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Evaluation of management practices against bollworms in cotton

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ABSTRACT

A field experiment was conducted at Entomology Research Area, CCS Haryana Agricultural University, Hisar to evaluate the management practices, viz. use of botanical pesticides, *Trichogramma chilonis* (Hymenoptera: *Trichogrammatida*e) release and intercropping with sesame were evaluated alone and in different combination against spotted bollworm, *Earias* spp. (Lepidoptera: Noctuidae) and pink bollworm, *Pectinophora gossypiella* Saunders (Lepidoptera: Gelechiidae) in cotton during 2016–17. From investigation, it was concluded that all practices, either alone or in combinations, provided significantly better control of spotted bollworm and pink bollworm than the control. The results revealed that lowest incidence of spotted bollworm (10.09 and 8.10%) recorded in treatment T_2 (Spinosad 45 SC @ 75 ml/acre) which was found at par with the treatment T_3 (Spinosad 45 SC @ 75 ml/ acre alternated with nimbecidine) i.e. 10.13 and 9.14%, and T_6 (Intercropping cotton with sesame + Release of *T. chilonis* adults alternated with nimbecidine) i.e. 10.14 and 8.41% during 2016–17, respectively. The Results on boll and locule basis, the significant lowest incidence of pink bollworm was recorded under treatment T_2 (2.67 and 2.00%, 20.00 and 13.00%) and it was at par with T_6 (2.89 and 2.53%; 21.33 and 14.36%) during 2016 and 2017, respectively.

Key words: Cotton, Incidence, Management practices, Pink bollworm, Spotted bollworm

Cotton, *Gossypium* spp. also known as queen of fibers is the most important commercial crop of our country contributing up to 75% of total raw material needs of textile industry. Area wise, India ranks first in world (11.55 million ha), whereas, it ranks second in production (37.10 million bales) next to China (Anonymous, 2017a). In Haryana, cultivation of cotton is on 6.39 lakh hectares with production of 22.00 lakh bales and average yield of 665 kg/ha. But, it is attacked by several insect pests causing drastic reductions in yield. Among, the various insect pests, spotted bollworm (*Earias vittella* Fabricius), (*Earias insulana* Boisdual), American bollworm (*Helicoverpa armigera* Hubner) and pink bollworm (*Pectinophora gossypiella* Saunders), cause significant damage to the crop and significant reduction in yield (Bennett *et al.* 2004). To mitigate the losses caused by bollworms, farmers still rely on chemical pesticides as they drastically control the pests but injudicious use of pesticides has resulted in residues in the food chain, pesticide resistance, and pest resurgence, in addition to causing harm to non-targeted beneficial organisms and the environment (Patil *et al.* 2017). So the use of insecticides for the control of these pests has been highly criticized and therefore switching from insecticides to ecofriendly approaches either alone or in combinations. However, efforts have been made by different workers to evaluate various environment friendly practices such as use of bio-control agents (Brar *et al.* 2002), botanicals (Asif *et al.* 2018) intercropping of cotton with different crops (Ram *et al.* 2002) and other practices to suppress their populations below damaging levels. The practices such as release of bio-control agents, botanicals sprays, and intercropping etc. were used alone and have been reported to offer varying level of check against pests. However, studies involving combined application of various practices against these pests are few. Therefore, it was considered worthwhile to evaluate different safer bollworm management practices alone and in combination to explore the possibility of providing comparable pest management.

MATERIALS AND METHODS

The study was carried out in the experimental area of CCS Haryana Agricultural University, Hisar, India during 2016–17. Cotton variety, HD-432 was sown on 14th May and 11th May during 2016–17, respectively. The plot size was of 16.17 m^2 with five rows of cotton of 4.8 m length, with a spacing of 67.5 cm between the rows and 30 cm between the plants. There were seven treatments (listed below) and three replications in each treatment and the experiment was laid out in a randomized block design (Fig 1).

T_1	Nimbecidine (0.03 % azadirachtin) @ 1 liter/acre in 200 liters of water
T_2	Spinosad 45 SC @ 75 ml/acre in 200 liters of water

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T_3	Spinosad 45 SC @ 75 ml/ acre in 200 liters of water alternated with nimbecidine (0.03 % azadirachtin) @ 1 liter/acre in 200 liters of water
T_4	Release of *Trichogramma chilonis* Ishii adults @ 60000 parasitoids/acre at 7 days' intervals
T_5	Sesame sown as intercrop in cotton in the ratio of 1:1
T_6	Intercropping (cotton + sesame) in 1:1 ratio + Release of *T. chilonis* adults @ 60000 parasitoids/acre alternated with nimbecidine (0.03 % azadirachtin) @ 1 liter/acre in 200 liters of water weekly.
T_7	Control (no spray)

Spraying of nimbecidine and spinosad were initiated as soon as the bollworms incidence reached economic threshold (i.e. at 5% incidence in fruiting bodies). *Trichogramma chilonis* adults were released initially as eggs of spotted bollworm appeared on cotton plants and after that released weekly. Observations on spotted bollworm incidence were recorded at 15 days intervals starting from 15th July. Fifty green fruiting bodies (intact as well as damaged or dropped) from each plot in each treatment were examined randomly for spotted bollworm damage. Observations on the incidence of pink bollworm in green bolls were recorded at 90, 110 and 140 days after sowing. For this purpose, 50 green bolls were collected and brought to laboratory for further examination. In laboratory, each green boll was cut opened along with the ridges of the locules with the help of a sharp cutter carefully and the presence of larvae inside the green bolls was recorded.In order to record the incidence of pink bollworm at harvesting stage, 50 opened bolls per plot were plucked randomly and were collected in polythene bags and brought to laboratory for further examination. In laboratory, lint was removed and each locule of the boll was examined carefully for pink bollworm damage. The presence of pink bollworm larvae was also recorded in the double seeds by carefully examines the lint. The incidence of spotted bollworm and pink bollworm was analyzed with analysis of variance using Randomized Block Design (RBD) wherever applicable. The differences were compared at 5% level of significance by using DMRT test (Duncan's multiple range test) with SPSS 19 software.

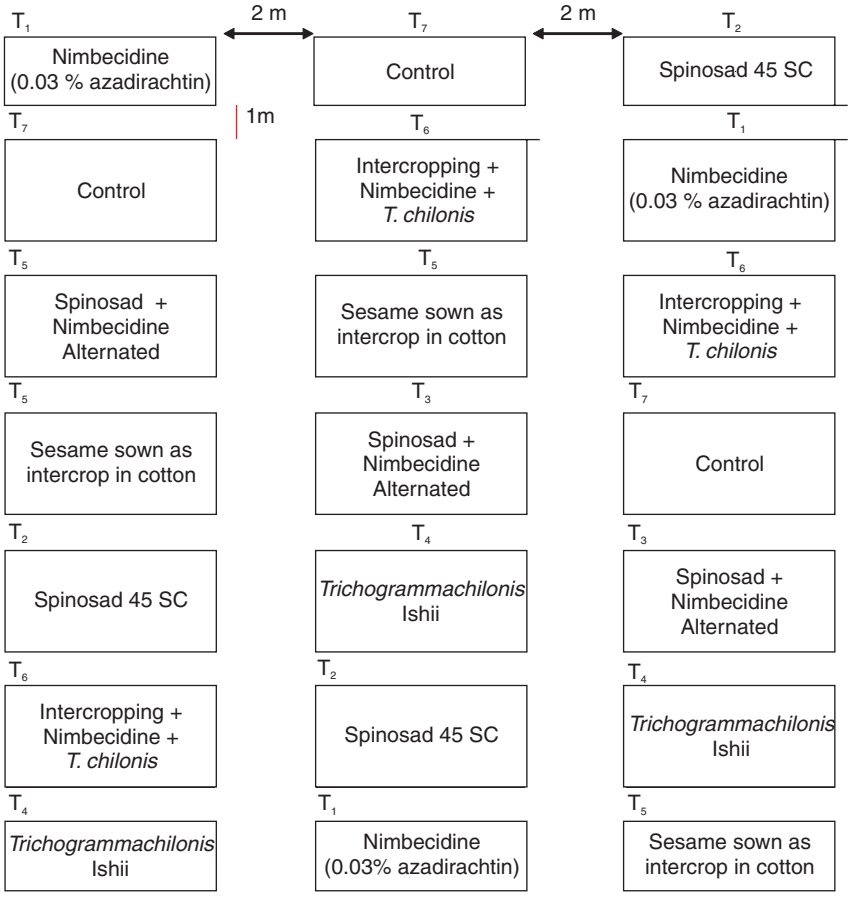

Fig 1 Layout plan of experiment.

RESULTS AND DISCUSSION

Spotted bollworm, Earias *spp.*: The results revealed that all the treatments included either alone or combined practices, were significant superior over the control (Table 1). While comparing the treatments, lowest incidence of spotted bollworm (10.09 and 8.10%) to be recorded in treatment T_2 (Spinosad 45 SC @ 75 ml/acre) which was found at par with the treatment T_3 (Spinosad 45 SC @ 75 ml/acre alternated with nimbecidine) i.e. 10.13 and 9.14%, and T_6 (Intercropping cotton with sesame + Release of *T. chilonis* adults alternated with nimbecidine) i.e.10.14 and 8.41% during 2016–17, respectively. It was followed by treatment T_1 (Nimbecidine-0.03% azadirachtin) i.e. 13.24 and 10.89%, and it was found at par with T_4 (Release of *Trichogramma chilonis* Ishii) i.e. 13.33 and 11.23% and T_5 (sesame sown as intercrop) i.e. 14.81% and 11.90%, during 2016–17, respectively. In the present study it was recorded that spinosad treated plot (T_2) the incidence was low and it was found at par with combined practices (T_6) i.e. intercropping +Release of *T. chilonis* adults alternated with nimbecidine. Similar results recorded by Singh (2005) and Godhani *et al.* (2009) who reported minimum incidence of bollworms in cotton intercropping system alternated with *T. chilonis* release and use of neem formulation. In the present study, all alone practices, viz. neem formulation (T_1), *Trichogramma* release (T_4) and cotton intercropped with sesame (T_5) also dominated or effective over control (T_7). Similarly, the suppression of spotted bollworm incidence by using *Trichogramma* recorded (Ram *et al.* 2002, Ahmad *et al.* 2011) and neem products (Dawkar *et al.* 2019). Furthermore results of combined practices (T_6) were superior/ highly significant over sole practices/

Table 1 Effect of different management practices on incidence of spotted bollworm and pink bollworm in cotton

Treatment	Spotted bollworm incidence		Pink bollworm incidence			
	Green fruiting bodies damaged by spotted bollworm (%)		Incidence (%) on green boll basis	Incidence (%) on locule basis	Incidence (%) on green boll basis	Incidence (%) on locule basis
	2016	2017	2016	2016	2017	2017
T_1	13.24[b] (17.80)**	10.89[b] (16.09)*	3.56[b] (8.41)	29.33[b] (32.35)	2.66 [b] (6.98)	14.50[b] (22.00)
T_2	10.09[a] (15.36)	8.10[a] (14.19)	2.67[a] (5.47)	20.00[a] (25.91)	2.00[a] (5.68)	13.00[a] (20.73)
T_3	10.13[a] (15.82)	9.14[a] (15.28)	3.11[a] (7.07)	22.67[b] (27.84)	2.55[a] (6.42)	14.33[b] (21.82)
T_4	13.33[b] (17.99)	11.23[b] (16.40)	3.33[b] (7.90)	31.67[b] (33.90)	2.89[b] (7.27)	13.83[b] (21.67)
T_5	14.81[b] (19.13)	11.90[b] (17.50)	4.00[b] (9.91)	29.67[c] (32.54)	3.22[b] (7.49)	17.00[c] (23.92)
T_6	10.14[a] (16.18)	8.81[a] (14.91)	2.89[a] (5.70)	21.33[a] (26.54)	2.53 [a] (6.36)	14.36[a] (21.89)
T_7	16.85[c] (21.32)	14.38[c] (19.60)	5.33[c] (10.26)	36.50[d] (36.89)	3.66 [c] (8.96)	18.67[d] (25.26)
SE± (m)	(0.75)	(0.64)	(1.26)	(0.21)	(0.45)	(0.26)
CD at 5%	(2.18)	(1.86)	(2.14)	(0.74)	(1.40)	(0.92)

*Means in column with the same letter are not significantly different at 0.05 levels (DMRT test)

**Figures in parentheses are angular transformed values.

treatments i.e. T_1, T_4 and T_5 and it might be due to additive effect of the practices.

Pink bollworm, Pectinophora gossypiella: The results of different practices on incidence of pink bollworm revealed that all practices, either alone or in combinations, provided significantly better control of pink bollworm than the control on both boll basis and locule basis (Table 1). The Results on boll and locule basis, the significant lowest incidence of pink bollworm was recorded under treatment T_2 (2.67 and 2.00%; 20.00 and 13.00%) and it was at par with T_6 (2.89 and 2.53%; 21.33 and 14.36%) during 2016 and 2017, respectively. The results on boll basis, treatmentT_1 (3.56 and 2.66%), T_4 (3.33 and 2.89%), and T_5 (4.00 and 3.22%) were found at par with each other and significant lower incidence of pink bollworm over control (T_7) i.e. 5.33 and 3.66%, during 2016 and 2017, respectively. And on locule basis, treatment T_3 (22.67 and 14.33%), T_1 (29.33 and 14.50%) and T_4 (31.67 and 13.83%) were found at par with each other. The results of present findings were in conformity with Yadav *et al.* (2008), Yogesh (2013) who recorded that spinosad reduced the pink bollworm incidence in green bolls in cotton crop. In the present study it was noted that *Trichogramma* reduced the incidence of bollworms in cotton. Similarly, it was reported that bollworms incidence reduced by releasing *Trichogramma* in the field (Chinna *et al.* 2019). Present study also showed that pink bollworm incidence reduced in Nimbecidine sprayed plot and similar results noted by Gavi *et al*. (2017), Nboyine *et al.* (2013) and Asif *et al.* (2018).

Economics: The results of yield revealed that maximum yield of seed cotton was recorded in T_2 (spinosad 45 SC) (2491 and 2547 kg/ha) which was at par with T_6 (intercropping+release of *T. chilonis* adults alternated with nimbecidine 0.03% azadirachtin) (2168 and 2260 kg/ha) and minimum yield was recorded in T_7 (control) (1462 and 1577 kg/ha) during 206 and 2017, respectively (Table 2). Furthermore, maximum net returns were recorded in T_2 (₹108988 and 125635/ha) which was followed by T_6 (₹ 99850 and 112750/ha), T_5 (cotton intercropped with sesame) (₹95747 and 103592/ha), T_1 (nimbecidine 0.03% azadirachtin) (₹85000 and 100735/ha), T_3 (spinosad 45 SC alternated with nimbecidine 0.03% azadirachtin) (₹88463 and 94258/ha), T_4 (release of *T. chilonis* adults) (₹ 78800 and 92345/ha) and minimum returns were recorded in T_7 (control) (₹73100 and 86735/ha). These results are in close agreement with Singh (2005) who recorded that yield and net returns were highest in cotton intercropping system alternated with *T. chilonis* release and use of neem spray. The highest yield might be due to the effective control of sucking pests and bollworms and more number of good opened bolls and less number of bad opened bolls and subsequently leading to higher seed cotton yield. Similarly, Karabhantanal *et al.* (2007) reported that yield was maximum in IPM module (612.97 kg/ha) and lowest in control treatment (242.99 kg/ha).

It is concluded from the investigation that all eco-friendly practices are either alone or in combinations, provided significantly better control of bollworms than the

Table 2 Effect of different management practices on economics of cotton

Treatment	2016				2017			
	Yield of seed cotton (kg/ha)	Treatments cost (₹/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	Yield of seed cotton (kg/ha)	Treatments cost (₹/ha)	Gross returns (₹/ha)	Net returns (₹/ha)
T_1^a	1826 (42.71)*	6300	91300	85000	1927 (43.90)	5250	105985	100735
T_2^b	2491 (49.91)	15562	124550	108988	2547 (50.47)	14450	140085	125635
T_3^c	2019 (44.72)	12487	100950	88463	1949 (44.16)	12937	107195	94258
T_4^d	1807 (42.48)	11550	90350	78800	1889 (43.46)	11550	103895	92345
T_5	1921 (43.83)	303	96050	95747	1805 (42.43)	303	103895	103592
T_6^e	2168 (46.49)	11550	108400	96850	2260 (47.52)	11550	124300	112750
T_7	1462 (38.21)	-	73100	73100	1577 (39.66)	-	86735	86735
SE± (m)	(1.65)	-	-	-	(1.00)	-	-	-
CD at 5%	(5.16)	-	-	-	(3.13)	-	-	-

*Figures in parentheses are angular transformed values. During 2016- T_1^a, Six spays of nimbecidine 0.03% azadirachtin; T_2^b, Five sprays of spinosad 45 SC; T_3^c, Three sprays of spinosad 45; SC + Three sprays of nimbecidine 0.03% azadirachtin; T_4^d, Eleven releases of *T. chilonis;* T_6^e, Five releases of *T. chilonis* and five sprays of nimbecidine 0.03% azadirachtin. During 2017- T_1^a, Five spays of nimbecidine 0.03% azadirachtin; T_2^b, Four sprays of spinosad 45 SC; T_3^c, Three sprays of spinosad 45 SC + Two sprays of nimbecidine 0.03% azadirachtin; T_4^d, Eleven releases of *T. chilonis;* T_6^e, Five releases of *T. chiloni;s* and four sprays of nimbecidine 0.03% azadirachtin. The rate of treatments Nimbecidine, ₹300/ acre; Spinosad= ₹1125/ acre in 2016 and ₹1325 in 2017; Tricho card, ₹300/ acre; Sesame seed, ₹140/Kg; Labour charge, ₹300 per spray/day Market rate of cotton, ₹5000/q in 2016 and ₹5500/q in 2017

control. Therefore, in spite of moving towards chemicals should go for eco-friendly combined practices. These eco-friendly practices are safe to environment, low cost, no resurgence problem and no residue in food. Thus, the adoption of these practices will be beneficial for the upliftment of farmers, their socio-economic conditions and consequently the government exchequer.

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