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Integrated control of bollworm H*elicoverpa armigera* (hub.) (Lep. Noctuidae) in cotton fields of Golestan province, northern Iran

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ABSTRACT

Objective: Helicoverpa armigera (Hub.) is the major pest of cotton in Golestan province, Iran. The present study was carried out during 2002-2003 in Fazel-Abad region of Iran to compare the efficacy of different control measures for managing this pest.

Methodology and results: The treatments were: 1) releasing of *Trichogramma brassicae* (Bez.) twice (2gr/ha/release); 2) combined release of *T. brassicae* (as above) + *Habrobracon hebetor* (Say.) (1000 adults/ha); 3) integration of *T. brassicae* + B.T.H (2 kg/ha); 4) integration of *T. brassicae* + *H. hebetor* + B.t.H (2 kg/ha); 5) application of Endosulfan 35% (3 lit/ha); and 6) untreated check. Sampling was done one day before and 3, 5, 7, 10 and 15 days after treatment. Ten plants were chosen randomly in each plot. Life stages of *H. armigera*, parasitoid eggs and larvae as well as the percentage of infested fruiting part of cotton were counted. The mortality was calculated using Abbott formula. The results indicated that there were significant differences among treatments at ($p<0.05$). The integration of *T. brassicae* + *H. hebetor* + B.t.H with 97.57% *H. armigera* mortality and 0.95% infested fruiting part; and treatment with *T. brassicae* + B.t.H with 92.98% *H. armigera* mortality and 0.98% infested fruiting part had the best performance was the least effective. .

Conclusion and application of results: It is concluded that integration of biological control + bio-pesticide (B.t.H) could be a suitable method for integrated control of *Helicoverpa armigera* (Hub.).

Key words: Integrated control, *Helicoverpa armigera* (Hub.), Cotton, Iran, B.t.H., Endosulfan

INTRODUCTION

American bollworm, *Helicoverpa armigera* (Hub.), is one of the important insect pests in the cotton fields of Golestan province in the north of Iran. This pest can do very serious damage to many weeds and crops, by feeding mainly on the flower buds, flowers and bolls. *Helicoverpa* caterpillar attack is most frequent on certain crops, such as cotton, grain sorghum, maize and sweet corn, garbanzo bean, tobacco, tomato and velvetleaf weed (Salavatian, 1960, 1991; Bayat-Assadi and Abaei, 1983). The annual damage of this pest on cotton has been estimated at 10-25% in ordinary years and 50-70% in out breaks years. The activity of *H. armigera* in Golestan province starts in early spring in crops such as chick pea and early planted tomato and rarely on cotton.

Damage of *H. armigera* on cotton occurs between July to September. This pest has 5 generations in Golestan province. The 3rd generation of this pest is more destructive. Nikzad (1964) cited *Habrobracon simono* as a parasitoid of *H. armigera.* Davachi *et al*. (1968) identified

Habrobracon sp. on larvae of *Heliothis dipsacea* in Karaj region while Noori (1993) studied the trend of parasitism of *H. viriplaca* on pea fields of Kermanshah province.

A number of alternative *H. armigera* control options were evaluated in sweet corn and compared with deltamethrin. The alternative tactics evaluated were: Heliothis nuclear polyhedrosis virus plus *Trichogramma* nr *brassicae* releases; *Bacillus thuringiensis*; and *Trichogramma* sp. alone. The *H. zea* nuclear polyhedrosis virus + *Trichogramma* plots had the lowest cob damage (6%), followed by the *B. thuringiensis* plot (12%), *Trichogramma* alone (20.2%) untreated control plots (23.2%) while deltamethrin treatment attained (53.5%). The findings indicate that the Heliothis nuclear polyhedrosis virus and *B. thuringiensis* can effectively control *H. armigera* when their action complements high natural levels of egg parasitism..

A small black wasp, *Microplitis demolitor*, commonly parasitizes second and third stage heliothis caterpillars. Older heliothis caterpillars are attacked by various other parasitic wasps and flies. The parasitized larvae feed in or on the caterpillars and pupate in cocoons in or near the dead caterpillars, or in the soil. Late stage parasitized caterpillars may pupate in the soil before the parasite larvae inside them finish feeding. Then the parasites pupate inside the dead heliothis pupae. Two slim, brightly coloured wasps, *Netelia producta* and *Heteropelma scaposum*, are common parasites of heliothis and other caterpillars (Goodyer, 1987).

A study was carried out to compare the mortality of *Helicoverpa zea* eggs and larvae of different ages on cotton treated with *Bacillus thuringiensis* subsp. Kurstaki. Mortality of *H. zea* neonates hatching from eggs collected from *B. thuringiensis* treated cotton plots was significantly (P<0.01) higher for egg than 2 days old at the highest (1.12 kg/ha) rate, but did not differ at the lowest rates. Mortality of 1 day old larvae placed on *B. thuringiensis* treated cotton terminals was significantly higher than for 3 and 5 days old exposed to 4.48 and 8.96 kg/ha rates of *B. thuringiensis*, respectively. These data indicate that in cotton pest management systems, *B. thuringiensis* applications need to be directed at maximum oviposition and selection of *H. zea* neonates because control is very low against larger larvae (Ali and Young, 1996). An adaptable IPM package developed for cotton at the Regional Research Station Raichur was demonstrated on over 100 ha in farmer's fields. It involves integration of seed treatment for early sucking pests and soil borne diseases, raising a trap crop, releases of *Trichogramma* egg parasitoids, application of *Helicoverpa* NPV and botanicals (neem) and selective use of pesticides.

Assessment of sucking pest and bollworm populations and the natural enemy complex were made both in IPM and non-IPM farmer fields. Analysis of the cost effectiveness of the IPM strategy indicated a reduction of 40 percent in pesticide applications with a 50 percent reduction in the cost of plant protection, resulting in higher net profit and natural enemy population in IPM fields (Patil and Bheemanna, 1998). Research on the effect of *B. thuringiensis* subsp. Kenyae emulsion in the control of bollworms in laboratory and field were conducted in China. Results of laboratory tests showed that exposure to a solution diluted 100 and 200 times for 96 h resulted in 100% mortality of 1^{st} to 3^{rd} instar larvae, while that of 5^{th} instar larvae was 86.6 and 73.3%. In fields severely infested by third generation bollworms and sprayed with a solution diluted 100 times, the insect population decreased by 81-92.3%. The bollworms were effectively controlled. Here the population density of natural enemies was 3.5 - 6 times higher than that in fields chemically treated (Zhao *et al*., 1995).

MATERIALS AND METHODS

To compare the efficacy of different control measure for cotton bollworm *H. armigera* 4 sites were chosen in 2002- 2003. These were carried out with 6 treatments and 4 replications with each site considered as a replication. The sites were located in Agricultural Research Station of Golestan province, a cotton field in Fazel-Abad region of Iran. Each treatment considered 2500 m^2 of cotton field with apportion buffer between

area them. All agronomic practices were done as traditionally and imidaclopride was used for seed treatment and Trephlan (2.5 lit/ha) for weed control (pre-emergence herbicide).
The treatments were as follows: 1) release of *Trichogramma brassicae twice*; 2) Two times release of *T. brassicae* + one time release *Habrobracon hebetor*; 3) Two times release of *T. brassicae* + one time spring *Bacillus thuringensis* var. Kurstaki serotype H-3a3b(Bt) (2 kg/ha) and Biolop (2 lit/ha, manufactured in Spain); 4) Two times release *T. brassicae* + one time release of *H. hebetor* + one time spraying with Bt.; 5) Application chemical insecticide Endosulfan (3 lit/ha); 6) Check with no chemical and biological control measure for bollworm. *T. brassicae* and *H. hebetor* were produced in insectariums of Gorgan Plant Protection Office and their rates were 100,000 and 1000 adults per hectare, respectively. Bt and Endosulfan were manufactured by Golsam in Golestan province and their rates were 2 kg/ha and 3 lit/ha, respectively. *T. brassicae* release started with egg laying by *H. armigera* in cotton and repeated after 7 days. BT and *H. hebetor* were used one and two weeks after the last release of *T. brassicae*, respectively, while Endosulfan application was based on the emergence of the first instars of bollworm larvae. Samplings were done 1 day before and 3, 5, 7, 10 and 15 days after chemical treatment. At each sampling 10 cotton plants were selected randomly in each treatment and the number of healthy and parasitized eggs and larvae were counted as well as the percentage of infested reproductive organs. The mortality was calculated using Abbott formula. The data were ed analyzed as RCBD and the means compared by the Duncan multiple range tests at 5% probability.

RESULTS

According to the two year experiments, the B.t.H was effective on bollworm larvae and caused 43.5-85 percent mortality of pests (tables 1, 2). The results indicated significant differences among treatments at ($p<0.05$). I Treatments integration of *T. brassicae* + *H. hebetor* + B.t.H attained 97.57% *H. armigera* mortality and 0.95% infested fruiting part while treatment with *T. brassicae* + B.t.H attained 92.98% *H. armigera* mortality and 0.98% infested fruiting part. Treatment with Endosulfan caused 75.93% *H. armigera* mortality and 1.18% infested fruiting part infestation. Treatment with *T. brassicae* + *H. hebetor* resulted in 55.03% *H. armigera* mortality and 5.31% infested fruiting part. Treatment with *T. brassicae* alone attained only 15.81% *H. armigera* mortality and 12.52% infested fruiting part(tables 2-5).

Table 1: Analysis of variance of effectiveness of bollworm control measures 10 days after spraying cotton in Golestan province, Iran (2002-2003).. Treatments were B.t.H, Biolop and Endosulfan.

Source of variance	Degree of freedom	Sum of squares	Mean of squares	F. value
Treatment	3	914.410	30.403	3.378 **
Replication	3	158.330	52.778	0.738
Error	9	251.574	27.952	
Total	15	1324.314		

C.V.: 10.68%

Table 2. Comparison of effectiveness of bollworm control methods on cotton in Iran. Data show mean effectiveness (%) of treatments 10 days after spraying.

Treatment	Effect. Mean (1%)	
B.t.H	85	A
Endosulfan	75.93	AB
Biolop	57.98	B

DISCUSSION

Research effect of B.t.H in the control of bollworm larvae is consistent with that reported by Zhao *et al*. (1995) and Ali and Young (1996). The investigation showed that the important natural enemies are parasitoid wasp that attack eggs and larvae. These include *Trichogramma brassicae* and *Habrobracon* *hebetor* (Nikzad, 1964; Davachi *et al*., 1968; Noori, 1993; Goodyer, 1987; Scholz *et al*., 1998), and as confirmed in this study.

The results indicated significant difference among treatments at ($p<0.05$). Integration of *T.brassicae* + *H. hebetor* + B.t.H had the highest effect with over 97.57% *H. armigera* mortality and 0.95% infested reproductive part. of cotton. This is the first study that has investigated integrated control of bollworm *Helicoverpa armigera* (Hub.) (Lep. Noctuidae) in cotton fields of Golestan province**,** Northern Iran. This finding is consistent with that reported by Zhao *et al*., 1995; Patil and Bheemanna, 1998; Scholz *et al*., 1998 on the same insect in India , Austeralia.and China.….

Thus, it is concluded integration of biological control + bio-pesticide (B.t.H) could be a suitable method for integrated control of Bollworm, *Helicoverpa armigera* (Hub.).

Therefore, an integrated pest management program can be recommended in the region as following: soil ploughing in the fall and winter, ploughing and disking in spring, seed treatment with Gaucho (confidor), using herbicides such as Treflan and Sonalan, biological control through releasing *Trichogramma* and *Habrabracon* and B.t.H spraying in the cotton fields and using safe-insecticide such as organophosphate and carbamate groups with appropriate timing.

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