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Development and validation of pest management strategy against mirid bug, *Creontiades biseratense* in *Bt* cotton

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ABSTRACT

Mirid bug [*Creontiades biseratense* (Distant)] (Miridae: Hemiptera) is a newly emerged key sucking pest of cotton in southern part of India. Present study was conducted at District Perambalur (Tamil Nadu) in farmer-participatory mode during *kharif* season of 2014-15, 2015-16 and 2016-17 with MRC 7918 BG II *Bt* cotton to develop a suitable IPM strategy for this emerging insect-pest. The results of the experiment showed that the population of mirid bugs were significantly lower in all treatments over farmer's practice. In respect to management studies, T_6 (lucerne as a trap crop, alternate foliar spraying of acephate 75 WP and azadirachtin 10000 ppm @ 2 ml/l alternatively between 15 days interval for 4 sprays) recorded lowest population of mirid bugs (av. 0.34 bugs/plant) as compared farmer's practice (av. 1.58 bugs/ plant). The results of the experiment revealed that the population of sucking pests was significantly lower and population of beneficials was significantly higher in treatment over farmer's practice. There was significant increase of 63.43% seed cotton yield due to protection of crop as compared to farmer's practice. Large scale validation in farmer-participatory mode results also indicated low incidence of sucking pests in IPM as well as farmers' practices (FP) during the entire crop season. Population of three beneficial insects, ladybird beetle (*Coccinella* spp.) and green lacewing (*Chrysoperla carnea*) and spiders was recorded significantly higher in IPM as compared to farmer's practice.

Key words : *Bt* cotton, Mirid bugs, Pest management, Validation

Cotton (*Gossypium* spp.) is an important cash crop playing a pivotal role in sustaining economy of India and livelihood of the Indian farming community. Cotton crop is ravaged by an array of insect pests accounting for profound crop loss. The main thrust of Indian cotton growers has so far been towards the repeated application of synthetic pesticides to combat pest problem and save the crop. With the changes in agronomical practices after the introduction of Bt genotypes for commercial cultivation, reduced number of sprays and use of target specific insecticides, the sucking pests, viz. leaf hoppers, aphids, whiteflies, thrips, mealy bugs and mirids assuming major status in Bt cotton ecosystem. The widespread adoption of *Bt* cotton has resulted in many ecological and agronomic changes, including dramatic shifts in pest community assemblages (NRC 2010, Lu *et al*. 2010, Catarino *et al*. 2015, Adam *et al*. 2016). In recent years, the mirid bug has emerged as a key sucking pest causing a severe damage to Bt cotton in southern part of our country. The green mirid [*Creontiades biseratense* (Distant)] (Miridae: Hemiptera) is posing a threat to the Bt cotton cultivation. The pest has also been reported from Tamil Nadu, Andhra Pradesh and Maharashtra (Surulivelu and Dhara 2007). Presently, mirid bug is appearing in severe form throughout the Karnataka, particularly in cotton growing tract of Haveri, Dharwad and Davangere districts (Rohini *et al*. 2009 and Udikeri *et al*. 2009). In recent years, it is a regular pest in Tamil Nadu also. These bug appearance coincides with peak reproductive stage where both nymphs and adults suck the sap from squares and tender bolls leading to shedding of fruiting bodies thereby causing drastic reduction in seed cotton yield (Ravi 2007, Bheemanna *et al*. 2010). There is a lack of information on strategies for management of mirid bugs. Hence, there is a dire need for environmentally sound management practices against mirid bug in Bt cotton. Therefore, the present study aimed to develop a suitable IPM strategy for this emerging insect-pest.

MATERIALS AND METHODS

Field experiments were conducted at three locations of district Perambalur (Tamil Nadu), viz. Research Farm of Hans Roever Krishi Vigyan Kendra, farmer's field in village Valikandapuram and Brammadesam, during *kharif* season of 2014-15 and 2015-16 with MRC 7918 BG II *Bt* cotton in Randomized Block Design with seven treatments

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replicated thrice to develop and validate pest management strategy for mirid bug of *Bt* cotton in each plot size of 12 m × 12 m. The details of pest management treatments in the field are given below:

Treatment	Details
T_1	Sowing of Lucerne as trap crop
T_2	Application of azadirachtin 10000 ppm @ 2 ml/litre of water (4 sprays at 15 days interval)
T_3	Application of acephate 75 WP @ 1g/l (4 sprays at 15 days interval)
T_4	$T_1 + T_2$
T_5	$T_1 + T_3$
T_6	T_1 + Application of azadirachtin and acephate alternately at 15 days interval
T_7	Farmer's practice (5 sprays, imidacloprid 17.8 SL+ SAAF (carbendazim+mancozeb), monocrotophos 36 SL + acephate 75 WP, thiodicarb 75 WP, imidaclopriod 17.8 SL and acetamiprid 70 SP)

The treatments were imposed 4 times at an interval of 15 days starting from initial notice of the mirid bug. In T_1, the lucerne crop was sown in a single row after every fifth row of Bt cotton. For taking counts of mirid bugs, twenty plants were selected randomly in each plot. Weekly observation of pest population on squares, flowers and boll were recorded. Weekly observations were also recorded for sucking pests –jassids (*Amrasca biguttula biguttula*), whiteflies (*Bemisia tabaci*) and thrips (*Thrips tabaci*) as the number of insects on three leaves each of 20 randomly selected plants per field. The adult population of three beneficials, ladybird beetle (Coccinella spp.) and green lacewing (*Chrysoperla carnea*) and spiders were recorded on 20 plants per plot per field. Seed cotton yield of each plot was recorded over the three pickings. During 2016-17, best pest management strategy (T_6) was validated in 10 ha in the village Annukur, district Perambalur, Tamil Nadu and was compared with farmer's practice in farmer-participatory mode. In farmer's practice, farmers used total of six sprays for the management of mirid bugs which included two sprays of imidacloprid 17.8% SL, one spray of thiomethoxam 25% WG, fipronil 5% SC and two sprays of acetamiprid 70% SP. Data collected on various parameters including weekly data on insect pests, natural enemies, and yield, etc. were subjected to ANOVA and student's t-test using statistical software.

RESULTS AND DISCUSSION

The pooled data of two years *kharif* season**,** 2014-15 and 2015-16 of the population of mirid bugs in *Bt* cotton at Perambalur region has been depicted in Table 1. The results of the experiment showed that the population of mirid bugs were significantly lower in all treatments over farmer's practice. During the entire crop seasons, the mirid bug population was prevalent and showing fluctuating trend. The mirid bugs population in T_6 showed its peak in 51 SMW and was on decreasing trend from 52-4 SMW, whereas in T_7 (FP) the population showed increasing trend towards the end of the season, i.e. 51-4 SMW. In respect to management studies, T_6 (lucerne as a trap crop + alternate foliar spraying of acephate 75 WP and azadirachtin 10,000 ppm @ 2 ml/l alternatively between 15 days interval for 4 sprays) recorded lowest population of mirid bugs (av. 0.34 bug/plant) followed by T_5 (av. 0.49 bug/plant), T_3 (av. 0.57 bug/plant), T_4 (av. 0.71 bug/plant), as compared to T_7, farmer's practice (av. 1.58 bug/ plant).

The results of the experiment revealed that the population of sucking pests was significantly lower and population of beneficials was significantly higher in treatment over farmers practice (Table 2). The treatment T_6, recorded lowest population of jassids (av. 3.56 nymphs or adults/plant) followed by T_3 (av. 3.81 nymphs or adults/ plant), T_5 (av. 3.82 nymphs or adults/plant) as compared to farmer's practice (av. 6.85 nymphs or adults/plant). Mean population of two years of whitefly, treatment T_6 and T_3 recorded lowest population (av. 1.79 adults/plant) followed by T_5 (av. 2.16 adults/plant) as compared to farmer's practice (av. 5.19 adults/plant). Similarly, as far as population of

Table 1 Impact of pest management treatments on the population of mirid bugs (pooled data of two year *kharif* season**,** 2014-15 and 2015-16).

Treatment	Population of mirid bug adults or nymphs/plant/ standard meteorological week												
	45	46	47	48	49	50	51	52	1	2	3	4	Average
T_1	0.12	0.84	0.97	1.17	1.05	1.04	1.10	1.14	1.50	1.54	1.77	2.10	1.20
T_2	0.09	0.44	0.84	1.07	0.80	0.90	0.97	0.44	0.80	0.87	0.56	0.70	0.71
T_3	0.17	0.27	0.74	0.81	0.54	0.60	0.64	0.37	0.67	0.84	0.51	0.64	0.57
T_4	0.00	0.30	0.87	1.00	0.74	0.94	1.04	0.47	0.70	0.90	0.57	0.14	0.64
T_5	0.13	0.20	0.47	0.70	0.44	0.46	0.31	0.30	0.64	0.81	0.47	0.97	0.49
T_6	0.14	0.07	0.30	0.40	0.24	0.37	0.74	0.33	0.47	0.54	0.29	0.20	0.34
T_7	0.12	0.49	1.08	1.44	1.78	1.55	1.38	1.45	2.15	2.24	2.49	2.75	1.58
SE (m)	0.01	0.01	0.01	0.06	0.02	0.01	0.02	0.02	0.01	0.01	0.08	0.05	0.02
CD (P=0.05)	0.04	0.04	0.04	0.17	0.05	0.04	0.06	0.05	0.04	0.03	0.24	0.16	0.05
CV	15.66	6.13	2.87	10.15	3.39	2.57	3.65	4.81	2.23	1.64	13.60	7.41	3.82

Details of treatments are given in Materials and Methods.

Table 2 Impact of treatments on the population of sucking pests and beneficials (pooled data of two year *kharif* season, 2014-15 and 2015-16)

Treatment	Jassid (*Amrasca biguttula biguttula*) (av. nymphs or adults/plant)	Whitefly (*Bemisia tabaci*) (av. adults/plant)	Thrips (*Thrips tabaci*) (av. adults/plan)	Lady bird beetle (*Coccinella* spp.) (av. adults/plant)	Green lacewing (*Chrysoperla carnea*) (av. adults/plant)	Spiders (av. adults/ plant)	Seed cotton yield (kg/ ha)	% increase of T_6 over FP
T_1	6.73	5.36	9.68	0.91	0.26	0.30	1199	16.29
T_2	4.33	2.5	7.15	0.15	0.22	0.20	1416	37.34
T_3	3.81	1.79	6.86	0.04	0.12	0.11	1524	47.81
T_4	4.39	2.42	6.92	0.1	0.21	0.14	1344	30.40
T_5	3.82	2.16	6.79	0.07	0.12	0.12	1595	54.70
T_6	3.56	1.79	6.72	0.69	0.23	0.26	1685	63.43
T_7 (FP)	6.85	5.19	9.72	0.08	0.14	0.17	1031	--
SE(m)	0.01	0.66	0.10	0.05	0.02	0.02	29.22	
CD (P=0.05)	0.03	2.05	0.31	0.14	0.07	0.07	91.04	
CV	0.14	37.77	3.41	27.42	21.09	19.78	3.63	

Details of treatments are given in Materials and Methods.

thrips is concerned, treatment T_6 recorded lowest population (av. 6.72 nymphs or adults/plant) followed by T_3 (av. 6.79 nymph or adults/plant) and T_5 (av. 6.86 nymph or adults/ plant) as compared to farmer's practice (av. 9.72 nymphs or adults/plant).

Among natural enemies, the population of ladybird beetle remained during the *Bt* cotton crop season and was higher in T_1 (av. 0.91 adult/plant) and T_6 (av. 0.69 adult/ plant) as compared to farmer's practice (av. 0.08 adult/ plant). Mean population of two years of green lacewing, treatment T_1 recorded highest population (av. 0.26 adult/ plant) followed by T_6 (av. 0.23 adult/plant) as compared to farmer's practice (av. 0.14 adult/plant). Similarly, the treatment T_1 recorded highest population of spiders (av. 0.30 adult/plant) followed by T_6 (av. 0.26 adult/plant) as compared to farmer's practice (av. 0.17 adult/plant). The average highest seed cotton yield was obtained in T_6 (lucerne as a trap crop + alternate foliar spraying of acephate 75 WP and azadirachtin 10,000 ppm @ 2 ml/l alternatively between 15 days interval for 4 sprays) which was 1685 kg/ha, followed by T_5, (1595 kg/ha) as compared to T_7, farmer's practice, (1031 kg/ha). It was also revealed from the data that there was significant increase of 63.43% seed cotton yield due to protection of crop with best suitable management technique (T_6) followed by 54.7% of T_5 and 47.81% of T_3 as compared to T_7, farmer's practice (Table 2). The results reveal that in all aspects T_6 was best integrated pest management (IPM) strategy among all the management techniques evaluated.

In 2016-17, large scale validation of integrated pest management (IPM) strategy was carried out in 10 ha of area in farmer-participatory mode in the village Annukur, district Perambalur, Tamil Nadu and was compared with farmer's practice and the data is presented in Table 3 and Fig 1. Results indicated low incidence of sucking pests in IPM as well as farmers' practices (FP) during the entire crop season. Population of mirid bugs was higher in farmer's practice as compared to the management fields and the differences between IPM and FP were statistically significant. Population of three beneficial insects, ladybird beetle and green lacewing and spiders was recorded significantly higher in IPM as compared to FP. All the data differed significantly from each other as per the student's 't' test. The differences in insect-pest population between IPM and FP were statistically significant ($P<0.05$) in most of the SMWs (Table 3). It is clearly revealed from the data in Fig. 1 that population of mirid bugs remained at higher level (average 2.51 nymphs or adult/plant) and population of natural enemies remained

Table 3 Insect-pest and beneficials in farmer-participatory mode at Perambalur region during *kharif* season of 2016-17

Pest/Beneficials	Integrated pest management (Range)	Farmer's practice (Range)	Statistically significant* ($P<0.05$) in following SMWs
Jassid (average nymphs or adults/plant)	2.01 (0.12-4.78)	2.43 (0.05-3.70)	44, 51-52, 1-2
Whitefly (average adults/plant)	2.44 (0.28-4.93)	3.19 (0.4-9.2)	44-46, 48-49, 51-52
Thrips (average nymphs or adults/plant)	1.85 (0.03-3.21)	2.10 (0.1-4.9)	44-45
Mirid bugs (average nymphs or adults/plant)	0.28 (0.05-0.70)	2.51 (0.8-5.0)	45-47, 50-52, 1
Lady bird beetle (average adults/plant)	0.20 (0.03-0.45)	0.13 (0.1-0.6)	44-46, 48-49, 52, 1-3
Green lacewing (average adults/plant)	1.05 (0.34-3.42)	0.24 (0.2-0.7)	48-51, 1
Spider (average adults/plant)	0.57 (0.25-2.43)	0.19 (0.1-1.2)	45, 50, 2

*Student t-test

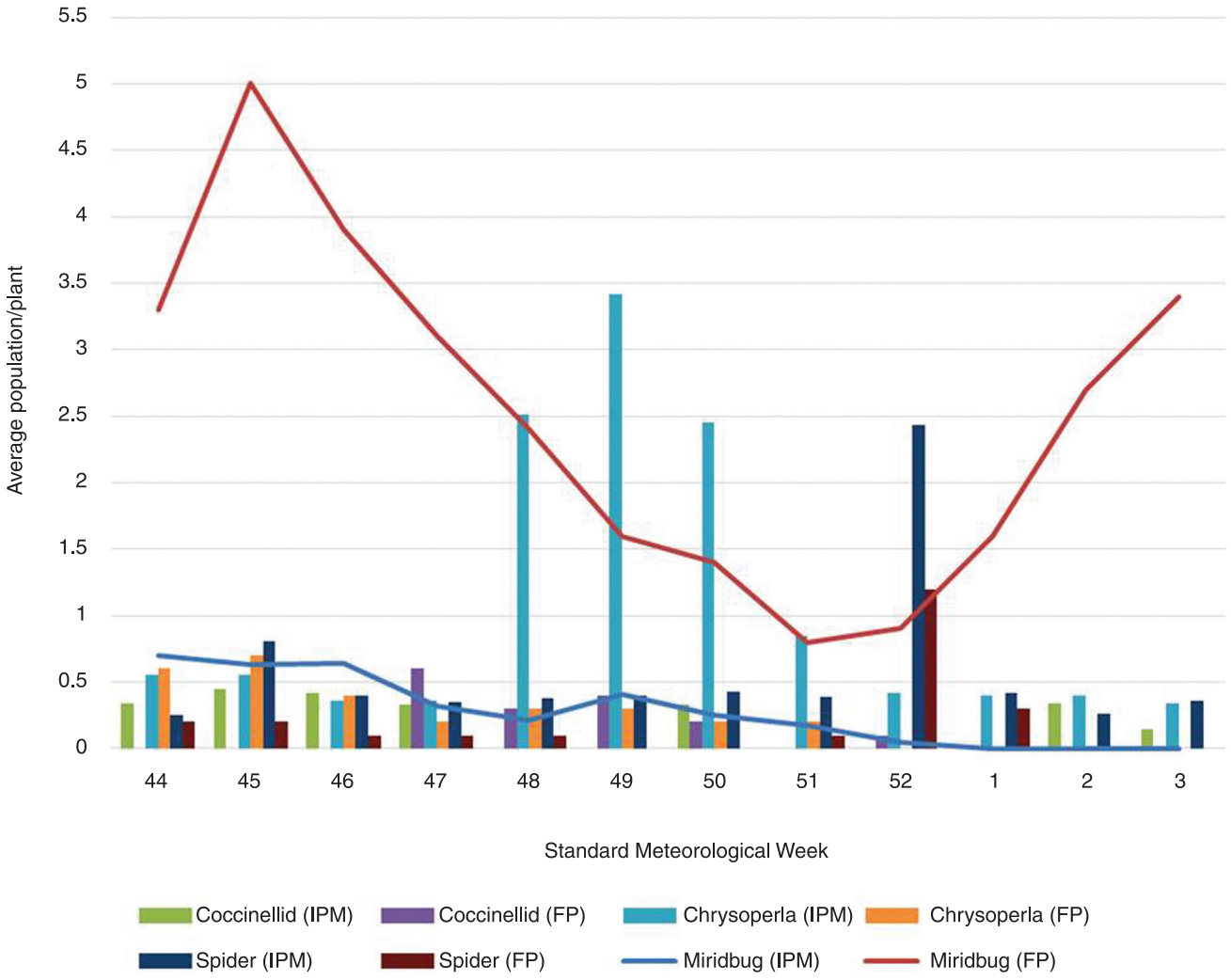

Fig 1 Trend of mirid bug and natural enemies population in IPM and FP fields during 2016-17.

at lower level during the crop season in 2016-17 in FP fields whereas population of mirid bugs remained at lower level (average 0.28 nymphs or adult/plant) and population of all the natural enemies remained at higher level in IPM fields. All organisms are capable of increasing in numbers through process of reproduction but population of natural enemies in FP fields was lower due to injudicious use of insecticides. In IPM fields, it was indicated from the data that population of beneficials was prevalent throughout the season and remained up to the end of the season however population was towards the decreasing trend during the crop season in FP fields. Integrated pest management validation in farmer-participatory mode resulted in higher yield (16.50 q/ha in IPM against 9.02 q/ha in FP) and benefit- cost ratio (2.87 in IPM and 1.62 in FP) in IPM plots as compared to farmer's practice.

Acephate is an organophosphate foliar insecticide of moderate persistence with residual systemic activity of about 10–15 days at the recommended use rate. Ravi (2007) reported that acephate 75 WP at 750 g a.i./ha was found to be superior over other chemicals in reducing the mirid bug population and recorded higher seed cotton yield. Udikeri *et al*. (2009) recorded higher bio-efficacy of acephate 75 WP and acetamiprid 20SP against mirid bugs. Rohini (2009) reported that highest seed cotton yield was obtained in acephate treated plots followed by profenophos, indoxacarb and buprofezin. Field studies conducted by Mensah and Khan (1997) revealed that in an experiment where lucerne was planted as strips within commercial cotton crop, were recorded on cotton as compared to cotton without lucerne strips. They concluded that lucerne could be incorporated into an IPM system to control green mirids on cotton. Jaastad *et al*. (2009) evaluated the effect of neem extract, garlic extract, vegetable oil and kaolin on populations and damage of mirids in apples. Results showed that neem extract was a promising alternative, giving as good control of mirid damage as several synthetic pesticides. Among different insecticides and bio-pesticides evaluated against mirid bug for their efficacy under field conditions, acephate 75 WP @ 1.0 g/l was found to be the most effective treatment. The reports of Ravi (2007), Rohini (2009) and Udikeri *et al*. (2009) on *C. biseratence* in cotton ecosystem revealed similar findings. Ravi (2007) reported on the efficacy of neem oil which has been found quite effective against mirid

bug in Bt cotton, whereas in our study the treatment T_2 with neem alone was not effective. The results of Shalini *et al.* (2012) indicated that the IPM module, M-III comprising of repeated application of acephate proved to be the best with maximum reduction in pest population followed by IPM module, M-II (Adaptable module). These findings were in close agreement with our research findings. By incorporating these management practices, application of synthetic insecticides can be reduced to a minimum possible level. Mirid bugs either prevailing hitherto or newer ones have assumed key status warranting couple of sprays during reproductive phase. Key strategies and integrated approaches are essential for sustainable use of Bt technology. Such an approach poses a lower risk to people, wildlife and the environment while simultaneously protecting economic interests among farmers. The technology will be helpful in increasing the seed cotton yield and improved quality especially in terms of reduced pesticides contents, thereby improving the socio-economic status of cotton growers of the country.

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