Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(2): 617-620

Received: 14-01-2019
Accepted: 18-02-2019

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Estimation of avoidable crop losses due to bollworm complex in bt cotton

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Abstract
The present investigation was carried out at the research farm of Cotton Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during *kharif* 2017-18. The results revealed that among the different treatments minimum bollworm damage (12.33%) was recorded in treatment T1 i.e. spray of Chlorantraniliprole 9.3% + Lamda Cyhalothrin 4.6% ZC @ 0.5 ml/L at 55 days after emergence (DAE) & subsequent spray was given at 15 days interval up to 145 DAE whereas, maximum 67.98 per cent was recorded in untreated control at the time of harvest. Maximum seed cotton yield (21.09 q/ha) was recorded in treatment T1 whereas minimum 2.65 q/ha was recorded in untreated controls. The data on per cent avoidable losses revealed that it was highest in treatment T1 (87.43%) followed by T2 (85.93%), T3 (84.13%), T4 (74.73%), T5 (67.03%) and T6 (37.20%). But on the basis of ICBR, treatment T3 (5 Sprays of Chlorantraniliprole 9.3% + Lamda Cyhalothrin 4.6% ZC @ 0.5 ml/L starting at 55 DAE with an interval of 15 days) was most cost effective treatment with highest ICBR (1:3.43) with net monetary return of Rs 46,996/ha.

Keywords: bollworm complex, bt cotton, avoidable losses, boll damage, loculi damage

1. Introduction
Cotton the "white gold" is one of the most important fibre crop of India. It plays prominent role in the National and International economy. It is grown mainly for its fiber, used in the manufacture of cloth for mankind [1]. Cotton, the most important commercial crop of India ranks first in acreage in the world. In India cotton is cultivated on 105.00 lakh ha. with average productivity of 68 kg lint per ha. In Maharashtra cotton crop is grown on 38.06 lakh ha with production of 83.25 lakh bales and productivity of 398.00 kg/ha. Approximately 62 per cent of India's Cotton is produced on rain-fed areas and 38 per cent on irrigated land. In terms of productivity, India ranks poorly compared to USA & China during 2016-17 [2]. Major constraint in attaining high production of seed cotton is the damage inflicted by insect pests. Insect pest problems in agriculture have shown a considerable shift during the first decade of twenty-first century due to ecosystem and technological changes. The global losses due to insect pests were 10.8 per cent towards the beginning of this century, whereas in India, the crop losses are around 17.5 per cent at present. In terms of monetary value, the Indian agriculture currently suffers an annual loss of about Rs 8, 63,884 million due to insect pests [3]. Production depends mainly on the timely arrival of monsoon, distribution of rainfall and management interventions. However, pink bollworm in central Maharashtra may cause yield losses albeit to a minor extent. The intensity of pink bollworm was more in the irrigated tracts of central Maharashtra. During 2017-18 pink bollworm damage was higher in Jalgaon and severe in Dhule and Nadurbar. Yield losses in these districts could have been close to 20-25 per cent due to the boll damage in the second-third pickings of cotton, which was estimated at 40,000 bales worth US$ 12 million in the three districts. The state may contribute 8.0 m bales this year from an area of 3.6 to 3.8 m hectares.

2. Materials and Methods
Field experiment was laid out in Randomized Block Design (RBD) with seven treatments replicated thrice. The treatment included spray of ready mix formulation Chlorantraniliprole 9.3% + Lamda Cyhalothrin 4.6% ZC @ 0.5 ml/L with T_1 - 1st spray at 55 DAE & subsequent spray was given at 15 days interval up to 145 DAE, T_2 - 1st spray at 70 DAE & subsequent spray was given at 15 days interval up to 145 DAE, T_3 - 1st spray at 85 DAE & subsequent spray was be given at 15 days interval up to 145 DAE, T_4 - 1st spray at 100 DAE & subsequent

spray was given at 15 days interval up to 145 DAE, T_5 - 1st spray at 115 DAE & subsequent spray was given at 15 days interval up to 145 DAE, T_6 - 1st spray at 130 DAE & subsequent spray was given at 15 days interval up to 145 DAE and T_7 Control. The plot size was 6.3 m X 6.0 m and spacing was 90 x 60 cm. sowing of seeds was done on 04th July 2017.

Periodical observations were taken to record the observation on open boll damage. All open bolls randomly selected from five plants from each net plot were assessed after the end of pickings for bollworm complex damage. Accordingly, the per cent open boll damage was worked out at harvest. For recording the observation on loculi damage, all open bolls randomly selected from five plants from each net plot were assessed after the end of pickings for bollworm complex damage. Accordingly, the per cent loculi damage was worked out at harvest. Observation on open boll damage and loculi damage were also undertaken. Thus the data generated were statistically analyzed by using Randomized Block Design.

3. Results and Discussion

3.1 Per cent open boll damage at harvest due to bollworm complex.

The data recorded on per cent open boll damage due to bollworm complex at harvest are presented in Table 1. Treatment T_1 found consistently significant over rest of the treatments at harvest time. The per cent mean open boll damage due to bollworm complex were ranges from 12.33-61.96 per cent among the treatments whereas, 67.98 per cent mean open boll damage was observed in the control treatment (T_7). Significantly lower per cent mean open boll damage was recorded in T_1 (12.33%) was significantly better than T_2 (25.88%), whereas T2 was at par with T_3 (37.21%) but was significantly better than T_4 (44.73%), T_5 (56.13%) and T_6 (61.96%). The result revealed that Chlorantraniliprole @ 30 g a.i. per ha was the most effective treatment for the control of bollworm complex on cotton [4]. The result reported that flubendiamid 20% WDG @ 100g a.i. per ha recorded lowest bollworm incidence (8.82 and 5.84%) with highest good open bolls (23.83 and 30.93 per cent) during 2008-2009 and 2009-2010 [5]. Also, observed that Ampligo 150 ZC (combination of chlorantranilipole 9.3% + lambda cyhalothrin 4.6% ZC) was highly effective insignificant reduction of per cent damage on squares, bolls and loculi attacked by bollworm complex in cotton during *Kharif* 2011 and 2013 [6].

3.2 Per cent loculi damage at harvest due to bollworm complex.

The data recorded on per cent loculi damage due to bollworm complex at harvest are presented in Table 1. At harvest time results revealed that treatment T_1 were significantly superior over control. Due to bollworm complex the per cent mean loculi damage were found to be in the of ranges 9.66-26.21 per cent. Treatment T_1 recorded significantly minimum mean loculi damage (9.66%) was at par with T_2 (14.14%) and followed by T_3 (17.94%), T_4 (21.63%), T_5 (23.83%) and T_6 (33.68%). However, maximum open boll damage (33.68%) was recorded in T_7 - control.

The present findings are more or less parallel to observed that chlorantranilipole 30 g a.i./ha had significantly lowest infestation of bollworm complex with minimum damage to locule [4]. Also, observed that Ampligo 150 ZC (combination of chlorantranilipole 9.3% + lambda cyhalothrin 4.6% ZC) was highly effective insignificant reduction of per cent damage of squares, bolls and loculi attacked by bollworm complex in cotton during *Kharif* 2011 and 2013 [6].

3.3 Effect of different treatments on seed cotton yield (q/ha).

The data on yield of seed cotton was recorded and presented in Table 1. The seed cotton yield in different treatments ranged from 4.22-21.09 q/ha. The highest yield of seed cotton yield in cotton T_1 (21.09 q/ha) The next best treatments in which the maximum seed cotton yield was obtained were T_2 (18.84q/ha) followed by T_3 (16.70q/ha), T_4 (10.49q/ha), T_5 (8.04q/ha) and T_6 (4.22q/ha). In untreated control plot, the lowest seed cotton yield (2.65 q/ha) was recorded. The result revealed that seed cotton yield was significantly higher in chlorantraniliprole [4]. Also observed that Ampligo 150 ZC (combination of chlorantranilipole9.3% + lambda cyhalothrin 4.6% ZC) in cotton gave significant reduction of per cent damage on squares, bolls and loculi as well as high yield during *Kharif* 2011 and 2013 [6]. The findings are superior in reducing larval populations of bollworms, per cent bollworm damage and recorded higher seed cotton yield than untreated control.

3.4 Effect of different treatments on per cent avoidable losses

The data on avoidable losses was recorded and presented in Table 1. Regarding avoidable losses Treatment T_1, T_2, T_3, T_4 and T_5 proved promising over control which showed 87.43, 85.93, 84.13, 74.73 and 67.03 per cent avoidable losses, respectively. The present findings collaborate with an assessment of losses due to spotted bollworm by comparing seed cotton yield in the protected and unprotected crop of cotton. The mean larval population and infestation on boll and loculi basis was significantly lower in sprayed as against unsprayed condition. The avoidable loss due to bollworms was 7.67 q/ha [7]. Avoidable losses due to the *Pectinophora gossipiella* and noctuids *Earias vittella* and *E. insulana* were assessed on cotton in india in 1983-86. Avoidable losses due to bollworms alone they were 7.42 q/ha. Avoidable losses due to bollworms were 10.5q/ha [8]. A field trial to assess the avoidable losses in yield of seed cotton due to bollworms for 3 years during 1980-1983 at Panjabrao Krishi Vidyapeeth, Akola. The pooled results indicated that losses were caused by bollworms (51.3%) [9]. An experiment to assess avoidable losses due to major pest of cotton by giving eight treatment including untreated control estimated that 21.43% avoidable yield loss due to bollworm complex [10]. The result reported that avoidable yield losses are recorded as 71.74 per cent in Maharastra [11].

3.5 Incremental cost benefit ratio of the different treatments

The ICBR of different treatments are presented in Table 2 and it seems that the treatment T_3 - was most cost effective in the order to merit with highest ICBR (1:3.43) with net monetary return of Rs 46,996/ha followed by T_2 - with ICBR (1:3.25) with net monetary return of Rs 53,501/ha and T_1- with ICBR (1:3.15) and highest net monetary return of Rs 60,481/ha. The next effective treatment was T_4 - with ICBR (1:2.09) and T_5 - with ICBR of (1:1.83) however, among the insecticides treatment T6 - recorded the lowest ICBR (1:0.23) with lowest net monetary return of Rs.1742 and found least cost effective treatment. The data on ICBR was recorded and presented in table 1. In the present investigation, the treatment T_3 - found

most cost effective in the order to merit with highest ICBR (1:3.43) followed by T_2 - with ICBR (1:3.25) and T_1 - with ICBR (1:3.15) where as the highest net monetary return of Rs 60,481/ha obtained from treatment T_1. The findings stated that the damage was more for second and subsequent pickings which considered more with T_2 and T_3 in the present study. Where ICBR is more and also per cent avoidable losses is comparable with T_1 [12]. The study reported that lambda-cyhalothrin @15 g a.i. ha−1 showed a maximum cost-benefit ratio of 1:4.73 [13]. Also the results recorded against bollworms complex supported the present findings [14-18].

Table 1: Effects of different treatments on open boll, loculi damage at harvest, yield and per cent avoidable loss

Treatments		Average boll damage (%)				Average loculi damage (%)				Yield (q/ha)	Avoidable loss%
		RI	RII	RIII	Mean	RI	RII	RIII	Mean		
T1	1st spray at 55 DAE & subsequent spray will be given at 15 days interval up to 145 DAE	9.00 (17.46)**	12.50 (20.70)**	15.50 (23.18)**	12.33 (20.56)**	7.65 (16.06)**	8.53 (16.98)**	12.81 (20.97)**	9.66 (18.00)**	21.09	87.43
T2	1st spray at 70 DAE & subsequent spray will be given at 15 days interval up to 145 DAE	32.33 (34.65)	25.30 (30.20)	20.00 (26.57)	25.88 (30.58)	17.59 (24.80)	13.91 (21.89)	10.91 (19.29)	14.14 (21.99)	18.84	85.93
T3	1st spray at 85 DAE & subsequent spray will be given at 15 days interval up to 145 DAE	32.90 (35.00)	36.71 (37.29)	42.03 (40.41)	37.21 (37.59)	20.68 (27.05)	16.46 (23.94)	16.67 (24.09)	17.94 (25.03)	16.70	84.13
T4	1st spray at 100 DAE & subsequent spray will be given at 15 days interval up to 145 DAE	35.95 (36.84)	45.95 (42.67)	52.30 (46.32)	44.73 (41.98)	19.35 (26.09)	19.60 (26.28)	25.94 (30.62)	21.63 (27.66)	10.49	74.73
T5	1st spray at 115 DAE & subsequent spray will be given at 15 days interval up to 145 DAE	45.55 (42.45)	56.58 (48.78)	66.27 (54.49)	56.13 (48.52)	21.84 (27.86)	28.01 (31.95)	21.65 (27.73)	23.83 (29.18)	8.04	67.03
T6	1st spray at 130 DAE & subsequent spray will be given at 15 days interval up to 145 DAE	68.00 (55.55)	62.96 (52.51)	54.92 (47.82)	61.96 (51.92)	23.71 (29.14)	30.08 (33.26)	24.84 (29.90)	26.21 (30.76)	4.22	37.20
T7	Control	60.77 (51.22)	67.78 (55.41)	75.38 (60.25)	67.98 (55.54)	42.59 40.74	27.37 (31.55)	31.09 33.89)	33.68 (35.39)	2.65	0.00
F test		-	-	-	Sig		-	-	Sig	Sig	
SE(m) ±		-	-	-	2.389		-	-	1.76	0.084	
CD at 5%		-	-	-	7.362		-	-	5.43	0.259	
CV%		-	-	-	10.11		-	-	11.37	7.76	

Fig. In parentheses, ** arc sin transformation, DAE-Day after emergence, C mean-cumulative mean

Table 2: Incremental cost benefit ratio and per cent avoidable loss of the different treatments

Sr. No.	Treatments	Cost of the treatments			Total cost (Rs/ha) (A)	Yield (qtl/ha)	Increased yield over control (qtl/ha)	Increased yield over control (Rs/ha) (B)	Net monetory return (Rs/ha) (B-A)	ICBR
		Cost of insecti-cides (Rs/ha)	Labour charges (Rs/ha)	Equip-ment charges (Rs.)						
1	1st spray at 55 DAE & subsequent spray will be given at 15 days interval up to 145 DAE	15750	3080	350	19180	21.09	18.44	79661	60481	1:3.15
2	1st spray at 70 DAE & subsequent spray will be given at 15 days interval up to 145 DAE	13500	2640	300	16440	18.84	16.19	69941	53501	1:3.25
3	1st spray at 85 DAE & subsequent spray will be given at 15 days interval up to 145 DAE	11250	2200	250	13700	16.70	14.05	60696	46996	1:3.43
4	1st spray at 100 DAE & subsequent spray will be given at 15 days interval up to 145 DAE	9000	1760	200	10960	10.49	7.84	33869	22909	1:2.09
5	1st spray at 115 DAE & subsequent spray will be given at 15 days interval up to 145 DAE	6750	1320	150	8220	8.04	5.39	23285	15065	1:1.83
6	1st spray at 130 DAE & subsequent spray will be given at 15 days interval up to 145 DAE	4500	880	100	5480	4.22	1.57	6782	1302	1:0.23
7	Control	-	-	-	-	2.65	-	-	-	-

Sale price of cotton - @ Rs, 4320/q.
Labour charges for one day/ha - @ Rs, 220/labour
Charges for hiring sprayer- @ Rs, 50/day, Ampligo 150 ZC (combination of chlorantranilipole9.3% + lambdacyhalothrin 4.6% ZC)–Rs. 9000/lit.

4. Conclusions

Spray of Chlorantraniliprole 9.3% + Lamda Cyhalothrin 4.6% ZC @ 0.5 ml/L at 55 days after emergence (DAE) & subsequent spray was given at 15 days interval up to 145 DAE recorded minimum bollworm damaged i.e. 12.33 per cent and maximum seed cotton yield (21.09 q/ha). But the treatment T_3 (5 Sprays of Chlorantraniliprole 9.3% + Lamda Cyhalothrin 4.6% ZC @ 0.5 ml/L starting at 55 DAE with an interval of 15 days) was most cost effective in the order to merit with highest ICBR (1:3.43) with net monetary return of Rs 46,996/ha. The data on per cent avoidable losses revealed that it was highest in treatment T1 (87.43%) followed by T2 (85.93%), T3 (84.13%), T4 (74.73%), T5 (67.03%) and T6 (37.20%).

5. Acknowledgement

Authors are thankful to the Director of Research and Head, Department of Entomology Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola for providing necessary facilities.

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