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Yield loss-infestation relationship and assessment of economic injury level of brinjal shoot and fruit borer, *Leucinodes orbonalis*

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Abstract: Studies on yield loss-infestation relationship and assessment of economic injury level of brinjal shoot and fruit borer, *Leucinodes orbonalis*, were steered at Insectary, Department of Entomology, C. S. Azad University of Agriculture and Technology, Kanpur, U.P. during rainy season 2009 and summer season 2010. The apparent losses of shoot and fruit borer on fruit were noticed 19.85 per cent in rainy and 17.22 per cent in summer season while 10.06 and 4.08 per cent were latent losses in respective season, which made total losses to the tune of 29.92 and 21.30 per cent as avoidable losses and 0.75 and 0.84 per cent were unavoidable losses in rainy and summer seasons, respectively. The economic injury level (EIL) of shoot and fruit borer was determined as 0.84 and 0.79 on shoots and 0.94 and 0.82 per cent on fruits, during respective seasons on brinjal. The general equilibrium position (GEP) of shoot and fruit borer was found 35.83 and 19.33 per cent on shoots and 28.33 and 24.33 per cent on fruits in respective seasons which is very high in comparison to its EIL in each seasons.

Keywords- Yield loss, EIL, Leucinodes orbonalis, Brinjal

Introduction

The eggplant or aubergine or brinjal (*Solanum melongena* L.) is one of the most important solanaceous vegetable in India. In India, this crop occupies 600 thousand hectare area along with annual production of 10378 (000 MT) and productivity 17.2 MT per hectare. It is widely used vegetable crops by most of the people and is popular in many countries *viz.,* Central, South and South East Asia, some parts of Africa and Central America (Harish *et al*., 2011). This important crop is subjected to attack by many insect pests throughout its growth period which act as limiting factor in its profitable cultivation. The important insect pests are- brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee), brinjal lace wing bug (*Urentius sentis* Distant), hadda beetle (*Epilachna vigintioctopunctata* Fabricius), jassid (*Amarasca bigutulla bigutulla* Ishida), brinjal stem borer (*Euzophera perticella* Rag.) (Atwal and Dhaliwal, 2005). According to Singh *et al.,* (2007) average yield losses due to shoot and fruit borer, *Leucinodes orbonalis* Guenee on brinjal fruits were calculated as 13.30 per cent, out of which 4.83 per cent were found to be totally un-consumable losses. The production and quality of fruits are mainly affected by number of insect pests, especially shoot and fruit borer, *L. orbonalis* which acts as a limiting key factor in profitable cultivation of the crop. It is known to damage shoot and fruit of brinjal in all stages of its growth. The yield loss due to the pest is to the extent of 70-92 per cent (Chakraborti and Sarkar, 2011). The production and quality of fruits are mainly affected by number of insect pests, especially shoot and fruit borer, *Leucinodes orbonalis* which acts as a limiting key factor in profitable cultivation of the crop, causing severe losses up to 48.03 per cent to this crop (Singh *et al*., 2000). The pest is active throughout the year on crop. It has specific nature of feeding as, it bores into the growing tips of prolonged the flower buds initial and fruiting phase of crop. The yield loss by this pest varied from 0.08-1.11 q/ha on the basis of inconsumable parts of damaged fruits and 0.46-3.80 q/ha when whole of the damaged fruits were taken into consideration (Singh and Singh, 2002).

Method and Materials

The seedling of brinjal var. Azad B-3 was planted at Insectary in plot measuring 4.0 x 3.0 m in randomized block design having three replications. Nine treatments were maintained by providing varying exposure periods to insecticidal applications. As per techniques of Stone and Pedigo (1972), as adopted the varying levels of fruit and shoot borer infestation were maintained by weekly spraying with endosulfan 35 EC @ 0.07% on the dates. The market price of produce and insecticide were collected from Senior Agriculture Marketing Officer and Plant Protection Officer, respectively to calculate the Gain Threshold while coefficient of regression was calculated between the mean infestation on shoots/fruits in each respective phases, and yield of fresh fruits showing apparent losses in case of fruits and latent losses in case of shoots in both seasons.

Extent of losses: The extent of apparent losses caused by *L. orbonalis* on fruits were calculated on the basis of total yield of fruits and yield of damaged fruits obtained from the untreated plots. Total losses caused by this pest were analyzed on the basis of total yield potential of the crop under maximum protection measures and yield in control. The latent losses caused by shoot and fruit borer were calculated by deducting the apparent losses from the total losses. The avoidable losses were determined by taking the yield of fresh fruits in the plots provided with maximum protection measures and yield of untreated control plots.

Economic injury level (EIL): The economic injury level (EIL) of the pest was determined by creating the variation in pest infestation as per techniques of Stone and Pedigo (1972 through varying exposure of endosulfan 35 EC applied @ 700 g a.i. ha^{-1} at 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9 times at weekly intervals. The incidence of shoots and fruits was recorded in all the treatments after 7 days of each application and data were computerized to obtain the economic injury level (EIL) and economic threshold (ET) of the pest on growing and fruiting phenological stage of the crop. The yield of fresh fruits (q/ha) obtained in different insecticidal treatments having different degree

of pest infestation was considered for calculating the EIL on fruits, whereas for EIL on shoots, total yield of infested and uninfested fruits was taken plots wise by deducting the effect of apparent fruit infestation.

Economic Threshold (ET): The Economic threshold was calculated on the basis of multiplication rate of pest in the particular week by dividing it with the number of days of week to determine multiplication rate per day.

General equilibrium position (GEP): General equilibrium position was calculated on the basis of mean of observations of pest infestation on shoots and fruits separately (Luckmann and Metcalf, 1994).

Result and Discussion

The experiments on "Yield loss-infestation relationship and assessment of economic injury level of brinjal shoot and fruit borer, *Leucinodes orbonalis* on brinjal are being presented and discussed in the light of the existing literature under head.

Extent of losses: The yield of brinjal 237.75 q/ha in rainy season and 184.51 q/ha in summer season were recorded by maximum (nine times) insecticidal application and 167.85 q/ha and 146.37 q/ha were noticed by without insecticidal application plots while production potential of brinjal crop was estimated 239.53 and 186.78 q in respective season (Table-1). The present investigation, on revealed extent of fruit damage 29.92 per cent in rainy season and 21.30 in summer season, are in complete agreement with those of Peswani and Lal (1964), who obtained 20.70 per cent to the brinjal crop in Delhi. The total losses caused by shoot and fruit borer to the top shoots and fruits, were as high as 29.92 per cent in rainy season and 21.30 percent in summer season; out of which 29.18 per cent and 20.46 per cent were recorded as avoidable losses through the maximum use of insecticides. In the earlier finding, extent of losses up to 48.03 per cent, out of which 21.31 per cent losses were apparent losses on the fruits, and 45.49 per cent of total losses were determined as the avoidable losses by Yadav and Kumawat (2013) recorded per cent avoidable losses recorded were 48.87 and 47.63, respectively (pooled, 48.25). Varma *et al.* (2009) reported that the damaged fruits and fruit weight loss varied from 3.76 to 45.45 per cent and 3.00 to 67.71 per cent in first year and 5.71 to 44.26 per cent and 3.00 to 51.33 per cent in second year due to *L. orbonalis*. Singh *et al*. (2000), 2.40 percent were unavoidable losses, confirm the trend losses obtained in the present findings. Crop losses only due to shoot and fruit borer, *L. orbonalis* have been reported to the tune of 20-89 per cent in various parts of India (Raju *et al*., 2007).

Economic injury level- On shoots: The insecticidal treatments provided varying degrees of shoot and fruit infestation. The data variation in yield, after deducting the infested fruit yield (Table-3), were computed the economic injury level (EIL) on shoot and fruit borer on brinjal shoots. The economic injury level was determined as 0.84 in rainy season and 0.79 summer season. Anaji and Balikai (2007) also reported crop loss estimation and economic injury level of *Peregrinus madis* on sorghum.

On fruits: The economic injury level of shoot and fruit borer on brinjal fruits was evaluated by considering the variation in fruit infestation obtained due to insecticidal application (Table-4). The gain threshold level was assessed on the basis of market prices of endosulfan 35 EC and brinjal fruits. The economic injury level (EIL) of shoot and fruit borer on fruit was determined as 0.94 and 0.82 per cent, in rainy and summer seasons respectively. This finding supported by Kumar and Singh (2013) the economic injury level of shoot and fruit borer on brinjal shoots was recorded as 0.96 & 0.90

Table-1: Production of brinjal under maximum protection

Treatments	Production (q/ha)			
	Rainy season 2009		Summer season 2010	
	Total fruits	Fresh fruits	Total fruits	Fresh fruits
Production potential	239.53		186.78	
Maximum insecticidal treatment	237.75	236.08	184.51	182.22
No insecticidal treatment	167.85	134.53	146.37	121.16

Table-2: Extent of losses on brinjal caused by shoot and fruit borer

Losses (%)	Rainy season 2009	Summer season 2010
Total losses	29.92	21.30
Apparent losses	19.85	17.22
Latent losses	10.06	4.08
Avoidable losses	29.18	20.46
Unavoidable losses	0.74	0.84

Table-3: Economic injury level of shoot and fruit borer, *L. orbonalis* on brinjal shoots during rainy and summer seasons

Treatments	No of sprayings	Rainy season		Summer season	
		Shoot infestation (%) (x)	Total yield (q/ha) (y)	Shoot infestation (%) (x)	Total yield (q/ha) (y)
T_0	0	30.74	167.85	22.22	146.37
T_1	1	23.33	175.83	17.04	151.21
T_2	2	22.96	179.51	14.43	158.72
T_3	3	18.15	190.69	13.52	162.54
T_4	4	13.17	198.68	10.15	167.92
T_5	5	9.63	204.86	5.54	171.63
T_6	6	6.29	212.43	4.06	174.25
T_7	7	3.70	219.16	2.21	178.57
T_8	8	1.85	226.60	1.67	179.25
T_9	9	0.74	237.75	0.58	184.51
Particulars		**Rainy season2009**		**Summer season2010**	
Regression coefficient		1.58		1.67	
Gain threshold		1.33		1.33	
Economic injury level		0.84		0.79	

Table-4: Economic injury level of shoot and fruit borer, *L. orbonalis* on brinjal fruits during rainy and summer seasons

Treatments	No of sprayings	Rainy season		Summer season	
		Fruit infestation (%) (x)	Infected yield (q/ha) (y)	Fruit infestation (%) (x)	Infected yield (q/ha) (y)
T_0	0	22.00	33.33	17.33	26.80
T_1	1	20.00	29.17	12.00	22.92
T_2	2	13.33	25.42	6.67	17.68
T_3	3	9.33	20.83	4.53	13.61
T_4	4	6.00	16.39	3.33	9.51
T_5	5	4.00	12.64	2.67	5.45
T_6	6	3.33	7.88	2.00	3.33
T_7	7	2.00	4.17	1.33	2.29
T_8	8	1.32	2.78	0.83	1.28
T_9	9	0.67	1.67	0.48	0.93
Particulars		**Rainy season**		**Summer season**	
Regression coefficient		1.41		1.63	
Gain threshold		1.33		1.33	
Economic injury level		0.94		0.82	

Table-5: Rate of multiplication of shoot and fruit borer, *L. orbonalis* on shoot and fruit of brinjal during rainy and summer seasons

Standard week/ month	Rainy season				Standard week/ month	Summer season			
	On shoots		On fruits			On shoots		On fruits	
	Infestation (%)	Rate of multiplication	Infestation (%)	Rate of multiplication		Infestation (%)	Rate of multiplication	Infestation (%)	Rate of multiplication
Aug. 34	-	-	-	-	May 18	-	-	-	-
35	6.67	0.95	-	-	19	6.67	0.95	-	-
Sept. 36	13.33	0.95	-	-	20	10.00	0.47	-	-
37	30.00	2.38	-	-	21	13.33	0.47	-	-
38	53.33	3.33	-	-	22	20.00	0.95	-	-
39	70.00	3.81	-	-	June 23	23.33	0.47	-	-
40	80.00	1.42	46.67	6.67	24	26.67	0.47	-	-
Oct. 41	26.67	-7.62	70.00	3.33	25	50.00	3.33	-	-
42	6.67	-2.86	56.67	-1.91	26	26.67	-3.33	36.67	5.22
43	-	-	30.00	-3.81	July 27	10.00	-2.38	50.00	1.91
44	-	-	26.67	-0.47	28	6.67	-0.47	46.67	-0.47
Nov. 45	-	-	20.00	-0.95	29	-	-	30.00	-2.38
46	-	-	13.33	-0.95	30	-	-	26.67	-0.47
47	-	-	10.00	-0.47	Aug. 31	-	-	20.00	-0.95
48	-	-	6.67	-0.47	32	-	-	13.33	-0.95
Dec. 49	-	-	3.33	-0.47	31	-	-	10.00	-0.47
-	-	-	-	34	-	6.67	-0.47	-	-
-	-	-	-	35	-	3.33	-0.47	-	-
GEP	35.83	0295	28.33	0.050	GEP	19.33	0.093	24.33	0.05

per cent during 1st and 2nd year, respectively and on brinjal fruits as 0.81 & 0.72 per cent during 1st and 2nd year. #Grain threshold= cost of protection Rs. per ha divided by cost of produce per quintal. Economic injury level= Grain threshold divided by Regression coefficient

The maintenance of varying degrees of shoot and fruit infestation through the insecticidal treatment could be argued on the basis of earlier report of Stone and Pedigo (1972), who also maintained the different levels of clover worm infestation with the varying insecticidal sprays of carbaryl. Singh *et al.* (2000), had also adopted this technique for the calculating the economic status of shoot and fruit borer on brinjal. The gain threshold level was assessed on the market price of endosulfan 35 EC and brinjal fruits. The economic injury level (EIL) of shoot and fruit borer on shoots were determined as 0.84 and 0.79 and on fruit 0.94 and 0.82 per cent, in rainy and summer seasons respectively, which are in complete agreement with those of Singh *et al*. (2000) who determined EIL as 0.91 per cent on shoots and 0.67 per cent on fruits in plains of U. P.

Economic Threshold (ET)- On Shoots: The rate of multiplication of shoot and fruit borer on shoots was 0.95 per cent per day during rainy season whereas the EIL was only 0.84 per cent revealed the rate of multiplication higher than EIL, therefore 0.0 level of infestation should be the ET. The EIL in summer only 0.79 per cent on shoots and multiplication rate was more or less in identical trend as was in rainy season. Therefore ET level will not be differ during summer season as well also.

On fruits: The rate of multiplication of infestation on fruits was also very high *i.e.* 6.67 per cent during rainy season and 5.22 per cent per day immediately after shifting of infestation from shoots to fruits against EIL values 0.94 and 0.82 per cent. Conversely, the ET for fruit infestation will again be zero *i.e.* immediately after fruit setting.

General equilibrium position (GEP): GEP of shoot and fruit borer on shoots was found to be 35.83 per cent during rainy and 19.33 per cent during summer season, while on fruits it was 28.33 and 24.33 per cent against very low EIL *i.e*. 0.84 and 0.74 on shoots and 0.94 and 0.82 per cent on fruits during both the seasons.

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