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Effect of Infested Shoot Removal and Light Trap on Brinjal Shoot and Fruit Borer (*Leucinodes orbonalis* G.) Infestation on Brinjal Fruit *Solanum melongena* L.

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Authors' Contribution
QW conceived and planned the study. She planted the crops, recorded and analysed the data and wrote the article. M. Afzal and M. Aslam helped in conceiving and planning the study. M. Aslam also helped in planting of crop and paper writing. ADA installed light trap and recorded the data.

Key words
Field sanitation, Cultural control, Mechanical control, BSFB management, Light traps.

ABSTRACT

Brinjal (*Solanum melongena* L.) is a very important crop in Southeast Asia. It is attacked by several insect pests, but brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* G. is the most important insect pest attacking almost all the plant parts except roots. The effect of removal of BSFB infested brinjal shoots and use of light trap was studied for management of this insect pest. The study was conducted on spring sown crop during 2013 in Sahiwal, Pakitan using brinjal variety, Nirala. The experiment was laid out in Randomized Complete Block Design with four treatments each repeated three times. The treatments were T1= removal of infested shoots, T2= Use of light trap, T3= T1+T2 and T4=control. The seedlings were transplanted on April 21, 2013 keeping plant to plant distance of 30cm. Kerosene oil lantern, hung over metallic tray filled with water, was used as light trap. Data for fruit infestation was recorded fortnightly, starting from mid-May, from twenty randomly selected plants. The percent fruit infestation in all three treatments was lower than control except on June 15 when infestation in control and in plots having light traps was not significantly different. Seasonal means for fruit infestation reduced fruit infestation by 16.1, 9.6 and 19.5 percent in T1, T2 and T3, respectively as compared to control.

INTRODUCTION

Brinjal (*Solanum melongena* L.) is an important solanaceous vegetable crop in Southeast Asia (Kantharajha and Golegaonkar, 2004; Thapa, 2010). Pakistan, India Bangladesh, Thailand and Sri Lanka are the main brinjal producing countries. Hot and humid climate of this region is favorable for good quality brinjal production (Hanson *et al*., 2006). Pakistan produces about 87,000 ton per year from 9,000 hactere area under brinjal cultivation (FAO, 2014). Brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* G. is economically most important among all insect pests of this crop (Chakraborti and Sarkar, 2011; Saimandir and Gopal, 2012). The larvae bore into tender shoots and fruit making fruit unfit for human consumption. Yield loses due to infestation may reach upto 85 to 90 percent (Misra, 2008; Jagginavar *et al*., 2009).

The farmers use insecticide spray two to three times a week to protect from infestation and get good marketable fruit. But injudicious use of insecticides causes human health hazards directly when application is made and indirectly by leaving residues in fruit (Pértile *et al*., 2009) and cause soil and water pollution (Martínez *et al*., 2004). Integrated pest management (IPM) strategies by combining different control measures have been developed to control BSFB (Alam *et al*., 2006). It is better to manage the insect pest population rather than completely eliminating the pests by using insecticides. IPM practices cannot eliminate the use of pesticides completely but can reduce it substantially, *i.e.,* up to about 48-50 percent (Mandal *et al*., 2009). Different compatible control methods can be integrated to manage the insect pests. Implementation of IPM technologies in the fields for management of BSFB had had been reported to have potential economic impact (Mandal *et al*., 2009). The present study was carried out to study the BSFB infestation as affected by combining cultural control (removal of infested brinjal shoots) and mechanical control (use of light traps) alone and in combination to recommend a suitable and economical management strategy.

MATERIALS AND METHODS

The study was carried out in Sahiwal on spring sown

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crop during 2013 from May 15 to September 30. The experiment was laid out in a Randomized Complete Block Design with four treatments, each replicated three times. The treatments were T1= removal of infested shoots, T2= use of light trap, T3= removal of infested shoots+use of light traps and T4= Control (no management practice). The seeds of brinjal variety Nirala, tolerant against BSFB infestation (Yousafi et al., 2016), were obtained from Ayyub Agriculture Research Institute. Seeds were sown in earthen pots on March 18. The seedlings were transplanted by hand on April 21 on ridges in the field. The replications for each treatment were on three different locations in the fields around Sahiwal. Each replication was consisted of a plot of 5x5 sq. meter having five 1.0 m long ridges. Transplanting was done on one side of ridges keeping plant to plant distance of 30cm. The distance among treatments on a location was kept ca. 200 m to minimize the effect of one treatment on the results of other. The light traps were made of a metal lantern with glass chimney. The lanterns were hung 140 cm high over a metal tray of diameter 36.6 cm and depth 18.3 cm. The tray was filled with water and kerosene oil in 10: 1 ratio. The lantern was lit daily from dusk to dawn. Adults were collected by sieving the water and kerosene mixture. The infested shoots were removed fortnightly on the same day of recording data.

Fruit infestation data were recorded from twenty randomly selected plants from each plot. All marketable fruit were plucked from the selected plants. Healthy and infested fruit were counted and percent infestation was recorded as under:

Percent *L. orbonalis* fruit infestation=
Fruits infested by *L. orbonalis*/Total No. of fruits x 100

Data were subjected to Analysis of Variance and mean separation was done by calculating Least Significant Difference at p=0.05 using Statistix (2000) statistical software at p = 0.05.

RESULTS AND DISCUSSION

The infestation of BSFB in different treatments (management practices) is presented in Table I. Control plots (no management) had consistently highest infestation as compared to those receiving other treatment on all the sampling dates, except on June 15 when infestation in control plots and plots having light traps was non-significantly different. Among other treatments, T2 (light traps only) had significantly higher infestation level than other two treatments, *i.e.,* T1 (removal of infested shoots) and T3 (removal of infested shoots+light traps). But on June 15 and 30; July 15 and September 15, T3 had significantly lower infestation level as compared to other two treatments. Treatment 1 had significantly lower infestation as compared to that in T2, except on September 15 when T1 and T2 had non-significantly different infestation, which was higher than that in T3. Seasonal mean infestation (sum of infestation on all sampling dates/ number of sampling dates) was significantly different among the three treatments. The infestation was highest in control plots, followed by that in T2, T1 and T3, respectively in descending order.

Table I.- Percent fruit infestation in different management practices against brinjal fruit borer (*Leucinodes orbonalis* G.) at Sahiwal in 2013.

Sampling dates	Treatments				LSD*
	Infested shoot removal (T1)	Light traps only (T2)	Infested shoot removal+ Light traps (T3)	Control (T4)	
15-May	12.52±1.0c	18.26±1.0b	12.36±1.0c	22.89±1.5a	4.58
30-May	12.14±0.6c	17.17±1.0b	8.76±1.0c	21.74±1.1a	3.49
15-Jun	16.76±0.7b	23.70±1.4a	11.23±0.7c	25.80±2.9a	4.92
30-Jun	16.68±1.9c	22.85±1.3b	11.63±0.5d	29.34±2.3a	3.6
15-Jul	16.75±0.9c	20.69±1.2b	12.37±0.5d	33.26±1.2a	3.41
30-Jul	14.23±0.7c	19.21±1.0b	11.48±1.1c	34.08±1.6a	4.32
15-Aug	13.85±0.6c	16.96±0.6b	11.34±0.8c	32.01±1.0a	2.66
30-Aug	10.37±1.0c	26.67±1.5b	6.95±0.6c	34.37±1.8a	4.86
15-Sep	16.04±2.7b	20.24±0.7b	10.57±1.1c	35.20±2.1a	4.66
30-Sep	11.71±0.8c	21.32±0.7b	11.43±0.4c	34.68±0.9a	2.48
Mean**	14.10±0.5c	20.71±0.2b	10.8±0.2d	30.34±1.0a	1.83

*, Means followed by same letter in rows are non-significantly different (LSD; P=0.05). **, Sum of infestation on all sampling dates / number of sampling dates.

It is evident that although the mean seasonal infestation was different in all treatment, all the treatment had, to a great extent, lower infestation as compared to that in control plots. Seasonal mean infestation was reduced by 16.1, 9.6 and 19.5 percent in T1, T2 and T3, respectively as compared to that in control. Among the tested management strategies removal of infested shoots+ use of light traps is relatively better option for keeping the fruit infestation low. This combination kept the infestation close to the economic injury level given by the Department of Agriculture, Government of the Punjab (PW and QCP, 2014) *i.e.,* 10 percent fruit infestation.

Based on the results of the present study cultural control (removal of infested shoots) combined with physical control (use of light traps) proved an adoptable and practical strategy for management of BFSB, but it needs to be tested rigorously in future studies on a wider area basis. These two techniques are inexpensive and can be affordably adopted by farmers in the study area. This combination can be more effective when integrated with other appropriate management tactics, *i.e.,* chemical control, use of resistant varieties and pheromone traps *etc*. Results of present study also partially confirm the findings of previous work for management of BSFB.

The use of pheromone traps along with continuous destruction of infested shoots was reported to reduce the BSFB infestation to a great extent (Srinivasan, 2008) and use of light trap was reported as commonly used technique for attracting Lepidopterous insects (Intachat and Woiwod, 1999). Rahman *et al*. (2002) reported that the quality of fruit, in terms of diameter and weight, was high in the fields under IPM package "Eggplant grafted on *Solanum torvum* as rootstock+collection and destruction of infested fruit and shoots". IPM modules against BSFB infestation in brinjal were tested and the module "pheromone traps+mechanical control (removal of infested shoots)+insecticide" was reported to be the best for reducing shoot and fruit damage and increasing marketable yield of brinjal (Rahman *et al*., 2009; Mandal *et al*., 2009; Dutta *et al*., 2011). Sasikala *et al*. (1999) found the combination of neem oil+removal of infested fruit and shoot+egg parasitoid, as the best IPM package against BSFB in brinjal. Use of physical barrier+clipping off infested shoots was found the best BSFB management practice for farmers in small scale production of eggplant, especially for off-season crops (Ghimire, 2001). In another study the combination of infested shoot removal with insecticide and physical barrier was found the most effective BSFB management strategy over other combinations tested on *Solanum aethipicum* L. (Onekutu et al., 2014). In all the studies mentioned above traps (light or sex pheromones) and removal of infested shoots were important component of the integrated pest management package. However, more research is needed for integration of more practices like burying of infested fruits, use of organic fertilizers and chemical control. Yousafi et al. (2015) found spinosad (Tracer 240SC) and emamectin benzoate (Timer 1.5EC) most effective against BSFB infestation. Khan and Naveed (2017) also found emamection benzoate effective against *Bactrocera zonata*. These environment friendly insecticides can be used in combination with removal of infested shoots and use of light trap for BSFB management.

CONCLUSION

It is concluded that BSFB can be successfully managed if these two techniques *i.e.,* use of light traps and removal of BSFB infested shoots, are integrated with other control measures.

Statement of conflict of interest

The authos declarethat there is no conflict of interests regarding the publication of this article.

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