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INTEGRATED MANAGEMENT APPROACH FOR CONTROL OF THE PEST COMPLEX OF OLITORIUS JUTE, *CORCHORUS OLITORIUS* L.

Sahidur Rahman[1]*, *Matiyar Rahaman Khan*[2]

[1] Department of Entomology, Assam Agricultural University, Jorhat-785 013, Assam, India
[2] Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya
Mohanpur-741252, West Bengal, India

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Abstract: Field trials were conducted with six treatments against the pest complex of olitorius jute var. JRO-524 during 2004 and 2005 at Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India. The results revealed that incidence of *Anomis sabulifera* Guen., *Spilarctia obliqua* Wlk., *Myllocerus discolor* Bohemus, *Apion corchori* Marshall and *Polyphagotarsonemus latus* Banks were found causing a minimum of 6.10, 4.68, 12.38, 5.09, and 10.47 percent plant infestation, respectively. These were the results from the 2004 crop season in the IPM module M_3 designed against insect, mite and nematode pests as compared to the other treatments. Similar results were obtained in 2005 with a relatively low plant infestation of 7.66, 28.60, 11.90 and 11.21 caused by *A. sabulifera*, *M. discolor*, *A. corchori* and *P. latus*, respectively, in module M_3 as compared to the other treatments. The maximum reduction (69.39 to 82.46%) of root-knot nematode (*Meloidogyne incognita* Chitwood) population along with low gall index (1.33 to 1.67) at harvest was observed in module (M_3) in 2004-05. The yellow mite population was observed to be a minimum of 14.33 and 19.33 per leaf in 2004 and 2005, respectively in M_3. The maximum average fiber yield of 30.32 q/ha and the benefit-cost ratio of 7.34 were also recorded in M_3. Based on the benefit-cost ratio, the performance of the treatments was in the decreasing order of $M_3 > M_2 > M_4 > M_5 > M_1 > M_6$. Considering performance for managing insect, mites and root-knot nematodes, M_3 was the most effective and economical management strategy against the pest complex of olitorius jute. Four spider species viz. *Neoscona mukerji* Tikader, *Neoscona* sp., *Araneus* sp. and *Xysticus* sp. were recorded for the first time in the jute ecosystem of West Bengal. The pest population in the jute ecosystem could be suppressed naturally to a great extent, because thirteen insects and ten spider predators were encountered in the experimental field during the crop season. Furthermore, a larval parasitoid (*Apanteles obliquae*) was found acting on the larvae of bihar hairy caterpillars.

Key words: Integrated pest management, insect, mite, nematode, jute, natural enemies, West Bengal

INTRODUCTION

Jute is the most important fibre crop next to cotton, and it is extensively grown in eastern India as a cash crop. India ranks first in area coverage and production of jute accounting for 62% of the world's production. West Bengal alone contributes 77% of the Indian jute (Sinha *et al*. 2004). Though two species of jute viz. *Corchorus olitorius* and *C. capsularis* are cultivated, the first one is more popular because of its higher productivity. This crop was facing attack by various pests including insects, mites and nematodes, from seedling stage to harvest. All the parts, from the roots to the tip of the plant are ravaged by various pests. The pests cause loss in yield and quality of fibres. In West Bengal, jute semilooper (*Anomis sabulifera* Guen), bihar hairy caterpillar (*Spilarctia obliqua* Wlk.), stem weevil (*Apion corchori* Marshall), grey weevil (*Myllocerus discolor* Bohemus), yellow mite (*Polyphagotarsonemus latus* Banks) and root-knot nematode (*Meloidogyne incognita* Chitwood) were recorded as the major pests of jute. Most of the previous efforts to combat the pest problem associated with jute were based on pesticide approaches. Chemical pesticides not only cause environmental and health hazards but also encourage pest resurgence and secondary pest outbreak. Banerjee *et al*. (2000) reported that integration of improved cultural management practices, use of biopesticides 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. Efforts were also made for integrated management of insect, mite and diseases of olitorius jute (Prasad *et al*. 2002; Hath and Chakraborty 2004). Such management included: using seed treatment with carbosulfan 25 DS at 3% w/w (Khan 2004) and through soil application of neem cake at 1500 kg/ha, carbofuran 3 G at 3 kg active substance (a.s.)/ha and neem coated urea at 88 kg/ha was also used for controlling root-knot nematode on jute (Bibha and Bora 2005). However, in West Bengal, jute crop is seriously inflicted by insect, mites and nematodes at different growth stages of the crop. Considering the local importance of finding a way to deal with the pest situation, the present investigation was undertaken

*Corresponding address:
srahman06@rediffmail.com; mrkhan_nema@yhaoo.com

to manage the combined problem of insect, mite and nematode of olitorius jute in a holistic manner.

MATERIALS AND METHODS

The experiment was conducted during pre-*kharif* to *kharif* seasons (April to August), 2004 and 2005 at Block 'C' farm of Bidhan Chandra Krishi Viswavidyalaya, West Bengal (22°56′ N latitude and 88°22′ E longitudes, elevation of 9.75 m above the mean sea level) with six treatment modules. Each module consisted of several operations, except the control. The soil was sandy loam and slightly acidic (pH 6.6). The weather parameters were recorded during the experimental period (temperature: 22.8–38.8°C; RH: 43.6–98.6%; total rainfall: 744 mm in 2004 and temperature: 22.6–39.9°C; RH: 47.0–98.0%; total rainfall: 634.7 mm in 2005). The experiment was laid out in a randomized block design with four replications. Each plot was 5 m x 4 m in size. The most popular olitorius jute var. JRO-524 was grown, as recommended on the package for the Gangetic new alluvial zone. The seeds were sown at 5 kg/ha in a row spacing of 25 cm and final plant to plant distance was maintained at 5–7 cm apart after thinning. Details of the treatment modules were as follows:

M_1 = Module-I (against nematodes only):
1. Seed treatment with carbosulfan 3% w/w (Marshal 25DS) at 2.5 g a.s./kg of seed.
2. Soil application with caofuran 3 G at 1 kg a.s./ha prior to sowing.

M_2 = Module-II (against insect and mite pests):
1. Mechanical destruction of early instar bihar hairy caterpillars.
2. Spraying with neemazal 5% EC at 1 ml/litre when other insects are found infesting.
3. Spraying with dicofol 18.5 EC at 185 g a.s./ha when mite infestation is observed.

M_3 = Module-III (against insect, mite, and nematode pests): $M_1 + M_2$

M_4 = Module-IV (recommended practices):
1. Mechanical destruction of early instar of bihar hairy caterpillars.
2. Spraying with endosulfan 35 EC at 350 g a.s. ha^{-1} against other insects and mites.

M_5 = Module-V (farmer practices):
1. Broadcasting method of sowing.
2. Spraying with endosulfan 35 EC at 350 g a.s./ha against pest infestation. 2 sprays at 15 day interval in all cases.

M_6 = Module-VI (untreated control).

Incidence of insect and mite pests, was recorded in terms of percent of plant and leaf infestation by the different pest. For this purpose, one square meter area from each treatment plot was selected randomly and pest attack was observed. Based on the number of infested and total plants per square meter, percent plant infestation was calculated. Similarly, leaf infestation was noticed on the plants of the sampled area in each plot. Based on number of leaves infested and the total of the top fifteen leaves from the infested plants, percent leaf infestation was worked out. Yellow mite population (nymph and adults) was counted on three randomly selected top leaves per infested plant, using a 10X hand lens. All the observations were repeated at weekly intervals until the occurrence of the individual pest. Incidence of root-knot nematode was studied in terms of nematode population (J_2 = second stage juvenile) in soil and root gall index. Initial nematode population (INP) was counted from 200 cc of soil prior to sowing. Estimation of soil nematode (J_2) was done using the method of Cobb's decanting and sieving followed by the modified Baermann's technique (Cobb 1918). Similarly, the final nematode (J_2) count in the soil was taken from the fields on the date of the harvesting of the crop. The root galls induced by *M. incognita* was indexed on a scale of 0–5 (0 = no gall, 1 = 1–2 galls, 2 = 3–10 galls, 3 = 11–30 galls, 4 = 31–100 galls and 5 = > 100 galls). After harvesting and retting, dry fiber and stick yield were recorded. Data obtained for pest incidence and economic yield under each treatment were statistically analysed by the "F" test. The benefit-cost ratio was calculated based on the benefit obtained per rupee invested in the treatments.

The occurrence of different natural enemies was recorded in the field at weekly intervals throughout the crop season. The insect and spider predator species were collected directly from field while gregarious larvae of bihar hairy caterpillar were reared in the laboratory till emergence of any parasitoid. All the insect and spider species of natural enemies were identified from Project Directorate of Biological Control (PDBC), Bangalore and Zoological Survey of India (ZSI), Kolkata, India, respectively.

RESULTS AND DISCUSSION

Incidence of the pest complex in 2004

The results presented in table 1 and figure 1 show that in 2004, the incidence of semilooper, bihar hairy caterpillar and stem weevil were considerably low in different treatments of the IPM module as compared to farmer practices and control plots. On the other hand, the incidence of myllocerus weevil and yellow mite was comparatively higher than the incidence of other pests, in all the treatment plots. The minimum plant infestation was recorded as 6.10, 4.68, 12.38, 5.09 and 10.47 percent caused by semilooper, bihar hairy caterpillar, myllocerus, stem weevil and yellow mite, respectively, in the treatment module designed against insect, mite and nematode pests (M_3). Similarly, the minimum leaf infestations were also found to be 3.68, 4.89, 15.35 and 7.91 percent caused by semilooper, bihar hairy caterpillar, myllocerus and yellow mite, respectively in the same module M_3. A maximum infestation by semilooper (19.30% plant and 12.03% leaf), bihar hairy caterpillar (10.39% plant and 9.19% leaf), myllocerus (24.72% plant and 20.20% leaf), stem weevil (13.63% plant) and yellow mite (21.72% plant and 15.19% leaf) was found in the control (M_6) plot. Upadhyaya *et. al.* (1992) reported 81 percent damage up to the 7th leaf and 35 percent damage up to the 9th leaf from the top of the plants, caused by semilooper. The highest number of mites (33.16 mites/leaf) was observed in module M_1 followed by the control plot (30.44 mites/leaf)

Table 1. Incidence of major pests of jute, var.JRO-524 under various Integrated Pest Management (IPM) modules, 2004

Module	Percentage of infestation by various pests									Mean No. of mites per leaf	RKN population per 200 cc soil		Percent increased/ decreased	RKN gall index
	A. sabulifera plant leaf		*S. oblique* plant leaf		*M. discolor* plant leaf		*A. corchori* plant leaf	*P. latus* plant leaf			initial	final		
M_1	7.61	7.45	8.73	8.62	16.68	18.53	9.50	15.70	14.39	33.16	615.00	110.33	– 82.06	1.33
M_2	7.68	4.84	5.44	7.31	12.64	15.92	8.59	12.83	10.51	17.92	827.33	1724.00	+ 108.38	4.67
M_3	6.10	3.68	4.68	4.89	12.38	15.35	5.09	10.47	7.91	14.33	713.67	132.33	– 82.46	1.67
M_4	8.72	7.18	6.79	6.97	16.75	16.68	5.45	14.06	12.24	28.45	612.00	1942.67	+ 217.43	3.67
M_5	12.94	8.71	10.33	7.81	23.76	18.87	10.69	17.32	12.89	25.73	910.67	2157.33	+ 136.89	4.33
M_6	19.30	12.03	10.39	9.19	24.72	20.20	13.63	21.72	15.19	30.44	814.67	2351.00	+ 188.56	4.67
±SE CD (0.05)	0.54 1.63	0.56 1.69	0.43 1.29	0.49 1.47	1.14 3.43	0.66 1.99	0.51 1.54	0.65 1.96	0.45 1.35	1.56 4.69	3.54 10.66	7.12 21.43		0.67 2.02

RKN – root-knot nematode; + increased; – decreased

Table 2. Incidence of major pests of jute, var. JRO-524 under various IPM modules, 2005

Modules	Percentage of infestation by various pests							Mean No. of mites per leaf	RKN population per 200 cc soil		Percent increased/ decreased	RKN gall index
	A. sabulifera		*M. discolor*		*A. corchori*	*P. latus*			initial	final		
	plant	leaf	plant	leaf	plant	plant	leaf					
M_1	10.70	10.07	30.33	22.45	15.94	17.55	14.30	31.45	254.67	93.67	– 63.22	1.67
M_2	9.39	8.43	29.93	16.65	14.33	11.74	11.29	25.14	313.33	1209.00	+ 285.86	3.67
M_3	7.66	5.12	28.60	16.38	11.90	11.21	7.92	19.33	287.00	113.67	– 60.39	1.33
M_4	10.37	6.78	30.67	17.01	15.84	16.80	10.75	22.56	316.33	2304.67	+ 312.44	3.67
M_5	12.39	11.27	33.27	20.44	17.32	18.56	13.42	30.88	212.00	7181.33	+ 362.89	4.00
M_6	17.42	16.16	34.63	22.97	22.64	25.29	18.53	37.22	310.67	6814.33	+ 355.25	4.67
±SE CD (0.05)	0.68 2.05	0.57 1.72	1.04 3.13	1.21 3.64	0.73 2.20	0.75 2.26	0.42 1.26	1.89 5.69	4.14 12.46	7.53 22.67	– –	0.92 2.76

RKN – root-knot nematode; + increased; – decreased

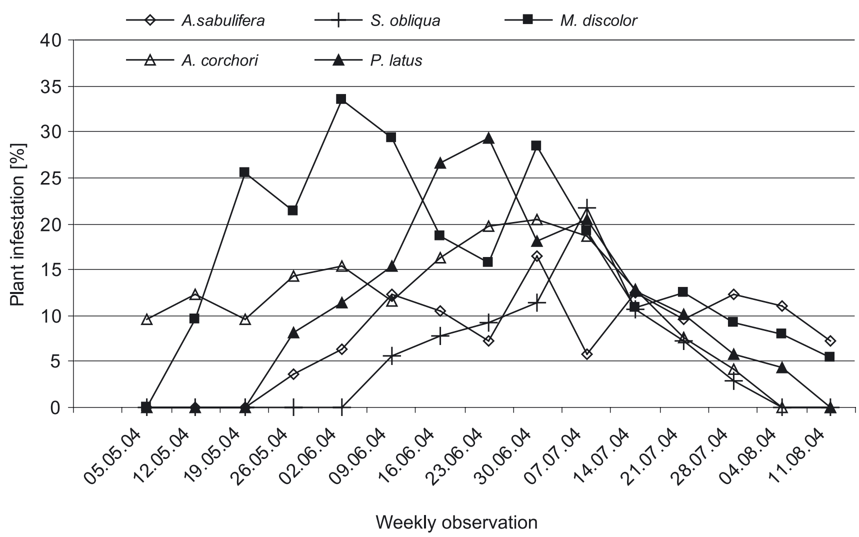

Fig. 1. Incidence of major pests of olitorius jute during 2004

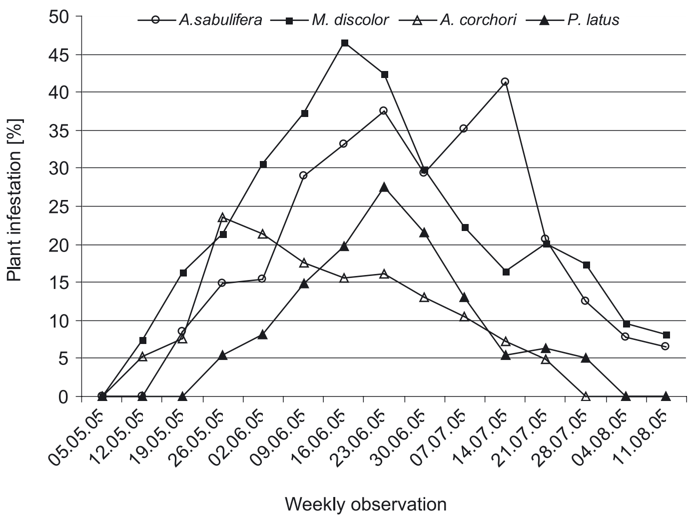

Fig. 2. Incidence of major pests in olitorius jute during 2005

and the lowest was found in module M_3 (14.33 mites/leaf). Mahapatra (1996) recorded the percentage of plant infestation caused by yellow mite ranged from 9.01 to 49.71 percent with a population density of 37.6 to 91.30 mites/leaf of olitorius jute. The plant infestations caused by yellow mite and stem weevil were reported to vary from 0.50 to 1.83 percent and 9.74 to 29.84, respectively during 2001–2002 in various IPM treatments as compared to 6.07–12.97 percent and 15.39–39.43 percent, respectively during 2000–2001 (Prasad *et. al*. 2002). In regards to the root-knot nematode incidence, the maximum reduction of nematode population (J_2) was found to be 82.46 percent from the INP of 713.67 to the final population of 132.33 per 200 cc soil with 1.67 root gall index at harvest in M_3 treated plots. In the treatment designed against insect and mite only (M_2), the incidence of insect and mite were observed to be low but the root-knot nematode (J_2) population was enhanced by 108.38 percent from the INP of 827.33 to the final population of 1 724.00 per 200 cc soil with 4.67 root gall index at harvest. The incidence of the insects and yellow mite were found at a higher level in the treatment against nematode only (M_1) whereas root-knot nematode population was found to be reduced by 82.06 percent i.e. from INP 615.00 to the final population of 110.33 in 200 cc soil with 1.33 root gall index at harvest. On the other hand, the nematode population was increased by many folds with higher root galling in the treatments considered as recommended practice (M_4), farmer practices (M_5) and the control (M_6). The incidence of different insects and yellow mite were also relatively higher in these treatments.

Incidence of the pest complex in 2005

The plant infestation by semilooper was found to be a minimum of 7.66 percent in M_3 and a maximum of 17.42 percent in M_6 in the crop season 2005 (Table 2, Fig. 2). Table 2 also indicated that *M. discolor* incidence was recorded to be high in all the treatments, ranging from 28.60 to 34.63 percent plant infestation in treatment M_3 and M_6, respectively. Prasad *et. al*. (2002) reported that semilooper and myllocerus weevil inflicted 15.82–59.44 and 7.18–15.20 percent plant infestation, respectively. The occurrence of stem weevil was observed to be higher ranging from a minimum of 11.90 percent to a maximum of 22.64 percent plant infestation in treatment M_3 and M_6, respectively. The minimum leaf infestation of 5.12 and 16.38 percent caused by semilooper and myllocerus, respectively, was recorded in treatment module M_3. The yellow mite incidence was recorded as maximum plant and leaf infestation of 25.29 and 18.53 percent, respectively in control plots; but the minimum incidence was observed to be 11.21 and 7.92 percent plant and leaf infestation, respectively in module M_3. Their population was found to be a minimum of 19.33 and a maximum of 37.22 leaf in the treatment M_3 and M_6, respectively. With the adoption of the treatment for managing nematode only (M_1), the root-knot nematode population in soil was decreased by 63.22 percent from the INP of 254.67 to the final population of 93.67 only in 200 cc soil with the lower gall index of 1.67 at harvest. In the treatment against insect and mite only (M_2), the root-knot nematode population was found to increase by 285.86 percent from the INP of 313.33 to attain 1209.00 per 200 cc soil with higher root galling (index 3.67) at harvest. In the module M_3, the nematode population declined by 60.39 percent from the INP of 287.00 to the final population of 113.67 per 200 cc soil and the gall index was just 1.33 at harvest. In the treatments M_4, M_5 and the control (M_6), a root gall index of 3.67, 4.00 and 4.67, respectively were observed as no protection measures were taken against nematode and thereby the INP multiplied profusely in the rhizosphere of jute and the soil nematode population was increased by 312.44, 362.89 and 355.25 percent in the said modules, respectively.

Yield and economics of the study

Average fibre and stick yield of a two year crop obtained from different treatment plots, along with the benefit cost ratio of the treatments over control plots were presented in table 3. The results revealed that maximum fibre and stick yield of 30.32 and 66.09 q/ha, respectively were obtained from the treatment against insect, mite and nematode (M_3) followed by M_2, M_4 M_5 and M_1, respectively. The minimum fibre yield was recorded to be 17.96 q/ha from the control plots (M_6). The highest benefit cost ratio of 7.34 was also found in treatment M_3. On the basis of the benefit cost ratio, performance of the treatments was found in the decreasing order of $M_3 > M_2 > M_4 > M_5 > M_1 > M_6$.

From the results of this two-year experiment, it was seen that the treatment against nematode only (M_1), which consisted of seed treatment with carbosulfan and soil application of carbofuran, not only suppressed the multiplication of root-knot nematode but also rendered to some extent, control of soil insect like grubs of myllocerus in the root zone of the crop. While the treatment against insect and mite pest (M_2) might be attributed to good control of the above ground pests, it had no check on the root-knot nematode which alone can damage the crop by 9–70 percent (Anonymous 1996). All the insects and yellow mite attacks were observed to be minimum in module M_3 as compared to the other modules in 2004. No bihar hairy caterpillars were noticed in the jute field in 2005 and the treatment module M_3 had the lowest recorded incidence of other pests. The maximum reduction of the nematode population and lowest gall index was also recorded in M_3. Two years of observations on the management of insects and yellow mites revealed that M_3 was the most effective control module against these pest complexes. Prasad *et al*. (2002) also reported that out of the five treatments including three IPM modules, the module III (IPM for insect, mite and diseases) was the most effective management strategy where a minimum attack by all the pests and diseases were recorded with a maximum fiber yield of 26.33 q/ha.

Nematode incidence was found to be minimum in M_3 where the INP was reduced by 82.46 and 60.39 percent in 2004 and 2005, respectively. The minimum root gall indices were also recorded to be 1.67 and 1.33 in 2004 and 2005, respectively in the same module M_3. Of course, the nematode incidence in terms of population reduction and gall indices were at a minimum in module M_1 for both the crop seasons, but insects and yellow mites were not under check in module M_1. While in the treatment modules M_2, M_4, M_5 and M_6, the nematode populations increased by many times from the INP to the final population, with a higher gall index at harvest of the crop. Bibha and Bora (2005) also reported a 19.4 percent decrease of nematodes from the INP of 390 to the final population of 314.3 per 200 cc soil at harvest of the jute var. JRC-212. From the study, it was obvious that M_3 was the most effective and economical management strategy against the spectrum of pests in olitorius jute. Hath and Chakraborty (2004) obtained good results adopting the IPM module against insect, mite and diseases with the resulting minimum attack of semilooper, bihar hairy caterpillar, yellow mite and stem rot disease. Hath and Chakraborty (2004) using the IPM module produced the maximum fiber yield of 30.85 q/ha as compared to the modules against insect and mite pests; against insects and diseases; against mite and diseases and the control plots.

Table 3. Yield and economics of different IPM modules

Module	Fiber yield [q/ha]			Stick yield [q/ha]			Benefit-cost ratio
	2004	2005	average	2004	2005	average	
M_1	20.85	21.26	21.06	45.45	46.35	45.90	2.16
M_2	28.50	28.27	28.39	62.13	61.63	61.88	6.79
M_3	30.45	30.19	30.32	66.38	65.81	66.09	7.34
M_4	25.28	25.26	25.27	55.11	55.07	55.18	4.69
M_5	22.67	21.72	22.19	49.39	47.35	48.37	3.14
M_6	17.35	18.57	17.96	37.82	40.48	39.15	–
±SE	0.64	0.58	–	2.57	2.16	–	–
CD (0.05)	1.93	1.75	–	7.74	6.50	–	–

Natural enemies of jute pests

In this study, the occurrence of natural enemies in the jute field was recorded. The list was presented in table 4.

Table 4. Natural enemies of pests in jute ecosystem

Species	Family	Order
Insects:		
Micraspis discolor	Coccinellidae	Coleoptera
Harmonia octomaculata	Coccinellidae	Coleoptera
Cheilomenes sexmaculata	Coccinellidae	Coleoptera
Coccinella septempunctata	Coccinellidae	Coleoptera
Stethorus sp.	Coccinellidae	Coleoptera
Coccinella transversalis	Coccinellidae	Coleoptera
Varania discolor	Coccinellidae	Coleoptera
Holobus kashmiricus	Staphylinidae	Coleoptera
Dragonfly (unidentified)	Gomphidae	Odonata
Damselfly (unidentified)	–	Odonata
Camponotus compressus	Formicidae	Hymenoptera
Rhynocoris sp.	Reduviidae	Hemiptera
Mirid bug (unidentified)	Miriidae	Hemiptera
Spiders:		
Araneus sp.	Araneidae	Araneae
Cheiracanthium melanestoma (Therell)	Clubionidae	Araneae
Cheiracanthium sp.	Clubionidae	Araneae
Oxyopes shweta Tikader	Oxyopidae	Araneae
Oxyopes sp.	Oxyopidae	Araneae
Neoscona mukerjei Tikader	Araneidae	Araneae
Neoscona sp.	Araneidae	Araneae
Thomisus cherapunjaus Tikader	Thomisidae	Araneae
Thomisus sp.	Thomisidae	Araneae
Xysticus sp.	Thomisidae	Araneae

Altogether thirteen insect and ten spider species as predators, were found feeding on different insect and mite pests. Among the insect predators, there were seven coccinellids, one staphylinid beetle, one formicid ant, one mirid bug, one reduvid bug, one gomphid dragonfly and one damselfly. Out of the ten predacious spiders; three belonged to the Araneidae family, and three belonged to the Thomisidae family, two belonged to the Clubionidae family and two belonged to the Oxyopidae family. Four spider species viz. *Neoscona mukerji* Tikader, *Neoscona* sp., *Araneus* sp. and *Xysticus* sp. were recorded for the first time in the jute ecosystem of West Bengal. Zaman (1990) also recorded six species of predatory insects, five species of insect parasitoids, three species of predatory mites and one ectoparasitic mite while encountering various pests of jute in Peshawar, Pakistan. Kalita and Borah (1993) recorded nine natural enemies of jute pests belonging to the orders Hymenoptera, Diptera and Coleoptera of which *Dolichogenidea hyposidrae* was the most prevalent parasitoid of semilooper larvae in Assam. Pradhan (2000) enumerated eight spider species predating on different jute pests. In the present investigation, only the larval parasitoid, *Apanteles obliquae* (Braconidae: Hymenoptera) was found attacking the larvae of bihar hairy caterpillars. The insect predators were found to be somewhat species specific but spider predators were found to be highly polyphagous.

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POLISH SUMMARY

INTEGROWANE ZWALCZANIE KOMPLEKSU SZKODNIKÓW JUTY, *CORCHORUS OLITORIUS* L.

W latach 2004 i 2005, w Bidhan Chandra Krishi Viswavidyalaya, zachodni Bengal (Indie), prowadzono doświadczenia polowe obejmujące sześć kombinacji zwalczania przeciwko kompleksowi szkodników juty olitorius. Wyniki wykazały, że występujące: *Anomis sabulifera* Guen., *Spilarctia obliqua* Wlk., *Myllocerus discolor* Bohemus, *Apion corchori* Marshall i *Polyphagotarsonemus latus*

Banks, były czynnikami sprawczymi powodującymi, odpowiednio, minimalne – 6,10; 4,68; 12,38; 5,9 oraz 10,47% zakażenia roślin. Takie wyniki otrzymano w sezonie 2004 roku, z programu: Integrowane zwalczanie szkodników, wzorzec M_3, opracowanego przeciwko owadom, pajęczakom i szkodliwym nicieniom, przedstawione w porównaniu do innych zabiegów. Podobne wyniki otrzymano w 2005 roku, z względnie niskim zakażeniem roślin (7,66; 28,60; 11,90 i 11,21%), wywołanym, odpowiednio, przez – *A. sabulifera*, *M. discolor*, *A. corchori* i *P. latus*, we wzorcu M_3, w porównaniu do innych kombinacji zabiegowych. Maksymalną redukcję (z 69, 39 do 82, 46%) populacji *Meloidogyne incognita* Chitwood wraz z niskim współczynnikiem narośli (1,33–1,67) w czasie zbiorów, obserwowano we wzorcu (M_3) w latach 2004–2005. Populacja żółtego przędziorka wynosiła, odpowiednio, minimalnie: 14,33 i 19,33% na liść w latach 2004 i 2005 w M_3. Maksymalny średni plon włókna wynoszący 30,32 g/ha i stosunek zysku do kosztu wynoszący 7,34, również zaobserwowano w M_3. W oparciu o stosunek zysk-koszt, w module M_3 odnotowano następującą kolejność skuteczności zabiegów: $M_3 > M_2 > M_4 > M_5 > M_1 > M_6$. Biorąc pod uwagę opanowanie owadów, pajęczaków i mątwików M_3 był najskuteczniejszy, jak również skuteczna była strategia ekonomicznego działania przeciwko kompleksowi szkodników juty. W ekosystemie juty, w zachodnim Bengalu, po raz pierwszy zostały wykryte cztery gatunki pajęczaków: *Neoscona mukerji* Tikader, *Neoscona* sp., *Araneus* sp., *Xysticus* sp. Populacja szkodników w ekosystemie juty mogłaby być ograniczona w znacznym zakresie, w naturalny sposób, ponieważ napotkano trzynaście owadów i dziesięć nadpasożytów pajęczaków na polu doświadczalnym w sezonie. Poza tym parazytoid larw (*Apanteles obliquae*) został znaleziony na larwach i włochatych gąsienicach.