL	Accredited Test Laboratory (ATL) for National Certification System for Tissue Culture Derived Plantlets (NCSTCP) *D. Sarkar*	2011-14	25
RKVY	Component I: Development of hybrid jute Nodal officer: Director, CRIJAF	2012-15	6
RKVY	Component II: Production of quality jute seed Nodal officer: Director, CRIJAF	2012-15	19
DST, West Bengal	Jute seed production in West Bengal: Exploring a new horizon *A.Bera*	2010-13	18
JCI	Large scale production of CRIJAF jute retting consortium for demonstration in jute growing areas of West Bengal *B. Majumdar*	2010-13	63
JTMAE 1.0 (JCI)	Development of jute ribonner (Under JTM, MM-III) *U.N. Borkar*	2008-13	61
NFBSFARA	Genomics for augmenting fibre quality improvement in jute *D. Sarkar*	2011-16	25

NFBSFARA	Understanding genetics and biochemistry of gum in ramie for developing low gum genotypes *P. Satya*	2012-15	13
MM-II of JTM	Adaptive research on jute seed production in West Bengal *C. S. Kar*	2011-13	18
TMJ(MM 1.1)	Identification and development of promising genotypes through interspecific hybridization in jute *C. S. Kar*	2006-13	
TMJ (MM 1.2)	Evaluation and selection of improved jute variety for finer quality fibre *P.G. Karmakar*	2007-13	1
TMJ (MM 1.3)	Improved management and degumming technology of ramie for higher productivity and better fibre quality *S. Mitra*	2007-13	64
TMJ (MM 1.5)	Drought management of jute and mesta crop under deficit rainfall *A.K. Ghorai*	2007-13	59
TMJ (MM 1.7)	Improvement of fibre quality through microbial, enzymatic and chemical treatment in jute *B. Majumdar*	2007-13	62
TMJ (MM 1.8)	Jute informatics and coordination cell *A. K. Chakraborty*	2007-13	65

16. Publications

16.1 Research Papers

Balasubramanian, A., Das, S., Bora, A., Sarangi, S., and Mandal, A. B. (2012). Comparative analysis of structure and sequences of *Oryza sativa* super oxcide dismutase. *American Journal of Plant Sciences,* 3: 1311-1321.

Bansal, S., Sharma, A. K. and Sengar, R. S. (2012). Major land marks and significance of biotechnology in agriculture. *Vegetos*, 25(1): 83- 88.

Barman, D., Saha, A. R., Kundu, D. K. and Mahapatra, B. S. (2012). Rainfall characteristics analysis for jute based cropping system at Barrackpore, West Bengal. *Indian Journal of Agricultural Physics*, 12(1): 23-28.

Bhattacharya, S. K., De, R. K., Bandopadhyay, A., Sen, K. and Sengupta, C. (2012). Integration and interaction of some bioagents with fungicide, weedicide and plant growth regulator in jute disease management. *Journal of Mycopathological Research,* 50(1): 131.

Biswas, C., Dey, P. and Satpathy, S. (2013). A multiplex nested PCR assay for simultaneous detection of *Corchorus* golden mosaic virus and a phytoplasma in white jute (*Corchorus capsularis* L.). *Letters in Applied Microbiology*, 56: 373-378.

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17. Library, Information and Documentation Unit

The Institute library has rich collection of books and journals of Agro-Biology especially on jute and other fibres crops such as flax, mesta, ramie, sisal, sunnhemp, etc. Library maintains its designated services and activities of acquisition of books and journals, exchange of literature, cataloguing and documentation. This library procures documents on different subjects such as Agronomy, Soil Science, Plant Breeding, Genetics, Entomology, Plant Pathology, Seed Science, Plant Physiology, Environment, Engineering by subscribing 100 journals including 25 foreign and 75 Indian journals. Presently, it holds 60 popular magazines, all newsletters, proceedings, books, research highlights of the ICAR Institutes, SAU's and other useful reading material from relevant organizations. At present, the library has a collection of 10000 books and 11720 bound journals. Newspaper clippings of related subjects are prepared and maintained for future use.

The CRIJAF publications were provided to over 350 different organizations in India and abroad. CRIJAF Annual Report, AINP Annual Report, Newsletters and other publications were distributed to different stakeholders and visitors from India and abroad. Library also provided the internet and reprography service to the readers. Recently, Document Delivery Service Systems by CeRA to access Science Direct journals through library has been introduced. As per consortium, this library under the Document Delivery Service Systems has sent copies to all researchers on request.

Fig. 17.1: Scientists and students are the regular users of library

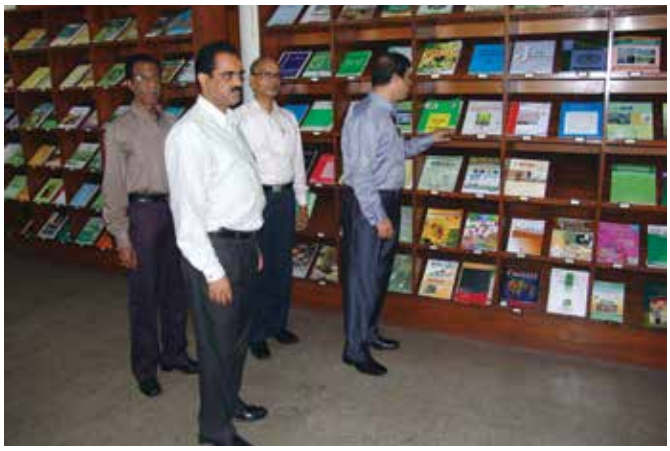

Fig. 17.2: Display of journals in the library

18. AKMU, ITMU and PME Cell

18.1 Agricultural Knowledge Management Unit (AKMU)

The AKMU maintains the website of the institute and provides internet facility to all users through LAN. *E-mail* facility has been provided to all the scientists. The server space (900MB) has been hired from BSNL for above purpose. Both POP and Web access is available in *E-mail* services. The Institute's web site *www.crijaf.org.in* has been reconstructed as per ICAR guidelines. The main objective of the website is to provide information about the technologies developed by CRIJAF, details about the organizational structure, mandate, research projects, staff and publications related to the institute. Besides the information about the events and the reports related to them, the facilities available in the institute, tender and recruitment notices are also featured in the website. The website also contains the RTI related matter and FAQs particularly useful for the farmers.

The LAN contains more than 80 nodes located at 5 different buildings. The main purpose of networking is to provide internet and print file sharing. The OFC backbone network has peer-to-peer connection. Recently internet backbone has been upgraded by converting UTP (Unshielded Twisted Pair) to OFC (Fibre-optic communication) in the stretch from Crop Protection building to Biotechnology Laboratory. AKMU also provides all facilities related to computer to all the users. Besides, AKMU also facilitates the multimedia presentations *viz*. various lectures, trainings, workshops, seminars and symposia. Personal Management Information System (PERMIS) and Project Information & Management System (PIMS) of ICAR is also maintained by AKMU.

18.2 Institute Technology Management Unit (ITMU)

ITMU of CRIJAF has been established as per ICAR guideline. It deals with all intellectual property (IP) protection, maintenance & technology transfer/ commercialization related matter at the institute level, and any other administrative or policy decision taken in the ICAR from time to time. ITMU & ITMC (Institute Technology Management Committee) of CRIJAF chaired by the Director is the highest decision making body at the institute level. MoU for commercialization of "Nail Weeder" and "Herbicide Brush" were signed with M/s Creative Displayer, Barrackpore, Kolkata during August 2012. Two bulletines were published on (1) Commercialized and Commercializable Technologies CRIJAF, (2) Protection of Jute Varieties - present status. CRIJAF technologies were displayed at **'Agri-Business Camp and Entrepreneurs Meet'** by the ITMU.

- **'Agri-Business Camp'** organized by NIRJAFT, Kolkata in collaboration with Bengal National Chamber of Commerce and Industries (BNCCI), Kolkata and Agri-Business Incubator, ICRISAT, Hyderabad held at BNCCI House, Kolkata on 18.03.2013
- **'Agri-Business Camp'** at National Research Centre on Pig, Rani, Guwahati, Assam on 13.02.2013
- **'Entrepreneurs Meet'** organized by Zonal Technology Management (ZTM) & Business Planning and Development (BPD) unit at NIRJAFT (ICAR), Kolkata during September 25-26, 2012
- **'Agri-Business Camp'** at DWM, Bhubaneswar, Odisha organized by ZTM&BPD Unit, NIRJAFT, Kolkata in association with Agribusiness Incubation Program, ICRISAT, on May 2, 2012.

18.3 Prioritization, Monitoring & Evaluation (PME) Cell

The PME cell of CRIJAF was established as per guidelines of the Council. It comprises of a group of four scientists headed by a Principal Scientist and one technical officer. Important activities performed by the cell are conducting Institute Research Council (IRC) meeting, 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*

Monitoring (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 has a Women's cell in place consisting of the women staffs across the scientists, technical officers and administrative personnels. The cell actively participates in women-related activities, besides mitigates the issues pertaining to the grievances of the women staffs. Women's cell conducts investigations on these matters by forming committees comprising of all the members of Women's Cell under the chairmanship of Dr. A. Shamna, Scientist (Agril. Extension Section) & Chairperson, Women's cell, Mrs. Geeta Venkata Krishnan (External Member & Director, Hope Foundation, Kolkata) and Dr. S. Satpathy (Head, Crop Protection & Vigilance officer, CRIJAF). On the basis of the recommendations of the committee the grievance-related matters are amicably solved.

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 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, बामड़ा, 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–I (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 स्वीकृति प्रदान की है।

राजभाषा गतिविधियाँ

केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान में भारत सरकार की राजभाषा नीति का अनुपालन सुनिश्चित करने के लिए संस्थान में एक राजभाषा 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 हैं:–

प्रशासनिक उपलब्धियाँ

संस्थान ने प्रशासन के क्षेत्र में भी काफी महत्पूर्ण उपलब्धियाँ प्राप्त की हैं:–

- 21 विहित फार्मों एवं 10 मानक मसौदे द्विभाषी हैं तथा बाकी फार्मों एवं मानक मसौदों का द्विभाषी रूप तैयार किया जा रहा है।
- अधिकांश रजिस्टरों के शीर्षक द्विभाषी हैं। बाकी रजिस्टरों के शीर्षक द्विभाषी रूप में किये जा रहें हैं।
- संस्थान में अधिकांश 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 बैठकें सिर्फ राजभाषा में 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, तथा बाकी में हिन्दी सॉफ्टवेयर लगाकर द्वि भाषी रूप में काम करने की व्यवस्था की जा रही 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 में "हिन्दी पखवाड़ा" का आयोजन

केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान, बैरकपुर, कोलकाता में दिनांक 14–28 सितम्बर, 2012 तक हिन्दी पखवाड़ा का आयोजन किया गया। समारोह का उद्घाटन 14 सितम्बर, 2012 को डा. बी0 एस0 महापात्र, निदेशक, के.प.स.रे.अ.सं. ने दीप प्रज्ज्वलित कर किया। उद्घाटन समारोह के अध्यक्ष एवं संस्थान के निदेशक, डा. बी.एस. महापात्र ने अपने संबोधन में कहा कि संविधान सभा द्वारा राज–काज चलाने के लिए तथा केन्द्र व राज्यों के बीच सम्पर्क भाषा की भूमिका निभाने का उत्तरदायित्व हिन्दी को ही सौंपा है, क्योंकि यह देश के अधिकांश भाग में बोली व समझी जाती है। किसी भी देश या वर्ग विशेष की पहचान उसकी भाषा और संस्कृति से होती है इसलिए हमें अपनी पहचान बनाए रखने के लिए राजभाषा हिन्दी को अपनाना आवश्यक है। हिन्दी भाषा को हम राष्ट्र भाषा के रूप में पहचानते हैं। हिन्दी भाषा विश्व में सबसे ज़्यादा बोली जाने वाली तीसरी भाषा है। विश्व में 500 से 600 मिलियन लोग हिन्दी भाषा का प्रयोग करते हैं। उन्होंने कहा कि हमें केवल हिन्दी पखवाड़ा मनाने मात्र तक सीमित नहीं रहना है, बल्कि यह संकल्प भी लेना है कि हम अपना अधिकाधिक कार्यालयीन कार्य हिन्दी में करने का प्रयत्न करें। डा. सुब्रत सत्पथी, प्रभागाध्यक्ष, फसल सुरक्षा ने संस्थान में समय–समय पर आयोजित होने वाली राजभाषा हिन्दी से संबंधित आयोजनों पर संतोष व्यक्त करते हुए कहा कि इससे संस्थान के अधिकारियों एवं कर्मचारियों में हिन्दी कार्य के प्रति जागरूकता बढ़ेगी और वे अपने कार्यालयीन कार्यों में इसका अधिकाधिक प्रयोग कर सकेगें। डा. डी.के. कुण्डु, प्रभागाध्यक्ष, फसल उत्पादन ने सभी से अपना अधिकाधिक कार्य हिन्दी में करने का आह्वान किया तथा यह सुझाव दिया कि संस्थान के

वेबसाइट में हिन्दी–अंग्रजी वाक्यांश को अपलोड़ किए जाएं जिससे फाइलों में नोटिंग करते वक्त प्रशासनिक पदबंधों का प्रयोग किया जा सके।

डा. बी.एस. महापात्र, निदेषक दीप प्रज्ज्वलित कर हिन्दी पखवाड़ा का उद्घाटन करते हुए।

इस समारोह में डा. विनोद कुमार, सहायक प्राध्यापक (हिन्दी), पश्चिम बंग विश्वविद्यालय, बारासात, कोलकाता मुख्य वक्ता के रूप में सादर आमंत्रित थे। उन्होंने अपने व्याख्यान में कहा कि संस्कृत और हिन्दी देश के दो भाषा रूपी स्तंभ हैं जो देश की संस्कृति, परंपरा और सभ्यता को विश्व के मंच पर बखूबी प्रस्तुत करते हैं। आज विश्व भर से विद्यार्थी हमारी भाषा और संस्कृति को जानने के लिए हमारे देश का रूख कर रहे हैं। हिन्दी बहुत ही सरल, सहज और आसान भाषा है जिसका हमें सर्वाधिक प्रयोग करना चाहिए।

कार्यक्रम का संचालन करते हुए डा. सुरेन्द्र कुमार पाण्ड़ेय, वरिष्ठ वैज्ञानिक एवं प्रभारी, हिन्दी कक्ष ने इस सुअवसर पर उपस्थित अधिकारियों एवं कर्मचारियों का संस्थान की राजभाषा कार्यान्वयन समिति की ओर से हार्दिक स्वागत करते हुए उन्हें हिन्दी पखवाड़ा के अन्तर्गत आयोजित किए जानेवाली विभिन्न हिन्दी प्रतियोगिताओं के बारे में जानकाकरी दी। उन्होंने संस्थान के सभी वर्ग के कर्मचारियों से सरकारी काम–काज में अधिक से अधिक हिन्दी का प्रयोग करने के लिए अनुरोध किया।

इस पखवाड़ा के अन्तर्गत कई कार्यक्रम आयोजित किए गए। दिनांक 14 सितम्बर, 2012 को तात्कालिक भाषण, 15 सितम्बर, 2012 को हिन्दी टिप्पण एवं मसौदा लेखन प्रतियोगिता 18 सितम्बर, 2012 को वाद–विवाद

संस्थान में हिन्दी पखवाड़ा समारोह के अवसर पर हिन्दी प्रतियोगिताओं में भाग ले रहे प्रतिभागीगण।

प्रतियोगिता, 19 सितम्बर, 2012 को शब्द पर्याय, वाक्यांश लेखन तथा अनुवाद प्रतियोगिता, 22 सितम्बर, 2012 को हिन्दी निबंध लेखन प्रतियोगिता, 24 सितम्बर, 2012 को हिन्दी श्रुतलेखन एवं पठन प्रतियोगिता, 25 सितम्बर, 2012 को हिन्दी अनुलेखन एवं पठन प्रतियोगिता, 26 सितम्बर, 2012 को हिन्दी टंकण प्रतियोगिता तथा 27 सितम्बर, 2012 को हिन्दी में लेख, पुस्तिका प्रकाशन हेतु वैज्ञानिकों के साथ विचार–विमर्श आदि का आयोजन किया गया। इन कार्यक्रमों में संस्थान के सभी वर्ग के अधिकारियों व कर्मचारियों ने उत्साहपूर्वक भाग लिया।

डा. एस.के. पाण्ड़ेय, वरि. वैज्ञानिक एवं प्रभारी, हिन्दी कक्ष स्वागत भाषण देते हुए

दिनांक 28 सितम्बर, 2012 को हिन्दी पखवाड़ा का समापन एवं पुरस्कार वितरण समारोह का आयोजन किया गया। संस्थान के निदेशक डा. बी.एस.महापात्र ने अपने संबोधन

में संस्थान में राजभाषा हिन्दी पखवाड़ा तथा इस दौरान आयोजित विभिन्न हिन्दी प्रतियोगिताओं के सफल आयोजन पर अपनी खुशी जाहिर की तथा उन्होंने आशा व्यक्त किया कि इससे संस्थान में हिन्दी के प्रयोग में उत्तरोत्तर प्रगति होगी। श्री मनोज कुमार पचौरी, वरिष्ठ प्रशासनिक अधिकारी ने अपने संबोधन में कहा कि 14 सितम्बर, 1949 को संविधान सभा ने एक मत से यह निर्णय लिया कि हिन्दी ही भारत की राजभाषा होगी। इसी महत्वपूर्ण निर्णय के महत्व को प्रतिपादित करने तथा हिन्दी को हर क्षेत्र में प्रसारित करने के लिए राष्ट्रभाषा प्रचार समिति, वर्धा के अनुरोध पर सन् 1953 से संपूर्ण भारत में 14 सितम्बर को प्रतिवर्ष हिन्दी–दिवस के रूप में मनाया जाता है। अतः हम सभी का कर्तव्य बनता है कि राजभाषा हिन्दी का प्रयोग कार्यालयीन कार्य में अधिकाधिक करें। श्री के.पी. नाथ, वित्त एवं लेखा अधिकारी ने प्रशासनिक कार्य को हिन्दी में करने पर बल दिया।

विभिन्न प्रतियोगिताओं में प्रथम, द्वितीय व तृतीय स्थान प्राप्त करने वाले प्रतियोगियों को निदेशक, डा. बी.एस. महापात्र, डा. डी.के. कुण्डु, प्रभागाध्यक्ष, फसल उत्पादन, श्री मनोज कुमार पचौरी, वरिष्ठ प्रशासनिक अधिकारी एवं श्री के.पी. नाथ, वित्त एवं लेखा अधिकारी के द्वारा पुरस्कार प्रदान किए गए। समापन समारोह संस्थान के निदेशक डा. बी.एस. महापात्र की अध्यक्षता में सम्पन्न हुआ। उन्होंने अपने समापन संबोधान में संस्थान के वैज्ञानिकों, अधिकारियों, कर्मचारियों से अनुरोध किया कि हिन्दी के प्रगामी प्रयोग को बढ़ावा देने के लिए जो कुछ भी किया जा रहा है वह निःसन्देह सराहनीय है, क्योंकि वैज्ञानिक उपलब्धियों को आम किसानों तक पहुंचाने का यह एक उचित माध्यम है और इसका निरन्तर प्रयोग हम सबका दायित्व बनता है। कार्यक्रम का समापन धन्यवाद ज्ञापन के साथ सम्पन्न हुआ ।

21. Committees

21.1 The Quinquennial Review Team (QRT)

The Indian Council of Agricultural Research constituted the Quinquennial Review Team (QRT) to review the functioning and progress of research and other relevant activities undertaken by the CRIJAF and the AINP (J&AF) centres during the five year period from 2007 to 2012.

The QRT consisted of Padmashree Dr. M. Mahadevappa Ex-Chairman, ASRB and Former Vice Chancellor, UAS, Dharwad as Chairman, Dr. B. Senapati, Ex-Vice Chancellor, OUAT, Bhubaneswar, Prof. M. Hossain, Former Jute Breeder, BCKV, Kalyani, Dr. B. K. Mandal, Ex. Head, Department of Agronomy, BCKV, Kalyani and Dr. A. K. Gogoi, Zonal Project Director as Members and Dr. S. Satpathy, Head, Division of Crop Protection, & In-charge, AINP (J&AF) acted as the Member Secretary. The QRT visited CRIJAF, Barrackpore and its regional stations at Budbud, Bamra, Sorbhog and Pratapgarh and reviewed the progress, present activities and infrastructure facilities. The members also visited most of the centres of AINP on jute and allied fibres and had interactive meetings with the scientists to review the progress (Table 21.1). The QRT interacted with the Director, HoDs and Scientists of CRIJAF, Barrackpore on 25.04.12 and reviewed the progress of research work, visited the laboratories, farm and other infrastructure facilities of the institute. Final report was submitted after discussion with the scientists of different AINP (J&AF) centres, representatives of jute industry and heads of other institutes involved in jute research and marketing.

21.2 Research Advisory Committee (RAC)

Meetings of the Research Advisory Committee (RAC) the institute was held during 7-8th March, 2013 under the chairmanship of Dr. P. Raghava Reddy, former Vice Chancellor, ANGRAU, Hyderabad. Dr. B.N. Singh, Ex-DoR, BAU, Ranchi, Dr. S.K. Mukhopadhyay, former VC, Viswa Bharati and Prof. K.P. Pandey, IIT, Kharagpur attended the meeting as members.

Table 21.1: Visit schedule of QRT

Date	Place	Station /centre reviewed
25.04.12	Barrackpore	CRIJAF, Barrackpore
26.04.12	Budbud	CSRSJAF, Budbud
27.04.12	Kalyani	BCKV, Kalyani
13.05.12	Bamra	SRS, Bamra
14.05.12	Kendrapara	JRS, Kendrapara
15.05.12	Amadalava-lasa	ARS, Amadalavalasa
21.05.12	Nagaon	RARS, Nagaon
22.05.12	Sorbhog	RRS, Sorbhog
04.06.12	Pratapgarh	ShRS, Pratapgarh
05.06.12	Bahraich	CRS, Bahraich
19.08.12	Coochbehar	UBKV, Coochbehar
16.11.12	Barrackpore	TRRI (Aduthurai), MPKV (Rahuri), JRS (BAU, Katihar)
17.11.12	Barrackpore	Interaction with industries, Scien-tists and other stakeholders

Fig. 21.1: Quinquennial Review Team (QRT) meeting in progress

Dr. D.K. Kundu Head, Crop Production Division acted as the Member Secretary. Few important recommendations are as follows:

- The research programmes must be taken up in project mode/discipline wise in case of the jute and allied fibre crops viz. ramie, sisal, sunnhemp and flax in respect of Crop Improvement, Crop Production,

Crop Protection and Post-Harvest Technologies.

- The biotechnological research in terms of genomics and marker identification and its utilization for genetic enhancement has to be strengthened and augmented with all commitment and dedication.
- Pre-breeding material has to be generated involving more diverse related species/lines/genotypes so that good segregating material is available so as to select elite genotypes with high productivity, good fibre quality, possessing tolerance for biotic and abiotic stresses.
- Varieties/hybrids should be developed with high quality fibre with less lignin content in jute and less gum content in ramie by conventional and molecular approaches
- Basic research has to be conducted in all the allied fibre crops (ramie, sisal, flax and sunnhemp) regarding inheritance of all economic parameters and fibre quality traits.
- Refine and standardize the INM practices including its impact on fibre quality in cropping system mode, and evolve profitable cropping systems to enhance economic returns to the farmers. Profitable inter-crops are to be developed for major farming situations.

Fig. 21.2: Research Advisory Committee (RAC) meeting in progress

21.3 Institute Management Committee (IMC)

The meeting of the Institute Management Committee (IMC) of CRIJAF, Barrackpore was held on 29.05.12 under the chairmanship of Director, Prof. B.S. Mahapatra and others members present in the meeting were Dr. K.K. Satapathy, Director, NIRJAFT and Prof. P.K. Sur, Chairman, Kalyani Municipality. The IMC members were apprised of research achievements for the year 2012-13 and other various issues like financial matters, budget utilizatization, condemnation of vehicles and administrative matters were discussed.

Fig. 21.3: Institute Management Committee (IMC) meeting in progress

21.4 Institute Research Council (IRC)

The meeting of the institute research council was conducted during April 3-4, 2012 at institute under the chairmanship of Director, Prof. B.S. Mahapatra. All the HoDs, Scientists from the regional stations, Programme Coordinator, KVK, Burdwan and Dr. A. K. Jana, Ex-Principal Scientist and PMC member were also present in the IRC meeting. Progress of the ongoing research projects were reviewed. On successfull completion, 13 research projects were concluded with specific recommendations. Further, 11 new research project proposals were discussed and necessary modifications were recommended. Eleven (11) new research projects on jute and allied fibres under TMJ (12th Plan) were thoroughly discussed and approved by the committee.

Fig. 21.4: IRC Meeting in progress.

21.5 Results-Framework Document (RFD) Committee

Results-Framework Document (RFD) Committee of the institute was constituted as per the guidelines of the ICAR. The committee meets periodically to discuss and finalize the success indicators of the monthly RFD, midterm and annual RFD performance report before sending to ICAR.

The institute set a very good performance standard and achieved a total composite score of 89% for the year under report (2012-13).

22. Distinguished Visitors

S.No	Name of the visitor	Affiliation	Date
CRIJAF, Barrackpore			
1	Padmashree Dr. M. Mahadevappa	Ex-Chairman, ASRB, New Delhi and Chairman, QRT, CRIJAF	25.04.2012 17.11.2012
2	Dr. B. Senapati	Former Vice Chancellor, OUAT, Bhubaneshwar	25.04.2012 17.11.2012
3	Dr. S.K. Biswas	Director, Directorate of Jute Development, Govt. of India, Kolkata	02.04.2012 30.06.2012 10.02.2013
4	Dr. P. Raghava Reddy	Chairman, RAC, CRIJAF and Former Vice Chancellor, ANGRAU, Hyderabad	25.04.2012 10.02.2013 07.03.2013
5	Dr. K. K. Satapathy	Director, NIRJAFT, Kolkata, West Bengal	29.05.2012 17.11.2012 07.03.2013
6	Shri Rabindranath Bhattacharya	Hon'ble Minister-In-Charge for Agriculture, Govt. of West Bengal	30.06.2012
7	Swami Vishwamoyananda	Ramkrishna Mission, Sargachi, Murshidabad	30.06.2012
8	Prof. S.K. Datta	Deputy Director General (Crop Science), ICAR, New Delhi	27.07.2012 10.02.2013
9	Dr. P. Das	Former DDG (Agril. Extension), ICAR, New Delhi	29.07.2012
10	Dr. A.K. Gogoi	Zonal Project Director, Zone III, ICAR for NEH, Barapani	17.11.2012
11	Mr. Subrata Biswas	Secretary (Agriculture), Govt. of West Bengal	17.11.2012
12	Dr. P. Majumdar	Agriculture Advisor, Govt. of West Bengal	17.11.2012
13	Dr. N. Gopalakrishnan	ADG (Commercial Crops), ICAR, New Delhi	10.02.2013
14	Dr. V.N. Sharda	Member, ASRB, New Delhi	22.02.2013
15	Mr. I.J. Sharma	Technical Advisor, Glostor Jute Mill, Kolkata	17.11.2012
Sunnhemp Research Station, Pratapgarh, Uttar Pradesh			
1	Padmashree Dr. M. Mahadevappa	Ex-Chairman, ASRB, New Delhi and Chairman, QRT, CRIJAF	04.06.2012
2	Dr. B. Senapati	Former Vice Chancellor, OUAT, Bhubaneshwar	04.06.2012
Sisal Research Station, Bamra, Odisha			
1	Dr. B. Senapati	Former Vice Chancellor, OUAT, Bhubaneshwar	13.05.2012
2	Dr. N. Gopalakrishnan	ADG (Commercial Crops), ICAR, New Delhi	06.01.2013
3	Mr. S. K. Mitra	Director (CS), ICAR, New Delhi	06.01.2013
Ramie Research Station, Sorbhog, Assam			
1	Padmashree Dr. M. Mahadevappa	Ex-Chairman, ASRB, New Delhi and Chairman, QRT, CRIJAF	22.05.2012

2	Dr. B. Senapati	Former Vice Chancellor, OUAT, Bhubaneshwar	22.05.2012
3	Dr. A.K. Gogoi	Zonal Project Director, Zone III, ICAR for NEH, Barapani	22.05.2012
4	Mr. S. K. Mitra	Director (CS), ICAR, New Delhi	20.11.2012
5	Dr. K. K. Satapathy	Director, NIRJAFT, Kolkata, West Bengal	20.11.2012
Central Seed Research Station for Jute and Allied Fibres, Budbud, West Bengal			
1	Padmashree Dr. M. Mahadevappa	Ex-Chairman, ASRB, New Delhi and Chairman, QRT, CRIJAF	26.04.2012
2	Dr. B. Senapati	Former Vice Chancellor, OUAT, Bhubaneshwar	26.04.2012
3	Dr. N. Gopalakrishnan	ADG (Commercial Crops), ICAR, New Delhi	16.05.2012

Padmashri Prof. M. Mahadevappa, Chairman QRT being welcomed by Prof. B.S. Mahapatra, Director, CRIJAF

Prof. S.K. Datta, Hon'ble DDG (Crop Science), ICAR visited the experimental fields of CRIJAF

Dr. B. Senapati, Former Vice-Chancellor, OUAT, Bhubaneswar on visit to SRS, Bamra, Odisha

Dr. P. Das, Former DDG (Agricultural Extension), ICAR interacting with CRIJAF Scientists

Dr. N. Gopalakrishnan, ADG (Commercial Crops), ICAR is welcomed at the institute

Swami Vishwamoyananda, Ramkrishna Mission, Sargachi, Murshidabad being welcomed during his visit to the institute

Dr. P. Raghava Reddy, Chairman, RAC, CRIJAF and Former Vice Chancellor, ANGRAU (Hyderabad) addressing the delegates at the Annual Workshop of AINP on Jute and Allied Fibres

Sh. Subrata Biswas, IAS, Secretary, Department of Agriculture, Govt. of West Bengal, attending the interactive meeting with QRT

Sh. Rabindranath Bhattacharya, Hon'ble Minister-in-charge for Agriculture, Govt. of West Bengal interacting with Scientists

Dr. V.N. Sharda, Member, Agricultural Scientist Recruitment Board (ASRB), New Delhi being welcomed by Prof. B.S.Mahapatra, Director, CRIJAF

Padmashree Prof. M. Mahadevappa, Ex-Chairman, ASRB inaugurating the Advance Crop Protection Laboratory

Dr. S.K. Biswas, Director, DJD, Govt. of India, Kolkata being welcomed during his visit on 10th February, 2013

23. Staff Position

Table 23.1: Staff position of CRIJAF along with its four sub-stations as on 31.03.2013

Grade	Sanctioned strength	Staff in position					
		CRIJAF (HQ)	CSRSJAF	RRS	SRS	SH.RS	Total
Scientist	74+1	39+1	02	02	01	02	46+1
Technical	108	44	12	04	06	05	71
Administration	62	30	01	05	02	02	40
Skilled supporting staff	92	37	03	01	04	03	48

Table 23.2: Staff position at Krishi Vigyan Kendra, Budbud, Burdwan as on 31.03.2013

Designation	Sanctioned strength	Staff 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
B. S. Mahapatra	Director	crijaf-wb@crijaf.org.in
Division of Crop Improvement		
P. G. Karmakar	Pr. Scientist (Plant Breeding) & Head I/C	pgkcrijaf@yahoo.com
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D. Sarkar	Pr. Scientist (Biotechnology)	debabrata_s@yahoo.com
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J. Mitra	Sr. Scientist (Plant Breeding)	jiban15@rediffmail.com
C. S. Kar	Sr. Scientist (Plant Breeding)	chandanskar@gmail.com
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D. Saha	Scientist SG (Economic Botany) (transferred on 18.07.2012)	dsaha@crijaf.org.in
A. K. Chakraborty	Scientist (Agril. Statistics) joined on (20.06.2012)	asimkumarc@yahoo.in
S.B. Choudhary	Scientist (Plant Breeding)	shashigen@gmail.com
H.K. Sharma	Scientist (Plant Breeding)	harrygpb@gmail.com
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Kanti Meena	Scientist (Biotechnology)	kantimeena@gmail.com
Anil Kumar	Scientist (Plant Breeding)	anil.arroju@gmail.com
A. K. Das	Technical Officer (T7-8) (superannuated on 30.04.2013)	--
Basudev Ghosh	Technical Officer (T5)	--
Division of Crop Production		
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B. Majumdar	Pr. Scientist (Soil Science)	bijju5@rediffmail.com
H. Chowdhury	Pr. Scientist (Agril. Chemistry)	hemantac1@rediffmail.com
U. N. Borker	Sr. Scientist (Farm Machinery & Power)	unborkar16@gmail.com

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S. R. Singh	Sr. Scientist (Agril. Microbiology)	shivramsingh22@gmail.com
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Amarpreet Singh	Scientist (Agronomy)	amarpreet225@gmail.com
M. K. Saha	Technical Officer (T5)	--
G. G. Basu	Technical Officer (T5)	--
S. Chakraborty	Technical Officer (T5)	--
Sk. Phirose	Technical Officer (T5)	--
Division of Crop Protection		
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P. K. Biswas	Technical Officer (T5)	--
B. Biswas	Technical Officer (T5)	--
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R. N. Paith	Technical Officer (T5) (superannuated on 30.04.2013)	--
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PME Cell		
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IPR & Institute Technology Management Unit		
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N. L. Das	Technical Officer (T5)	--
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R. S. Toppo	Technical Officer (T5)(transferred on 30.11.12)	--
B. M. Prusti	Technical Officer (T5) (superannuated on 31.01.2013)	--
Sunnhemp Research Station, Pratapgarh, Uttar Pradesh		
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Harish E.R.	Scientist (Entomology)(transferred on 31.05.2012)	harish_ento@crijaf.org.in
Om Prakash	Technical Officer (T5)	--
Central Seed Research Station for Jute and Allied Fibres, Budbud, West Bengal		
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Library		
J. Mitra	Sr. Scientist (Plant Breeding) & I/C	jiban15@rediffmail.com
Administration & Accounts		
M. K. Pachauri	Senior Administrative Officer (upto 17.10.2012)	sao@crijaf.org.in
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K. P. Nath	Finance & Accounts Officer	fao@crijaf.org.in
P. C. Mohanto	Asst. Administrative Officer (superannuated on 31.07.2012)	aao@crijaf.org.in
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Santanu Banerjee	Asst. Administrative Officer (Administration)	aao@crijaf.org.in
Official Language Cell		
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Farm		
D. K. Kundu	Pr. Scientist (Soil Science), Head, Crop Production & I/C	kundu_crijaf@yahoo.com
A. K. Das	Technical Officer (T7) and Farm Manager	

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 and 25.3

Table 25.1: Financial Statement of CRIJAF for the year 2012-13 (*Rs in lakhs*)

Sub-Head	Non Plan R.E. 2012-13	Expenditure up to 31-03-2013	Plan R.E. 2012-13	Expenditure up to 31-03-2013
Establishment Charges	1275.00	1247.35	0.00	0.00
Wages	480.00	474.00	0.00	0.00
Retirement Benefit	415.00	388.16	0.00	0.00
O.TA.	0.40	0.31	0.00	0.00
T.A.	7.00	7.00	19.00	18.87
Other Charges	157.23	149.24	163.50	162.80
Works-Maintenance				
a) Residential	15.00	14.90	0.00	0.00
b) Non Residential	20.00	19.97	0.00	0.00
c) Equipment & others	12.00	12.00	0.00	0.00
d) Minor Works	6.00	6.00	0.00	0.00
Major Works	0.00	0.00	3.16	3.15
H.R.D	0.00	0.00	6.50	6.21
Equipment	5.00	4.71	41.84	40.05
Information Technology	0.00	0.00	0.00	0.00
Furniture	5.00	4.72	0.00	0.00
Library Books & Journals	0.00	0.00	11.00	10.85
Total	**2397.63**	**2328.36**	**245.00**	**241.93**

Table 25.2: Financial Statement for AINP on Jute & Allied Fibres and Technology Mission on Jute for the year 2012-13 (*Rs in lakhs*)

Head	Target	Expenditure
A.I.N.P.	402.00	401.91
T.M.J. (MM I)	72.00	69.65
K.V.K.	105.00	104.13

Table 25.3: Revenue generated at CRIJAF and its sub-stations for the year 2012-13 (*Rs in lakhs*)

Institute/ Sub-station	Total revenue
CRIJAF (H.Q), Barrackpore	33.06
CSRSJAF, Budbud	7.45
Ramie Research Station, Sorbhog	2.55
Sisal Research Station, Bamra	2.96
Sunnhemp Research Station, Pratapgarh	1.16

26. Agricultural Meteorology

The meteorological data of CRIJAF (HQ), Barrackpore; CSRSJAF, Budbud, West Bengal; Sunnhemp Research Station, Pratapgarh, Uttar Pradesh; Ramie Research Station, Sorbhog, Assam and Sisal Research Station, Bamra, Odisha are presented in Tables 26.1, 26.2, 26.3, 26.4 and 26.5, respectively.

Table 26.1: Meteorological data of CRIJAF, Barrackpore, West Bengal

Month	Temp. (^{0}C)		R.H. (%)		Rain-fall (mm)	Rainy Days (No.)	Bright Sun-shine Hour (hrs.)	Wind Speed (km/hr.)	Evapo-ration (mm)	Soil temperature (^{0}C)					
										Morning			Noon		
	Max.	Min.	Morn-ing	Noon						5 cm	15 cm	30 cm	5 cm	15 cm	30 cm
Apr-12	35.28	23.55	87.90	49.23	078.6	06	7.00	5.20	5.68	27.77	29.47	30.84	37.08	33.06	31.20
May-12	36.69	26.19	87.25	55.90	058.5	04	8.41	5.72	6.17	30.67	32.10	32.88	39.95	36.19	33.51
Jun-12	35.19	26.73	89.36	68.53	150.1	10	4.52	5.89	5.15	30.69	31.66	32.18	38.01	34.40	32.69
Jul-12	32.11	25.64	93.35	83.09	420.1	22	4.46	4.00	3.58	28.62	29.14	29.42	32.58	31.22	30.06
Aug-12	31.80	25.41	94.03	79.64	232.5	19	4.46	3.01	3.07	28.19	28.73	29.22	33.21	31.16	29.64
Sep-12	31.96	25.06	93.63	76.56	302.0	14	4.62	2.53	2.83	27.83	28.45	28.83	33.17	31.22	29.18
Oct-12	31.50	21.57	91.61	62.12	129.8	04	7.62	2.30	2.58	24.82	25.75	28.97	29.45	29.45	29.40
Nov-12	28.52	17.75	92.70	52.76	044.8	03	6.70	1.55	2.15	19.92	21.35	-	27.42	24.50	-
Dec-12	24.79	12.22	96.38	56.41	009.4	01	5.57	1.18	1.50	14.71	16.78	-	23.31	20.64	-
Jan-13	23.86	10.48	95.67	46.38	000.0	00	5.60	1.59	1.76	13.32	15.36	-	23.43	19.93	-
Feb-13	27.58	14.00	93.25	46.92	008.8	01	6.88	2.46	2.86	16.82	18.95	21.37	28.25	24.13	21.63
Mar-13	34.56	19.91	91.09	40.67	000.0	00	7.69	2.22	4.32	24.48	25.95	27.49	36.46	32.27	27.70

Table 26.2: Meteorological data of CSRSJAF, Budbud, Burdwan, West Bengal

Month	Temperature (^{0}C)		R.H (%)	Rainfall (mm)
	Max.	Min.	Noon	
Apr-12	38.30	24.64	50.1	055.4
May-12	39.61	27.79	67.2	064.4
Jun-12	35.93	24.61	68.5	054.1
Jul-12	35.08	25.37	85.5	364.8
Aug-12	33.91	25.25	82.4	203.0
Sep-12	34.31	24.06	79.2	268.5
Oct-12	33.27	23.25	68.9	101.9
Nov-12	29.46	18.37	56.9	000.0
Dec-12	24.46	11.14	48.9	001.5
Jan-13	22.8	10.43	50.1	006.7
Feb-13	25.44	15.55	10.2	000.0
Mar-13	31.74	21.62	22.2	000.0

Table 26.3: Meteorological data of Sunnhemp Research Station, Pratapgarh, Uttar Pradesh

Month	Temperature (⁰C)		R.H (%)		Rainfall (mm)	Rainy days (No.)
	Max.	Min.	Morning	Afternoon		
Apr-12	37.90	19.70	60.0	33.7	004.0	01
May-12	42.01	22.36	53.9	25.1	000.0	00
Jun-12	42.26	25.76	54.7	33.1	001.0	01
Jul-12	33.29	23.11	87.7	72.6	448.6	18
Aug-12	32.71	22.53	89.4	75.7	247.2	18
Sep-12	32.44	21.29	87.3	72.6	271.8	12
Oct-12	33.38	16.07	82.9	41.8	007.0	01
Nov-12	28.82	8.63	85.8	35.8	000.0	00
Dec-12	21.90	8.57	86.7	59.5	000.0	00
Jan-13	20.52	6.04	93.0	50.4	000.4	01
Feb-13	25.42	11.57	90.2	48.9	078.2	05
Mar-13	32.37	15.83	79.5	39.3	005.1	03

Table 26.4: Meteorological data of Ramie Research Station, Sorbhog, Assam

Month	Temperature (⁰ C)		Rainfall (mm)	Rainy Days (No.)	Cloudy Days (No.)	R.H. (%)	Soil temperature (⁰C)			
							Morning		Noon	
	Max.	Min.					5 cm	15 cm	5 cm	15 cm
Apr-12	24.11	19.38	377.1	24	26	86	25.0	25.4	33.0	29.0
May-12	28.13	22.46	285.4	15	23	90	26.6	27.0	35.4	31.6
Jun-12	27.41	23.56	1537.5	23	25	97	28.5	29.5	33.1	30.2
Jul-12	28.00	787.2	623.3	23	27	91	20.5	30.0	35.0	33.0
Aug-12	27.90	25.86	236.1	17	24	89	28.8	30.0	37.4	34.0
Sep-12	27.20	24.74	528.2	20	24	93	27.0	28.3	34.5	32.0
Oct-12	24.81	19.87	161.6	7	10	82	23.5	25.5	33.4	30.0
Nov-12	21.86	13.24	-	0	0	78	19.0	20.0	29.5	26.0
Dec-12	18.97	10.6	-	0	0	82	16.0	17.2	25.3	21.4
Jan-13	17.28	228.3	-	0	0	80	12.5	14.0	24.0	19.5
Feb-13	19.89	11.13	13.2	2	5	75	16.4	18.0	28.4	23.3
Mar-13	22.25	16.46	20.0	2	8	72	20.2	21.8	33.5	26.9

Table 26.5: Meteorological data of Sisal Research Station, Bamra, Odisha

Month	Temp. (°c)		RH (%)		Rainfall (mm)	Rainy Days (No.)	Wind Speed (km/hr.)	Evapo-ration (mm)	Soil temperature (° c)			
							Morning		Morning		Noon	
	Max.	Min.	Morning	Noon					5 cm	15 cm	5 cm	15 cm
Apr-12	40.29	19.23	59.10	22.10	0007.0	01	3.80	4.62	26.45	29.21	46.03	38.18
May-12	42.38	23.10	59.22	19.87	020.8	01	3.31	4.73	32.85	33.10	51.58	40.79
Jun-12	39.72	25.44	72.56	42.76	193.5	08	4.79	4.70	29.40	30.94	45.25	36.25
Jul-12	32.60	23.60	89.25	74.29	326.3	20	4.43	3.06	26.41	27.51	32.89	30.75
Aug-12	30.97	23.65	88.35	75.67	730.0	18	3.28	1.75	26.70	27.44	32.88	30.35
Sep-12	32.15	22.55	90.46	67.56	206.9	12	2.27	2.62	27.03	27.50	34.68	31.41
Oct-12	32.04	18.16	88.38	51.83	039.1	03	1.45	2.40	23.99	24.81	35.27	30.98
Nov-12	28.95	12.05	80.55	59.90	150.4	03	1.63	2.15	16.36	19.66	30.93	26.27
Dec-12	28.68	09.13	81.16	66.32	000.0	00	1.62	2.41	15.87	17.90	32.10	26.60
Jan-13	27.88	09.09	75.38	39.12	002.0	01	1.90	2.26	14.32	16.82	32.55	25.15
Feb-13	29.94	12.43	77.03	39.46	016.4	01	2.76	2.53	16.93	17.93	36.06	29.93
Mar-13	35.40	15.10	61.74	19.70	010.2	03	2.77	4.02	22.15	23.20	42.72	33.42

Note

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch

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