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Evaluation of newer molecules for the management of pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae) in cotton (*Gossypium* spp.)

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Abstract

A field experiment was conducted at AICRP on cotton, Haradanahalli, Chamarajanagara during *kharif* 2018 to assess the efficacy of different insecticides against pink bollworm. Observation were made on number of pink bollworm larvae/20bolls, locule damage (%), good open bolls per plant, bad open bolls per plant and yield (Kg/ha).Finally the per cent reduction of larvae was calculated. The results of the experiment revealed that, the application of chlorantraniliprole 18.5 SC @ 0.21ml/l was found superior over the other treatments with minimum larval population (6.67 larvae/ 20 bolls), maximum good open bolls (35.55 GOB/plant) and highest yield (2002.96 kg/ha). Higher per cent reduction (71.00 per cent) of larvae was recorded in same treatment followed by emamectin benzoate 5 SG @ 0.31g/l and flubendiamide 39.5 SC @ 0.17 ml/l with 63.78 and 62.30 per cent reduction of larvae, respectively. The next best treatments which proven better were thiodicarb 75 WP @ 1.40 g/l and profenophos 50 EC @ 2ml/ l with per cent reduction of 59.43 and 56.52 larvae, respectively.

Keywords: *Pectinophora gossypiella,* cotton and bio-efficacy of insecticides

Introduction

Cotton (*Gossypium hirsutum* L.) as "King of the Fibre" is one of the most ancient and important cash crop in India and plays a significant role in the Indian national economy. It is being grown in more than seventy countries in the world. It belongs to the genus *Gossypium* of the family Malvaceae. Cotton plays a major role in industrial sector, economy and foreign exchange, hence it is called as 'White gold'. India gains foreign exchange annually to the tune of 12-14 US $ billion from the cotton yarn, thread, fabrics and apparels exports. It provides employment opportunities to millions of people in the country who are involved in its cultivation, trading, processing, manufacturing, fabricating and marketing 13.5 million bales of 170 kg each. The extent of international and domestic trade from India is estimated as (Rs. 15,000 Cr.) 30 US $ billion annually [1]. Among the bollworm complex, pink bollworm *Pectinophora gossypiella* (Sanuders) is a serious and destructive pest of cotton. The infestation of pink bollworm has been noticed both on *Bt* and non Bt cotton causing maximum seed cotton loss in quality and quantity. At present, severe yield loss of cotton is due to development of resistance in pink bollworm, *P. gossypiella* on first and second generation *Bt* cotton hybrids. Within hours after emergence, pink bollworm larvae enter the fruiting bodies and pin holes of entry close down by excreta of larvae. Therefore, it is difficult to exercise any target specific control measure against this pest. The larvae of *P. gossypiella* damages the floral outgrowths *i.e.*, improper flower opening, small round holes are seen on the septa between the locules, stained lint around the feeding area and bad quality seed cotton. It causes 2.80 to 61.90 per cent loss in the seed cotton yield, 2.10 to 47.10 per cent loss in oil content and 10.00 to 55.00 per cent damage to green bolls [2]. It interferes with the growth of cotton plant by incomplete boll opening, reducing the staple size, strength and enhances the contents of trash in the lint [6].

Keeping these view, it is important to compare the efficacy of insecticides against pests for effective pest management and to reduce the indiscriminate use of insecticides. Thus, the present study was conducted to evaluate newer insecticide molecules available in the market for their efficacy against pink bollworm at AICRP on cotton at Haradanahalli, Chamarajanagara.

Materials and Methods

A field study was conducted to evaluate the bio efficacy of selected insecticides against pink bollworm, *P. gossypiella* during *kharif* 2018 under randomized block design (RBD) at AICRP, Haradanahalli, Chamarajnagara with eight treatments including an untreated control and were replicated thrice. A popular cotton hybrid HB2110 BG-II was sown during *kharif* 2018 with a spacing of 90 × 60 cm in the plot size of 4.2 × 4.5 m. Insecticides were sprayed twice during the investigation period.

In each treatment five plants were selected randomly, PBW incidence was recorded on selected plants. The pre-count observation was made one day before spray and the post-treatment observations were recorded on 3, 7 and 14 days after spraying. The observations were recorded on number of PBW larvae/ 20 bolls, locule damage (%), GOB and BOB from each treatment by destructive sampling method. The yield was recorded from each plot and converted to hecter bases. The data from each treatment was subjected for ANOVA (Gomez and Gomez, 1984; Hosmand, 1988) [5, 7] and means were separated by Tukey's HSD (Tukey, 1953) [12].

$$\text{Green boll damage (\%)} = \frac{\text{No.of damaged green bolls}}{\text{Total no.of green bolls}} \times 100$$

$$\text{Open locule damage (\%)} = \frac{\text{Damaged locules}}{\text{Total no.of locules}} \times 100$$

The percentage reduction of damage over control was worked out using modified Abbot's formula as given below. (Fleming and Ratnakaran, 1985) [4]

$$P = \frac{100 \text{ X } 1 - (T_a \text{ X } C_b)}{(T_b \text{ X } C_a)}$$

Where,

P = Percentage population reduction over control

T_a = Population in treatment after spray

C_a = Population in control after spray

T_b = Population in treatment before spray

C_b = Population in control before spray

Results and Discussion

Larval population

Under field condition, seven insecticide molecules were evaluated for their bio-efficacy against pink bollworm, *P. gossypiella*. The results of the present study indicated that, all the treatments proved their superiority over the untreated control (Table 1). The mean data of all observations revealed that (Fig.1), significantly lower number of larval population (6.67 larvae/ 20 bolls) with higher (71.00) per cent reduction in larval population were observed in chlorantraniliprole 18.5 SC followed by emamectin benzoate 5 SG (8.33 larvae/ 20 bolls) and flubendiamide 39.5 SC (8.67 larvae/ 20 bolls) with 63.78 and 62.30 per cent reduction over control, respectively. The next best treatments were thiodicarb 75 WP and profenophos 50 EC which recorded 9.33 and 10.00 larvae/ 20 bolls with 59.43 and 56. 52 per cent reduction in larval population over control, respectively. However, significantly higher larval population (23.00 larvae/ 20 bolls) were recorded in untreated control. The present results are in conformity with Tatagar *et al*. (2009) [11] who advocated that flubendiamide 39.5 SC, emamectin benzoate 5 SG and spinosad 45 SC are effective in the management of American and Spotted bollworms. The opinion of Udikeri *et al*. (2004) [13] were also in close agreement with present findings which indicated that lowest larval population were recorded in emamectin benzoate 5SG followed by spinosad 45 SC. Similarly, the present findings are in confirmed with Manikrao (2017) [8] who reported that minimum open locule damage and green boll damage by larva was recorded in chlorantraniliprole 18.5 SC treated plots followed by emamectin benzoate 5 SG and spinosad 14.5 SC. Next effective insecticides were flubendiamide 39.5 SC and thiodicarb 75 WP against control. Similar results were obtained by Bajya *et al*. (2015) [3] who recorded that Ampligo 150 ZC (combination of chlorantraniliprole 9.3% + lambdacyhalothrin 4.6% ZC) showed least per cent locule and boll damage.

Good and bad opened bolls (GOB/BOBs)

In all the insecticides treated plots significantly highest GOBs/ plant were recorded as compared to control (Table 2). Highest GOBs/ plant were registered in chlorantraniliprole18.5 SC treatment with 35.55 GOBs/ plant which stood on par with emamectin benzoate 5 SG (31.95 GOBs/ plant) followed by flubendiamide 39.5 SC which recorded 26.75 GOBs. Next best treatments were thiodicarb 75 WP and profenophos 50 EC with 24.52 and 21.00 GOBs/ plant, respectively which were on par with spinosad 45 SC (17.50 GOBs/ plant). The lowest GOB (15.30GOBs/ plant) were recorded in phenthoate 50 EC, but significantly higher than the untreated control. Significantly low BOBs/ plant was noticed in chlorantraniliprole 18.5 SC (10.80) which was on par with emamectin benzoate 5 SG (11.40) followed by flubendiamide 39.5 SC (14.20). The highest number of BOBs/ plant was observed in phenthoate 50 EC (22.45). However, untreated control where maximum of 33.10 BOBs/ plant were registered.

The present findings are in conformity with Shivanna *et al*. (2012) [9] who reported that significantly higher GOBs/ plant in spinosad 45 SC followed by thiodicarb 75 WP and emamectin benzoate 5 SG treated plots with significantly less number of BOBs/ plant and the control plots registered less number of GOBs and more number of BOBs/ plant when compared with other treatments.

Yield parameter

The yield obtained in different treatments and per cent yield increase over control was recorded and analysed. The results showed significant difference in the yield over control in different treatments as indicated in Table 2.

Among the new insecticide molecules which were tested, highest seed cotton yield was recorded in chlorantraniliprole 18.5 SC treatment (2002.96 kg/ha) followed emamectin benzoate 5 SG (1823.83 kg/ha). The yield was found on par with flubendiamide 39.5 SC (1765.50 kg/ha). The next highest yield was recorded in thiodicarb 75 WP (1603.94 kg/ha) and profenophos 50 EC (1597.46 kg /ha) followed by spinosad 14.5 SC (1547.55 kg/ha). The lowest yield was recorded in phenthoate 50 EC (1491.23 kg/ha) but significantly higher yield than the untreated control with 1241.69 kg/ha seed cotton yield. However, all the treatments were showed significantly higher yield than the control (1241.69 kg/ha) (Table 2).

The per cent yield increase over control was also maximum in chlorantraniliprole 18.5 SC (61.30%) followed by emamectin benzoate 5 SG (46.88%), flubendiamide 39.5 SC (42.18%) thiodicarb 75 WP (29.17%) and profenophos 50 EC (28.65%), spinosad 14.5 SC (24.63%) and phenthoate 50 EC (20.09%).

The results on the yield in different plots of insecticidal treatments are in accordance with Manikrao (2017) [8] who recorded highest seed cotton yield in chlorantraniliprole 18.5 SC followed by emamectin benzoate 5 SG, spinosad 14.5 SC, flubendiamide 39.5 SC and thidiocarb 75 WP. The present findings were also supported by Sreekanth *et al*. (2015) [10] who reported maximum yield in chlorantraniliprole 18.5 SC treated plots followed by fubendiamide 39.5 SC in pigeon pea. Bajya *et al*. (2015) [3] also recorded highest yield in Ampligo 150 ZC (combination of chlorantraniliprole 9.3% + lambdacyhalothrin 4.6% ZC).

Conclusion

To control the pink bollworm damage on cotton, among the seven insecticide molecules tested foliar application of chlorantraniliprole 18.5 SC @ 0.21ml/l and emamectin benzoate SG @ 0.3g/l were found most effective in controlling the larval population and green boll damage of pink bollworm.

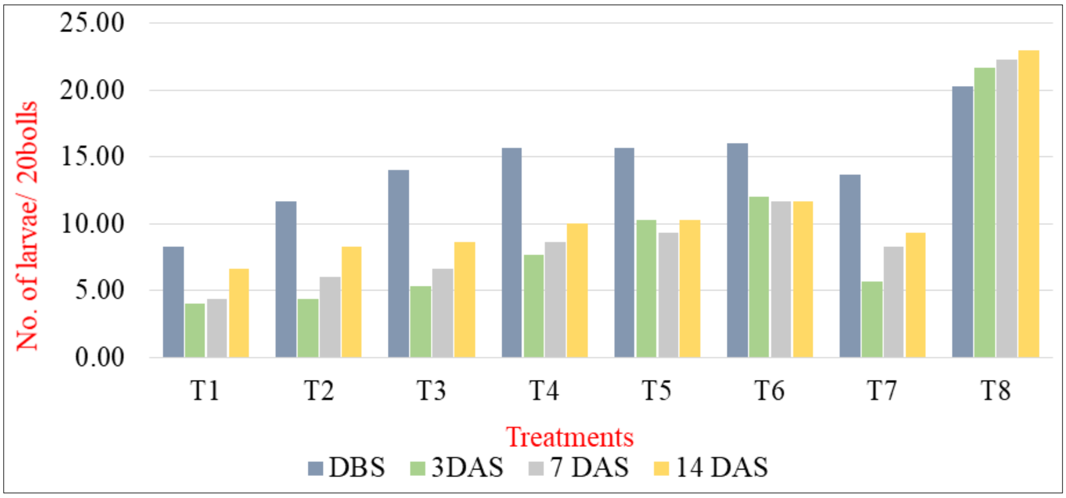
Table 1: Bio-efficacy of insecticides against pink bollworm larvae, *P. gossypiella*

Sl. No.	Treatments	Dose/ha		No. of larvae/ 20 bolls								ROC (%)
		a. i (g/ml)	Formulation (g/ml)	I Spray DBS	I Spray 3 DAS	I Spray 7 DAS	I Spray 14 DAS	II Spray DBS	II Spray 3 DAS	II Spray 7 DAS	II Spray 14 DAS	
1	Chlorantraniliprole 18.5 SC	30	150	16.00 (4.04)	10.67 (3.34)^{a}	7.33 (2.79)^{a}	8.33 (2.97)^{a}	8.33 (2.97)^{a}	4.00 (2.12)^{a}	4.33 (2.19)^{a}	6.67 (2.67)^{a}	71.00
2	Emamectin benzoate 5 SG	11	220	14.33 (3.83)	12.33 (3.58)^{b}	8.67 (3.02)^{b}	11.67 (3.48)^{b}	11.67 (3.48)^{b}	4.33 (2.19)^{ab}	6.00 (2.54)^{b}	8.33 (2.97)^{b}	63.78
3	Flubendiamide 39.5 SC	48	120	15.00 (3.93)	12.67 (3.62)^{bc}	9.00 (3.08)^{bc}	14.00 (3.80)^{c}	14.00 (3.80)^{c}	5.33 (2.41)^{c}	6.67 (2.67)^{bc}	8.67 (3.02)^{bc}	62.30
4	Profenophos 50 EC	750	1500	17.33 (4.22)	14.67 (3.89)^{bcde}	10.33 (3.29)^{bcde}	15.67 (4.02)^{e}	15.67 (4.02)^{e}	7.67 (2.85)^{e}	8.67 (3.02)^{de}	10.00 (3.24)^{bcde}	56.52
5	Spinosad 45 SC	100	220	16.67 (4.14)	15.00 (3.93)^{bcdef}	10.67 (3.34)^{f}	15.67 (4.02)^{ef}	15.67 (4.02)^{ef}	10.33 (3.29)^{f}	9.33 (3.13)^{def}	10.33 (3.29)^{abcdef}	55.08
6	Penthoate 50 EC	1000	2000	16.00 (4.05)	15.67 (4.01)^{bcdefg}	12.00 (3.53)^{g}	16.00 (4.06)^{efg}	16.00 (4.06)^{efg}	12.00 (3.53)^{g}	11.67 (3.48)^{g}	11.67 (3.48)^{g}	49.26
7	Thiodicarb 75 WP	750	1000	14.00 (3.80)	13.33 (3.71)^{bcd}	9.67 (3.18)^{bcd}	13.67 (3.76)^{cd}	13.67 (3.76)^{cd}	5.67 (2.48)^{cd}	8.33 (2.96)^{d}	9.33 (3.13)^{bcd}	59.43
8	Untreated control	-	-	17.33 (4.21)	18.00 (4.37)^{h}	18.00 (4.30)^{h}	20.33 (4.56)^{h}	20.33 (4.56)^{h}	21.67 (4.70)^{h}	22.33 (4.77)^{h}	23.00 (4.84)^{h}	
	SE m ±			NS	0.06	0.04	0.06	0.06	0.05	0.07	0.04	
	CD @ 5%				0.20	0.14	0.19	0.19	0.18	0.23	0.13	

* DBS: Day before spraying; DAS: Days after spraying; NS: Non significant; Figures in the parentheses indicate $\sqrt{X + 0.5}$ transformed values; the values followed by same alphabets did not differ significantly as per DMRT; ROC: Reduction over control

Table 2: Locule damage (%), number of GOB and BOB/ plant and yield (kg/ha) in different treatments

Sl. No.	Treatments	Dose/ha		Locule damage (%)	GOB/ plant	BOB/ plant	Yield (kg/ha)	% Yield Increase over control
		a.i (g/ml)	Formulation (g/ml)					
1	Chlorantraniliprole 18.5 SC	30	150	18.89 (25.85)^{a}	35.55^{a}	10.80^{a}	2002.96^{a}	61.30
2	Emamectin benzoate 5 SG	11	220	19.26 (26.00)^{ab}	31.95^{ab}	11.40^{ab}	1823.83^{b}	46.88
3	Flubendiamide 39.5 SC	48	120	21.97 (27.96)^{c}	26.75^{c}	14.20^{c}	1765.50^{bc}	42.18
4	Profenophos 50 EC	750	1500	24.22 (29.49)^{cde}	21.00^{cde}	15.50^{cde}	1597.46^{dc}	28.65
5	Spinosad 45 SC	100	220	27.03 (31.34)^{f}	17.50^{cdef}	19.30^{f}	1547.55^{dce}	24.63
6	Phenthoate 50 EC	1000	2000	28.13 (32.04)^{fg}	15.30^{cdefg}	22.45^{fg}	1491.23^{dcef}	20.09
7	Thiodicarb 75 WP	750	1000	23.03 (28.68)^{cd}	24.52^{cd}	16.05^{cd}	1603.94^{d}	29.17
8	Untreated control	-		33.55 (35.41)^{h}	9.60^{h}	33.10	1241.69^{h}	-
	SE m±	-		0.58	1.21	0.88	30.47	
	CD @ 5%	-		1.76	4.06	2.95	101.90	



T1 - Chlorantraniliprole 18.5 SC
T2 - Emamectin benzoate 5 SG
T3 - Flubendiamide 39.5 SC
T4 - Profenophos 50 EC
T5 - Spinosad 45 SC
T6 - Phenthoate 50 EC
T7 - Thiodicarb 75 WP
T8 - Untreated control

Fig 1: Bio - efficacy of insecticides against pink bollworm, *P. gossypiella* after second spray

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