New IPM module against stem rot and insect pests of jute (*Corchorus olitorius* L.)

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Abstract

A new IPM module consisting of cultural (deep ploughing to expose soil to sun, sowing in line with 5 - 6 lakh plants /ha, NPK: 60 (30+15+15):30:30, manual hand weeding once at 21 DAS, variety: JRO 204 (Suren)); chemical (soil application of $Ca(OCl)_2$ *@ 30 kg/ha at 7 DBS, seed treatment (ST) with (a) carbendazim @ 2g/kg + (b) imidachloprid @ 4g/kg, application of pesticides: spiromecifen @ 1 ml/litre, profenophos @ 2 ml/litre) and biological (ST with* Trichoderma viride *@ 10g/kg, soil application of* Pseudomonas fluorescens *@ 100g/ sq. m before sowing and spraying of neem oil @ 3 - 4 ml/litre) components was tested against stem rot caused by* Macrophomina phaseolina *and yellow mite, semilooper, hairy caterpillar, apion and indigo caterpillar of jute (*Corchorus olitorius *L.) crop during 2015-20 at ICAR-CRIJAF, Barrackpore and farmers' field in four different villages in North 24 Parganas district of West Bengal. Stem rot was lowest (2.5%) in full IPM treatment with all components compared to 20% in actual farmers' practice. Similarly, yellow mite was reduced to 0.8%, semilooper to 0.4%, indigo caterpillar to 1%, apion 0.7%, hairy caterpillar 0.6% using IPM compared to 4-8% in farmers' practice. Higher fibre yield and benefit cost ratio of 31.5 q/ha and 1.78 were observed in full IPM module as compared to 14.7 q/ha and 1.4, respectively, in actual farmers' practice. As jute plants grow older, susceptibility to stem rot increases.*

Keywords: Integrated pest management, Apion, *Corchorus olitorius,* hairy caterpillar, indigo caterpillar, insect pests, jute*, Macrophomina phaseolina*, Semilooper, Stem rot, Yellow mite.

Introduction

Jute, also called 'golden fibre', is cultivated as Pre-*Kharif* crop mainly in the eastern India in West Bengal, Bihar and Assam contributing 78.3, 11.5 and 8.7% of National production, respectively (Anonymous, 2019). Jute crop is the major bast fibre yielding crops which produce the cheapest natural fibres used for packaging and other diversified uses. Besides the crop husbandry practices adopted, the yield and quality of fibres depend on the plant protection measures as the insect pests and diseases have adverse effect on both these parameters.

Major disease and insect pests of jute are namely, (1) stem rot (incited by *Macrophomina phaseolina* (Tassi) Goid.) and major insect pests, namely, (2) yellow mite (*Polyphagotarsonemus latus* Banks), (3) indigo caterpillar (*Spodoptera exigua)*, (4) jute semilooper *(Anomis sabulifera G),* (5) jute apion *(Apion corchori M)* and (6) hairy caterpillar (*Spilosoma obliqua* Walk). etc. Stem rot is economically the most important disease affecting in both cultivated species, namely, *Corchorus olitorius* L. and *C. capsularis* L. in all jute growing areas in India and other countries (De, 2020). The disease and insect pests are nightmares for both researchers and farmers due to their devastating nature. Stem rot is seed, soil as well as air borne and its management targets manipulation of soil, pre-sowing seed treatment and foliar spraying of fungicides or judicious integration of all.

Singular approach targeting single pests may not provide enough protection to crops. As we know that integrated pest management (IPM) is dynamic system that selects the best available tools according to the pest status, control strategies, new and effective pesticides, varieties, etc. for sustainable and economical management of pests. Hence, all methods of management, including resistant variety, clean cultivation, biocontrol and cultural management are to be used as a package with best rational combination considering the profitability and efficacy of each component. A holistic approach with all the methods (chemical, cultural, biological, host resistance and agronomic manipulations, etc.) together in a harmonious manner to keep disease and insect pest below economic threshold level with least environmental erosion is the prime objective.

Application of different techniques of management of jute stem rot using botanicals (De, 2012a), fungicides (De, 2012c; De, 2014b; De *et al.,* 2010 and 2014), host resistance (De and Mandal, 2012 a and b), balanced NPK fertilizer (De, 2014a and 2015), and manipulation of date of sowing (De, 2012b; De, 2013) was studied. However, few approaches involving multiple options were earlier tried against diseases and insect pests of jute.

Therefore, present investigation was carried out with a new farmers' friendly IPM module for management of diseases and insect pests of jute at the ICAR-CRIJAF experimental farm and nearby farmers' fields.

Materials and methods

A field investigation was carried out with a new IPM module consisting of cultural ((i) deep ploughing to expose soil to sun, (ii) sowing variety JRO 204 (Suren) in line using ICAR-CRIJAF multi row seed drill maintaining 5 - 6 lakh plants /ha, (iii) NPK: 60 (30+15+15):30:30 with full P + full K +1/3 N as basal during sowing + 1/3 N at 30 DAS + 1/3 N at 60 DAS, (iv) manual hand weeding once at 21 DAS, (v) variety: JRO 204 (Suren)); chemical (vi) soil application of bleaching powder $Ca(OCl)_2$ @ 30 kg/ha at 7 DBS, (vii) seed treatment with (a) carbendazim @ 2g/kg + (b) imidachloprid @ 4g/kg, (viii) application of pretilachlor @ 3 ml/litre within 48 hr of sowing in moist soil, (ix) spraying of pesticides: spiromecifen @ 1 ml/litre, profenophos @ 2 ml/litre, carbendazim @ 2g/litre); biological (seed treatment with (x) *Trichoderma viride* @ 10g/kg or soil application of *Pseudomonas fluorescens* @ 100g/ sq. m before sowing and (xi) spraying of neem oil @ 3 - 4 ml/litre) was tested in randomized block design with three replications at main farm of ICAR-CRIJAF, Nilganj, Barrackpore and was further tested in farmers' fields in four different villages, namely, Malikapur (beside WB State University), Paschim shimla, Makaltala and Borgachhia, near Nilganj in North 24 district of West Bengal, India during five consecutive cropping seasons, 2015-20. The soil of the experimental field was neutral in nature (pH 6.5 - 7.5) and sandy loam in texture. The inoculum density of *M. phaseolina* was 3.4×10^2 colony forming units/g soil at the surface up to 5 cm depth, gradually decreasing with the depth. Incidence of stem rot was carefully monitored throughout the cropping season and percentage incidence of stem rot and five different insect pests of jute were noted at fortnightly intervals starting from 21 days after sowing (DAS) after final thinning and manual weeding of crop using following formula. To determine the effect of plant age on susceptibility to stem rot of jute, a pot study with same variety in sterilized soil and similar inoculum pressure 42.7×10^3 colony forming units/g soil of *M. phaseolina* was conducted.

$$\text{Stem rot incidence or pest infestation (\%)} = \frac{\text{Number of infected plants}}{\text{Total number of plants observed}} \times 100$$

Results and discussion

Influence of Integrated pest management module on individual pests and other parameters is explained as follows.

Stem rot of jute

Pooled data of five years experimentation indicated that, incidence of stem rot was reduced to lowest (2.5%) in full IPM treatment with all components, namely, cultural, chemical and biological measures, in comparison with highest incidence of 20% in treatments with actual farmers' practice. As the different components were removed from full IPM package, the stem rot increased slowly in treatments without cultural (3.7%), chemical (4.5%) and biological (4.7%) components. When two components were taken away from IPM packages, further rise in stem rot incidence was observed from (4.5 – 8.8%). More damage due to stem rot in treatments with removal of single or more components may be attributed to the absence of their controlling effect on said disease, which was positively influenced in treatment with full package (Table 1 and Fig. 1).

Sucking pest of jute

Infestation of 8% of yellow mite, being the single major sucking pest of jute, was recorded in treatment with actual farmers' practice, whereas, it was significantly reduced to only 0.8% in full IPM treatment. In full package without chemical components (T3), an infestation of 1.6% was observed. This reduction in yellow mite damage may be due to effect of spraying of acaricide spiromecifen and other chemicals (Table 1 and Fig. 1).

Other insect pests of jute

In treatments with actual farmers' practice, infestation of indigo caterpillar was highest (5.8%), followed by hairy caterpillar (BHC) (5.2%), semilooper (4.3%) and apion (4%). Their damage was significantly decreased to only 1, 0.6, 0.4 and 0.7%, respectively, in treatments with full IPM package. The infestation of these insect pests was 0.7-1% in treatment (T3) without application of insecticides either as seed treatment and/or spraying. This decline in the damage caused by these insects pest in full IPM package may be due to the effect of neem oil imidachloprid and profenophos (Table 1 and Fig. 2).

Table 1. Evaluation of new IPM module consisting of cultural, chemical and biological components against stem rot disease, insect pests, yellow mite, semilooper, hairy caterpillar, apion, indigo caterpillar in jute (*Corchorus olitorius)* variety JRO 204 during 2015-20 at ICAR-CRIJAF, Barrackpore.

Treatments	% stem rot*	% Yellow mite infested plant*	% Semilooper infested plant*	% Indigo caterpillar infested plant*	% Apion infested plant*	% Hairy caterpillar infested plant*	Fibre yield q/ha*	BC Ratio*
T1 = Full IPM Module with Cultural + Chemical + Biological components	2.5 (9.0)	0.8 (5.2)	0.4 (3.8)	1.0 (5.7)	0.7 (4.8)	0.6 (4.4)	31.5	1.78
T2 = T1 - Cultural components	3.7 (11.1)	1.4 (6.7)	0.6 (4.4)	0.8 (5.2)	0.7 (4.9)	0.7 (4.7)	27.9	1.64
T3 = T1 - Chemical components	4.5 (12.2)	1.6 (7.2)	0.7 (4.9)	0.7 (4.8)	1.0 (5.6)	0.7 (4.9)	26.0	1.60
T4 = T1 - Biological component	4.7 (12.6)	1.9 (7.8)	1.0 (5.6)	1.1 (6.0)	1.0 (5.7)	0.9 (5.4)	24.6	1.59
T5 = T1 - Cultural and Chemical components	4.5 (12.3)	1.9 (7.8)	1.2 (6.4)	1.1 (6.0)	1.1 (5.9)	0.9 (5.5)	23.4	1.58
T6 = T1- Cultural and Biological components	6.3 (14.5)	2.6 (9.2)	1.5 (6.9)	1.8 (7.6)	1.4 (6.9)	1.2 (6.2)	21.4	1.53
T7 = T1 - Chemical and Biological components	8.8 (17.2)	2.9 (9.7)	1.9 (7.9)	2.2 (8.4)	1.8 (7.6)	1.2 (6.3)	20.5	1.49
T8 = Farmers' practice (Actual)	20.0 (26.5)	8.0 16.4)	4.3 (12.0)	5.8 (13.9)	4.0 (11.6)	5.2 (13.1)	14.7	1.40
CD (P= 0.05)	(1.1)	(0.7)	(0.8)	(0.7)	(0.5)	(0.8)	0.7	-
SE + m	(0.5)	(0.3)	(0.4)	(0.3)	(0.2)	(0.4)	0.3	-

*Pooled mean of three replications. Figures in the parenthesis indicate Arc Sin transformed values. BC= Benefit cost

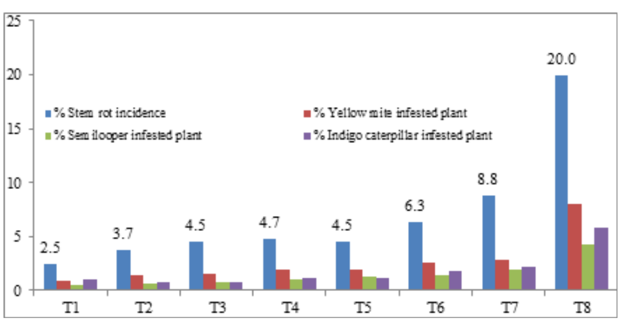

Figure 1. Effect of IPM module on stem rot, yellow mite, semilooper and indigo caterpillar in jute (mean of 2015-20).

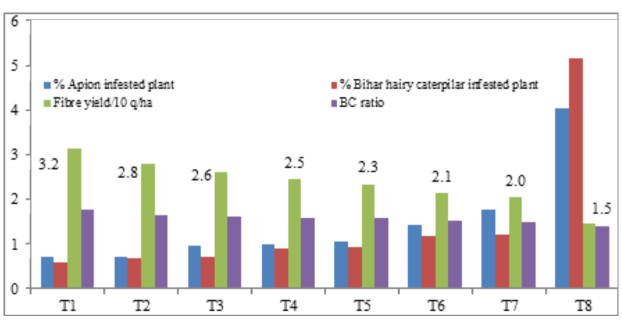

Figure 2. Effect of IPM module on apion, Bihar hairy caterpillar, fibre yield/10 and BC ratio in jute (mean of 2015-20).

Economics of new IPM module of jute

Dry fibre yield of jute was highest (31.5 q/ha) in treatments with full IPM package due to the significant reduction in damages caused due to stem rot disease, sucking and other insect pests of jute. As the different components of IPM were removed from the package, the fibre yield was also slowly declined from 27.9 in cultural, 26 in chemical, 24.6 in IPM without biological components to 20.5 in treatment (T7) without chemical and biological components. Lowest fibre yield (14.7 q/ha) was noted in treatment with actual farmers' practice.

Benefit cost (BC) ratio was a good measure of efficacy of any newly introduced change in existing jute system. BC ratio was lowest (1.4) in case of treatment (T8) with actual farmers' practice. On the contrary, maximum BC ratio was recorded (1.78) in treatment (T1) with full IPM package with all components, namely, cultural, chemical and biological measures. Benefit of IPM is gradually eroded with removal of individual or more IPM components from the IPM system from 1.64-1.59 without only cultural / chemical /biological components (T2, T3 and T4) to 1.58-1.49 without any two components, i.e., either cultural and chemical (T5) or biological / cultural components (T6) or chemical and biological components (T7). In other words, as farmers would go on investing more and more in the form of plant protection measures, namely, components like, cultural, chemical and biological measures, it is most likely to get more and more monetary benefit out of these in the jute crop system (Table 1 and Figure 1 and 2).

Performance of IPM module in farmers' fields

In the farmers' fields, apion was major problem followed by indigo caterpillar, yellow mite, semilooper and BHC, but stem rot caused heavy toll on plant mortality. High damage of stem rot and insect pests in local broadcast crop showed that IPM module was effective in reducing them. In Paschim Shimla village, maximum stem rot of 38% was reduced from 4-11% in different varieties using IPM module. Among insect pests, apion infested heavily (52%) at Makaltala, semilooper at Borgachhia (23.8%), indigo caterpillar at Paschim Shimla (39.6%) and Malikapur (22.6). New IPM module was effective in decreasing the infestation of different insect pests from 38-15 % in farmers' local practice to 22-2% in different varieties. With the benefit of using IPM module, farmers obtained more fibre yield of 31.1 -23.4 q/ha compared to 16-18 q/ha for substituting IPM module with their own local practice. BC ratio was also higher (1.4-1.7) in different varieties using IPM module than their own practice (1.2), clearly indicating that, new IPM module was economically viable and cost effective in the farmers' fields (Table 2). Present IPM module consisting of cultural, chemical and biological components has tremendous potential for application for efficient management of insect pests and diseases of jute in the farmers' fields.

Plant age and susceptibility to stem rot of jute

In a pot study with variety JRO 204 and similar inoculum pressure of *Macrophomina phaseolina,* it was observed that incidence of stem rot was maximum (32.8%) at 120 day old plants. The least stem rot incidence (0.34%) was recorded in as young plant as 15 day old and it slowly increased with increasing age of the plants, steadily increasing incidence of 4.4% at 30 day old plants, 7.6% at 45 DAS, 15.4% at 75 DAS, finally reaching the peak of 32.8 % at harvesting age of 120 DAS. As jute plants grow older, susceptibility to stem rot increases (Table 3 and Figure 3) with highest susceptibility at the maturity stage of the plants.

Among various methods of management of jute stem rot, use of botanicals (De, 2012a; Choudhury *et al*., 2014), biocontrol by *Trichoderma* and PGPR (Bandypadhyay *et al*., 2008; Bhattacharyay *et al*., 2017), fungicides (De, 2012c; De, 2014c; De *et al.,* 2010), bleaching powder or calcium hypochlorite [$Ca(OCl)_2$] (De *et al*., 2014; De and Ghorai, 2017), host resistance (De and Mandal, 2012a; b; Meena *et al* ., 2015), wild relatives (De, 2014b), balanced NPK fertilizer (De, 2014a; 2015, 2017), and manipulation of date of sowing (De, 2012b; De, 2013) and plant population (De and Tripathi, 2015) were most important. Inoculation techniques (De, 2016), seed infection and its management (De and Mandal, 2012c) in jute were also reported. Influence of nitrogenous fertilizer on yellow mite was studied by Gotyal *et al.,* (2016).

Spraying with endosulfan 35EC and dicofol 18.5EC reduced the infestation of insects and yellow mite significantly (Rahman and Khan, 2006). Integration of improved cultural management practices, use of bio-pesticides and conservation of natural enemies and a need-based use of chemicals could effectively control the insect and mite pest complex problem associated with jute (Banerjee *et al.* 2000). In field trial, occurrence of stem weevil, gray weevil, semilooper and yellow mite were not significantly different in three IPM modules (Prasad *et al.* 2002). Adopting the IPM module against insect, mite and diseases resulted in minimum attack of semilooper, hairy caterpillar, yellow mite and stem rot with maximum fiber yield of 30.8 q/ha compared to control plot (Hath and Chakraborty 2004). The incidence of semilooper, stem

Table 2. Field evaluation of new IPM module in farmers' plots in four different villages, namely, (1) Borgachhia (near Nilganj), (2) Paschim Shimla, (3) Makaltala and (4) Malikapur (beside WB State University) in North 24 Parganas district of West Bengal.

Pests/ Parameters	Farmers' fields located at four different villages, namely, Borgachhia, Paschim Shimla, Makaltala and Malikapur																		
Villages	Borgachhia			Paschim Shimla							Makaltala				Malikapur				Overall mean of four villages
Jute variety	JRO 204	Farmers' local practice	Mean	JRO 204	JRO 524	JBO 2003 H	CO 58	S 19	Farmers' local practice	Mean	JRO 204	JRO 524	Farmers' local practice	Mean	JRO 204	JRO 524	Farmers' local practice	Mean	
Apion	6.8	15.6	11.2	11.2	9.6	8.8	11.2	5.4	38.0	14.0	9.6	10.6	52.0	24.0	11.2	9.8	36.4	19.1	17.0
Hairy catterpillar	7.4	16.8	12.1	7.8	13.4	8.4	11.8	4.6	38.6	14.1	14.4	7.6	24.2	15.4	7.8	12.4	34.6	18.2	14.9
Yellow mite	4.8	18.4	11.6	11.2	9.6	12.8	15.0	13.6	35.8	16.3	13.0	10.0	17.0	13.3	8.2	22.6	32.8	21.2	15.6
Semilooper	2.4	23.8	13.1	9.0	8.0	10.4	15.4	11.8	33.0	14.6	13.0	14.6	22.6	16.7	7.8	8.8	37.2	17.9	15.5
Indigo caterpillar	2.4	5.4	3.9	9.6	9.6	11.8	13.6	12.2	39.6	16.0	15.2	13.0	40.2	22.8	9.4	12.2	44.8	22.1	16.2
Stem rot	4.6	29.2	16.9	11.2	9.6	8.3	11.2	5.4	38.0	13.9	9.6	10.6	32.0	17.4	11.2	9.8	36.4	19.1	16.8
Fibre yield q/ha	31.1	16.3	23.7	28.7	23.4	26.4	27.3	25.7	18.6	25.0	27.8	24.3	17.6	23.2	30.4	29.7	17.1	25.7	24.4
BC ratio	1.7	1.3	1.5	1.6	1.5	1.6	1.5	1.5	1.3	1.5	1.6	1.4	1.3	1.4	1.6	1.7	1.3	1.5	1.4

Table 3. Effect of plant age of jute variety JRO 204 and susceptibility to stem rot caused by *Macrophomina phaseolina*

Variety	Mean stem rot incidence*							
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS
JRO 204	0.3	4.4	7.6	12.0	15.4	22.7	26.4	32.8

*Mean of three replications

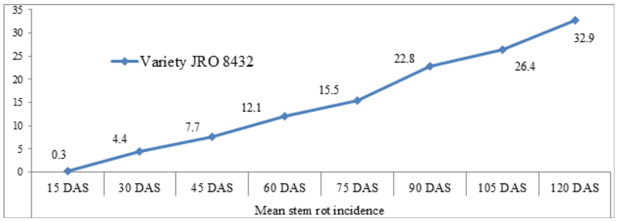

Figure 3. As plants grow older, susceptibility to stem rot increases.

weevil, ash weevil and yellow mite as well as stem rot and root rot diseases were significantly low in comparison to farmers' practice and control in IPM comprising hand weedings, followed by seed treatment and spraying of *Beauveria bassiana* and neem oil with fibre yield of 2.8 tonnes/ha and were superior to farmers' practice (2.06 tonnes/ha) and untreated control (1.79t/ ha) (Prasad *et al.* 2007). Pandit *et al*., (2004) reported that IPM module prepared and followed in farmers field showed very effective management of insect pests, diseases and weeds in jute with minimum chemical and biological pesticides improving yield and quality of fibre. Maximum fibre and stick yield were obtained from treatment consisting of seed treatment with carbosulfan, soil application with carbofuran 3 G, mechanical destruction of early instar hairy caterpillars, spraying with neemazal 5% EC and dicofol 18.5 EC with highest benefit cost ratio of 7.34 (Rahman and Khan 2010). De *et al.* (2019) reported IPM module consisting of cultural, chemical and biological components in jute.

Utility of a new IPM module consisting of cultural, chemical and biological components was demonstrated against stem rot disease, insect pests, namely, yellow mite, semilooper, hairy caterpillar, apion, indigo caterpillar in jute. Feasibility of management of insect pests and diseases of jute at the farmers' field level was also clear. Jute growers being mainly the small and marginal farmers may be benefited with adoption of this new IPM module. Different components/ inputs of new IPM module were selected considering their easy availability and adoption at low cost avoiding any toxicity/ health hazards and environmental pollution, making it farmers' as well as eco-friendly.

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Received: 25-11-2020 Accepted: 15-2-2021