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Effects of IPM Package against Brinjal Shoot and Fruit Borer (*Leucinodes orbonalis* Guenee) on Brinjal

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A b s t r a c t

A field experiment was conducted at the farmer's field at Sreepur, Gazipur during the cropping season of 2019-2020 to evaluate the effects of IPM package against brinjal shoot and fruit borer on brinjal. Crop under IPM plots (Sex pheromone + Sanitation + Beneficial insects) resulted comparative lower fruit damage and produced higher yield than the non IPM plots. The lowest shoot and fruit infestation was obtained from the IPM plots (6.85% and 5.78%, respectively) whereas highest was in the non IPM plots (17.23% and 15.28%, respectively). Reduction of fruit infestation was 62.17% over non IPM plots. The infestation status of IPM and non IPM plots reflects in the yield. Higher yield was obtained from IPM plots (55.70 t/ha) than the non IPM plots (40.23 t/ha) which was 38.45% higher than the non IPM plots. Higher gross return (Tk. 557000/ha) and gross margin (Tk. 322700/ha) was also recorded from IPM treated plots than the non IPM plots.

Keywords: Brinjal, IPM package, BSFB, shoot infestation and fruit infestation.

Introduction

Brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* Guenee, is the most damaging pest of brinjal in Bangladesh. BSFB is the major pest of brinjal (Latif et al., 2010; Chakraborti and Sarkar, 2011; Saimandir and Gopal, 2012) and is found in all brinjal producing countries (Dutta *et al.,* 2011). Areas having a hot and humid climate are conducive for its distribution and incidence (Srinivasan, 2009). Larvae of this insect bore inside plant shoots and fruits adversely affecting plant growth, yield and fruit quality, and thus making it unfit for human consumption. The yield reduction could be as high as 70% (Islam and Karim, 1991; Dhandapani *et al*., 2003). In order to control the pest farmer's indiscriminately use large quantities of chemical insecticides at every alternate day, every day, and even twice a day. Survey of pesticide use in Bangladesh indicated that farmers spray up to 180 times with chemical insecticides during a year to protect their brinjal crop against BSFB (SUSVEG Asia, 2007). This practice not only increases cost of production but also causes environmental pollution and human health hazard. As a result, this pest has become resistant to insecticides. For these reasons, integrated pest management (IPM) package is essential to reduce the application of insecticides for the control of brinjal shoot and fruit borer and to save natural enemies from adverse impacts of insecticides. AVRDC – The World Vegetable Center has recently developed, validated and promoted an IPM strategy for the control of BSFB in South Asia during 2000-2005 (Alam et al., 2003; Alam et al., 2006). However, BARI scientists have already been developed IPM package to combat the pest. IPM package involving use of sex pheromone trap, weekly release of egg and larval parasitoid and removal of infested shoots and fruits (sanitation) can significantly reduce the insect population.

Sex pheromones are important component of IPM programs and they are mainly used to monitor as well as mass-trap the male insects. Zhu *et al*. (1987) identified (E)-11-hexadecenyl acetate (E11-16: Ac) as the major component of BSFB sex pheromone in China. They synthesized this chemical in the laboratory and used at the rate of 300-500 µg per trap to attract the BSFB males in the field. However, E11-16:Ac when used alone or in combination with E11-16:OH attracted significantly high numbers of male moths in India and Bangladesh, although E11-16:OH alone showed no attraction at any concentration (AVRDC, 1996; Srinivasan and Babu, 2000). Cork et al. (2001) at the Natural Resources Institute (NRI), UK also identified the presence of E11-16:Ac as a major component and E11-16:OH as a minor component in the pheromone gland extracts of BSFB from India and Taiwan. They

also found that E11-16:Ac and E11-16:OH (100:1) attracted significantly more numbers of male moths than E11-16:Ac alone in India. Hence, the BSFB sex pheromone was included as a potential component in the BSFB IPM program that was implemented by AVRDC in South Asia.

Delta traps and funnel traps could be used for the BSFB sex pheromone lures in field conditions. For instance, in the AVRDC-led BSFB IPM program in South Asia, delta traps consistently caught more BSFB male moths than funnel traps in Gujarat, whereas funnel traps performed better than delta and water-trough traps in Uttar Pradesh (Alam et al., 2003). Similarly, delta traps caught and retained ten times more moths than either Spodoptera or uni-trap designs in Bangladesh (Cork et al., 2003). The optimal trap height will also vary with locations. As an example, the traps placed at crop canopy level caught significantly more male moths than traps placed 0.5 m above or below the crop canopy in Bangladesh (Cork et al., 2003), whereas traps installed 0.25 m above crop canopy caught higher moths than either at crop canopy or at 0.25 m below crop canopy in Uttar Pradesh (Alam et al., 2003). The traps should be erected at every 10 m or less for effective attraction (Prasad et al., 2005). In general, it has been suggested to place the traps at a density of 100 per ha (Cork et al., 2003). Thus, the BSFB sex pheromone traps as a component of IPM significantly reduced the fruit damage and increased the yield in South Asia (Alam et al., 2003; Cork et al., 2003).

Although several natural enemies (predators, parasitoids and entomopathogens) have been recorded against BSFB in South and Southeast Asia, their role in keeping the BSFB population at levels below causing economic damage is not significant (Srivastava and Butani, 1998). However, Trathala flavoorbitalis seems to be a potential candidate in biological control of BSFB among all these natural enemies, because of its presence in several countries in the region as well as its higher rate of parasitism in field conditions. Hence, AVRDC has started exploring the local natural enemies including T. flavoorbitalis that have the potential to control BSFB in the region. T. flavoorbitalis was the only active parasitoid against BSFB in Sri Lanka, Gujarat (India) and Bangladesh, with maximum parasitism of 61.7%. In addition to T. flavoorbitalis, Goryphus nursei (Ichneumonidae: Hymenoptera) was recorded in Uttar Pradesh. This was an active parasitoid during winter season, with maximum parasitism of 7%. Similarly, few specimens of Pristomerus testaceus, Elasmus corbetti and Euagathis sp. have been recorded from BSFB in Thailand, although T. flavoorbitalis remained predominant species. The level of parasitism by T. flavoorbitalis has significantly increased after withholding the pesticide use (Alam et al., 2003). Hence, T. flavoorbitalis would be an ideal bio-control candidate in BSFB IPM program in the region. Therefore, the present study was undertaken to observe the performance of the IPM package in a large scale among the farm community.

Materials and Methods

The trial was carried out at the farmer's established brinjal field at Sreepur, Gazipur during 2019-2020. The experiment was laid out in RCB design with 6 dispersed replications. The unit plot size was 0.15 ha and total area was 0.9 ha. There were two treatments viz. T_1: IPM trials [Sex pheromone trap (trapping was started after one month of transplanting brinjal seedling) + weekly release of egg parasitoid, *Tricogramma evanescence* @ 1g parasitized eggs/ha and larval parasitoid, *Bracon hebetor* @ 1 bunker (1000-1200 adults)/ha + sanitation (weekly removal of infested shoots and fruits) and T_2: Non IPM trials (Farmer's practice – spraying of Voliam Flexi 300SC or Proclaim 5SG or Sobicron and Basthrin at 4 days interval). A distance of 500 m was maintained between the IPM and non IPM plots. The sex pheromone trap was placed with 10m × 10m spacing in the field. The sex pheromone trap was placed one after another on June, 2019.

Pheromone Trap (Plastic pot) The pheromone, 'methyl eugenol' or 'cue lure' used for teasel gourd plants simply case of BSFB phero was used that mimics the scent of female flies that pulls the male flies and traps them in massive numbers resulting to mating disruption. Simple plastic containers developed by BARI scientists cited to as 'BARI trap' or popularly mentioned as 'Magic trap' were prepared for deployment of the pheromones.

The rectangular plastic container of 3-liter capacity with 20-22 cm tall was utilized in the experiment. A triangular hole measuring 10-12 cm height and 10-12 cm base was cut in any two opposite sides. The lower part of the triangular hole was 3 cm above rock bottom of the container. Water containing with two-three drops of detergent was maintained within the trap throughout the season. Pheromone-soaked cotton or lure was tied within the trap with thin wire. BSFB adults enter the trap and fall into the detergent contaminated water and die. Water within the trap was replenished usually to assure the trap isn't dry. A pheromone dispenser was maintained and continued throughout the cropping season. This operation was done in targeted plots, starting from 30 days before full maturity and continued until last harvest.

Data on shoot and fruit infestation were recorded from randomly selected areas/plot at each harvest (1 m^2). Yield and infestation data were also recorded from both IPM and non IPM plots**.** Number of insects caught in the pheromone traps was also recorded. Data were analyzed statistically using paired T-test.

The integrated pest management (IPM) package for the control of brinjal shoot and fruit borer (BSFB) consists of sex pheromone, cultural, mechanical and biological control methods.

Results

The results indicated encouraging performance of the IPM package to reduce brinjal shoot and fruit borer (Table 1). The lowest shoot and fruit infestation was obtained from the IPM plots (6.85% and 5.78%) whereas highest was in the non IPM plots (17.23% and 15.28%). Reduction of fruit infestation was 62.17% over non IPM plots. The infestation status of IPM and non IPM plots reflects in the yield. Higher yield was obtained from IPM plots (55.70 t/ha) than the non IPM plots (40.23 t/ha) which was 38.45% higher than the non IPM plots. Higher gross return (Tk. 557000/ha) and gross margin (Tk. 322700/ha) was also recorded from IPM treated plots than the non IPM plots (Table 2). Number of captured adult per trap increased with the increase of plant age and reached peak at 10^{th} – 14^{th} week of trap setting and thereafter population decreased with the progress of the season (Fig 1).

Table 1. Effect of IPM package against brinjal shoot and fruit borer at Sreepur, Gazipur during 2019-2020

Treatments	Shoot infestation (%)	Shoot infestation reduction (%)	Fruit infestation (%)	Fruit infestation reduction (%)	Yield (t/ha)	Yield increase (%)
IPM	6.85	60.24	5.78	62.17	55.70	38.45
Non IPM	17.23	-	15.28	-	40.23	-
"t" value	17.41	-	22.61	-	11.69	-
Level of significance	**	-	**	-	**	-

** = Significant at 1% level

Discussions

Parasitoids are one of the most important bio-control agents. They are the organisms that, during its development, lives in or on the body of a host individual, eventually killing that individual and develop as a free living adults. Among the parasitoids

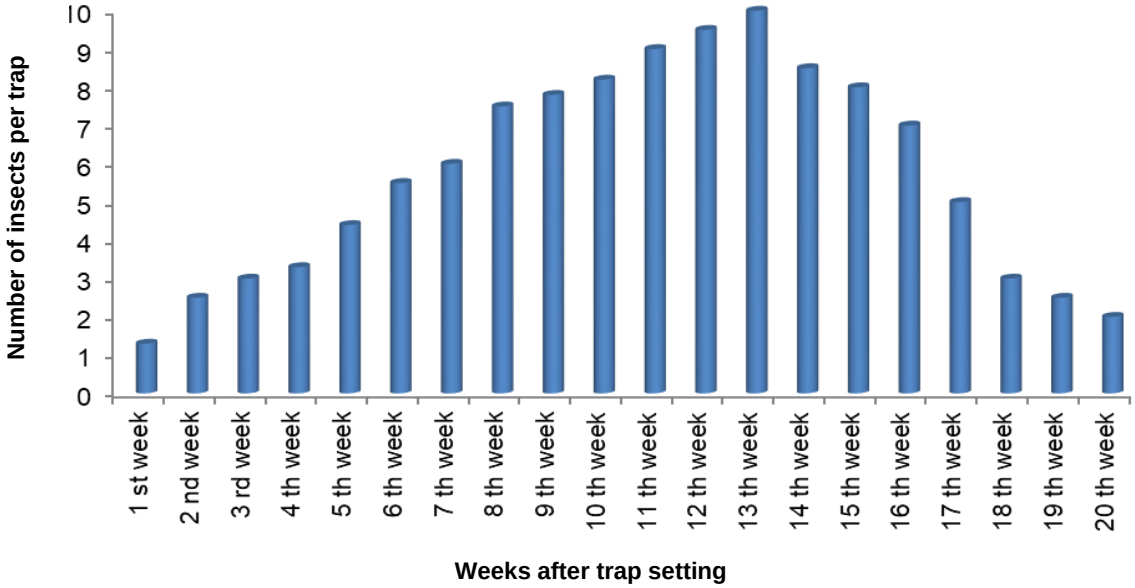

Figure 1. Number of insects per trap in different weeks after trap setting at Sreepur, Gazipur

Trichogramma is a potential biological control agent against Lepidopteran insect pest. *Trichogramma* spp. are extremely tiny wasps in the family Trichogrammatidae under the order Hymenoptera. *Trichogramma* belongs to the category of egg parasitoid of biological agents. *Trichogramma* wasps seek out eggs, but do not feed on or harm vegetation. It is a particularly effective control agent because it kills its host before a plant can be damaged. It attacks the pest at the egg stage itself and hence damage done by larvae is avoided. The *Trichogramma* eggs on hatching, feed the embryonic contents of host's egg, completes its development and adult comes out of the host egg by chewing a circular hole. *Trichogramma* spp., the most widely used bio- control agent in the world and is effective against bollworms of cotton, stem borers of sugarcane, fruit borers of fruits and vegetables. It offers a lower cost but more effective plant protection option in comparison to insecticides. A single *Trichogramma*, while multiplying itself, can thus destroy over 100 eggs of the pest.

The biological control of insect pests plays an important role in plant protection. When integrated with other pest management tactics, the efficacy of pest management can be enhanced. The extreme environmental conditions are the potential risk for the effective application of the bio-control agents. The parasitoid, *Bracon hebetor* can be used as an efficient tool for integration with chemical insecticides to perform effective pest control.

Although several natural enemies (predators, parasitoids and entomopathogens) have been recorded against BSFB in South and Southeast Asia, their role in keeping the BSFB population at levels below causing economic damage is not significant (Srivastava and Butani, 1998). However, Trathala flavoorbitalis seems to be a potential candidate in biological control of BSFB among all these natural enemies, because of its presence in several countries in the region as well as its higher rate of parasitism in field conditions. Hence, AVRDC has started exploring the local natural enemies including T. flavoorbitalis that have the potential to control BSFB in the region. T. flavoorbitalis was the only active parasitoid against BSFB in Sri Lanka, Gujarat (India) and Bangladesh, with maximum parasitism of 61.7%. In addition to T. flavoorbitalis, Goryphus nursei (Ichneumonidae: Hymenoptera) was recorded in Uttar Pradesh. This was an active parasitoid during winter season, with maximum parasitism of 7%. Similarly, few specimens of Pristomerus testaceus, Elasmus corbetti and Euagathis sp. have been recorded from BSFB in Thailand, although T. flavoorbitalis remained predominant species. The level of parasitism by T. flavoorbitalis has significantly increased after withholding the pesticide use (Alam et al., 2003). Hence, T. flavoorbitalis would be an ideal bio-control candidate in BSFB IPM program in the region. Hence, weekly release of egg parasitoid, *Tricogramma evanescence* @ 1g parasitized eggs/ha and larval parasitoid, *Bracon hebetor* @ 1 bunker(1000-1200 adults)/ha would be an ideal bio-control candidate in BSFB IPM program in the region. This findings are silimar with the present study.

Due to the poor mobility of insects, the insect can be easily collected by hand and adults, eggs and larvae were killed by hand. This happens from 10.30 am to 11.00 am. 3:30 pm to 4:00 pm. When the insect activity in plants is high, it was carried out twice on plots used for treatment measures.

Cultural control methods involve the manipulation of crop environment as well as management, whereas mechanical control involves the use of mechanical forces or manual operations to interfere with the insect feeding, shelter and reproduction. For ince, sanitation of the field before, during and after the cropping, removal of the alternate food sources for the pests and mechanibarriers are some of the cultural and mechanical control measures to manage BSFB in the field. However, BSFB moths that emerge from the pupae in soil or migrate from neighboring eggplant crops are important sources of infestation. In addition to these known sources of infestation, dry brinjal stalks from previous crop that have been stored by the farmers as fuel for cooking serve as another important source of BSFB infestation (Alam et al., 2003). Removal and prompt destruction of the BSFB infested shoots and fruits at regular intervals have been suggested as an effective strategy to manage the BSFB on brinjal in South and Southeast Asia (Rahman et al., 2002; Talekar, 2002; Arida et al., 2003;

Table 2. Cost and return analysis of brinjal at Sreepur, Gazipur during 2019-2020

Treatments	Gross return (Tk/ha)	Cost of production (Tk/ha)	Gross margin (Tk/ha)
IPM	557000	234300	322700
Non IPM	402300	248625	153675

The market price of brinjal was 10 Tk/kg.

Satpathy *et al.,* 2005). This pruning is especially important in early stages of the crop growth, and this should be continued until the final harvest. The use of barriers combined with prompt destruction of the BSFB infested shoots significantly reduced the damage to shoots than by using either the barrier or the sanitation alone (Alam et al., 2003). Hence field sanitation and mechanical barriers could significantly reduce the BSFB damage and could be an effective component in BSFB IPM.

Socioeconomic Impact and Future of the BSFB IPM Technology

The profit margins and production area significantly increased whereas pesticide use and labor requirement decreased for those farmers who adopted this IPM technology. For instance, socioeconomic studies in Bangladesh revealed that the adoption of BSFB IPM has reduced about 30% of the total production cost when compared to the non-IPM adopters (Alam et al., 2003). It has clearly been proven that this IPM technology has positive impacts on the lives of brinjal growers in the region.

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