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DETERMINATION OF ECONOMIC INJURY LEVEL FOR THE TOBACCO CAPSULE BORER, *HELICOVERPA ARMIGERA* (HUBNER) ON FCV TOBACCO

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Tobacco capsule borer *Helicoverpa armigera* (Hubner) is one of the major pests of tobacco. The damage potential of the pest to flue-cured Virginia (FCV) tobacco seed and economic injury level of *H. armigera* larva were worked out. There was a significant reduction in pod damage at various levels of larval infestation as compared to completely protected plots. The capsule damage ranged from zero in the completely protected plant to 37.82% where five larvae per plant were released. The correlation between number of larvae per plant and the per cent capsule damage was positive and significant (r=0.98). The results also revealed that the reduction in seed weight with increased larval density. The seed weight in different treatments ranged from 12.26 to 21.37 g/plant. The correlation between the number of larvae per plant and the seed weight was negative and significant (r = -0.85). Statistical analysis revealed that the correlation between larval population and reduction in seed weight per plant was positive and significant (r = 0.85). Regression analysis and the computation of EIL showed that the per cent reduction in yield per incremental larva over control was 10.52. Reduction in seed yield per incremental larva was 1.43 g/plant. The seed capsules damaged per incremental larvae was 7.18%. On an average a single larva per panicle reduced seed yield to an extent of 100 kg/ha in 2011 and 116 kg/ha in 2012 crop seasons, respectively. The ratio of the value of the yield (price of tobacco seed sold for oil extraction) to the cost of insecticide application at one third instar larva per panicle was 0.98 and 0.96 in 2011 and 2012 seasons, respectively. Based on the damage, yield relationship and cost of protection, the EIL for *H. armigera* was determined as one third instar larva/panicle.

Key words: *H. armigera,* Economic injury, FCV tobacco

INTRODUCTION

Tobacco is grown in 0.4 lakh hectares in India. It is estimated that about 3000 tones of tobacco seed oil is expelled annually and exported from India to other countries for various uses. Refined tobacco seed oil is being used as edible oil in Bulgaria, Tunisia, Turkey and Greece (Singh and Rao, 2005). Tobacco plant is a prolific producer of seed consisting nearly ten million seeds per kilogram. The seed oil produced in the country is mainly a by product of cigarette tobacco and the oil recovery from this type is about 30% (Patel and Parmar, 2005). Though chewing and *bidi t*obacco seed yields are higher than cigarette tobacco, their cultivation warrants decapitation of growing terminal bud and removal of auxiliary suckers. It is necessary to examine the damage potential of the tobacco capsule borer, *Helicoverpa armigera* which is a key pest of all types of tobaccos. For integrated pest management determination of Economic Injury Level (EIL) is a prerequisite for need based use of insecticides and avoidance of economic losses which was not worked out for seed crop of tobacco. EIL is the lowest population density that will cause economic damage. It is the level at which damage can not be tolerated and therefore at this point or before reaching this level it is desirable to initiate deliberate control measures. Hence, present studies were carried out with the objective of establishing damage-yield relationship and to determine the EIL of the pest.

MATERIALS AND METHODS

An experiment was conducted with four replications and six treatments to find out the EIL of *H. armigera* to seed capsules in the variety Siri in CTRI Farm Katheru for two seasons (2010-2012). Varying levels of artificial infestation of third instar larvae of *H.armigera* was created at

seed filling stage for each panicle on five tagged plants per plot, with a spacing of 70 x 70 cm and with a population of 30 plants per plot. The panicles were enclosed in a white nylon mesh to prevent exterior infestation. Observations were recorded at seed harvest on total number of pods, number of damaged pods and yield (seed weight) per plant and per cent pod damage was worked out. The EIL was computed based on the procedure given by Stone and Pedigo (1972) and modified by Ogunlana and Pedigo (1974) using the following formula:

EIL = Gain threshold Yield reduction per larva
Gain threshold = Management cost (Rs/ha)
Market value of grain (Rs/ha)

Management cost was calculated for the insecticide flubendiamide 480 SC @ 0.1% /10 l (Rs. 1930) along with application costs. One application is sufficient to keep the crop free from infestation. The cost of the tobacco seed for oil extraction purpose was calculated based on the prevailing market rate (Rs.1400/q). The correlation coefficient 'r' between the variables, population level of the pest and reduction in seed yield per plant was worked out using the following formula.

$$r = N \Sigma XY - \Sigma X \Sigma Y \div \sqrt{(N \Sigma X^2 - (\Sigma X)^2 (N \Sigma Y^2 - (\Sigma Y)^2}$$

where,
N is the total number of observations
X is the population levels of larvae/plant
Y is the reduction in seed yield

A regression equation of Y= a + bx form was obtained where 'a' is the intercept; 'b' is the yield reduction per larva. Thus b is the per plant reduction in yield by increase in one larva. Substituting the values in the above formulae, EIL was computed (Abhilash and Patil, 2008).

RESULTS AND DISCUSSION

In 2010-11 season, the seed weight in different treatments ranged from 4.60 to 12.50 g/plant. The reduction in yield per incremental larva was 7.37 g/plant and the per cent reduction in yield was 10.9 deduced from the regression equation y = 15.82 + 10.19x. The seed loss per plant was 1.28 g/plant deduced from the equation y = 10.46 -1.28x. The capsule damage was 7.37% per incremental larva as derived from equation y = 1.19 + 7.37x. During 2011-12 the per cent reduction in yield was 10.8 with regression equation y= 20.56 + 10.86 x. The seed loss per plant was 1.58 g per plant as deduced from the equation y= 11.25 – 1.58 x. The per cent capsule damage was 6.9 per incremental larvae as derived from equation y= 2.08 – 6.99 x. Calculation based on injury levels and economics of plant protection resulted in EIL of one third instar larvae per panicle. Similarly, while computing EIL of *Maruca vitrata* in mung bean in Bangladesh (Zahid *et al.,* 2008) reported EIL as 1 and 1.16 larvae per meter row. Reddy *et al.* (2001) also determined EIL of *H.armigera* in pigeon pea as 0.8 larva per plant and reduction in yield calculated as 138.5 kg per hectare at this ETL.

The results of combined analysis of two years study revealed that there was significant difference in pod damage between treatments, which received varied number of larvae and plants completely protected from the capsule borer damage. The per cent capsule damage ranged from zero in the completely protected (T6) plant to 37.82 where five larvae per plant were released (T5) (Table 1). The treatments *viz.,*T1, T2, T3 and T4 wherein plants received 1 larva, 2, 3 and 4 larvae per plant differed significantly with each other and from T5 and T6. The correlation between number of larvae per plant and the per cent capsule damage was positive and significant (r=0.98). Similar linear relations were reported between the number of larvae and the per cent pod damage in case of *Adisura atkinsoni* in field bean (Mallikarjunappa and Rajagopal,1991) and *Cydia ptychora* in soybean (Abhilash and Patil, 2008). The results in the table also revealed that the reduction in grain weight increased with larval density. The seed weight in different treatments ranged from 12.26 to 21.37 g per plant (92.60 to 272.19 kg/ha) (Table 2). The correlation between the number of larvae/plant and the seed weight was negative and significant (r= -0.85).

Statistical analysis revealed that the correlation between larval population and reduction in seed weight per plant was positive and significant (r = 0.85) and from regression analysis it was found that larval intensity vs per cent reduction in yield over control was y = 20.56 + 10.52 x. That is per cent reduction in yield per incremental larvae was 10.52. The equation for larval intensity vs seed weight was y = 10.54 - 1.43 x. *i.e.* reduction in seed yield per incremental

Table 1: Capsule damage as influenced by different larval population of *H. armigera*

Treatment	Capsule damage (%)		
	2010-11	**2011-12**	**Pooled**
1 larva/plant	8.62 (16.90)	8.52 (16.83)	8.42 (16.86)
2 larvae/plant	18.75 (25.57)	20.37 (26.71)	19.42 (26.14)
3 larvae/plant	23.75 (29.13)	24.07 (29.31)	23.86 (29.13)
4 larvae/plant	28.25 (32.07)	27.90 (31.82)	28.02 (31.94)
5 larvae/plant	38.75 (38.47	36.60 (37.17)	37.63 (37.82)
No larva/plant	0.0	0.0	0.0
Season means	**16.10**	**16.10**	
	SEm±	**CD (P=0.05)**	
Means	**0.35**	**NS**	
Treatments	**0.89**	**2.56**	
S x T	**1.25**	**0.00**	

CV (A) = 7.17 CV (B) = 10.61
Figures in parenthesis are arc sin transformed values

Table 2: Tobacco seed weight as influenced by different larval population of *H. armigera*

Treatment	Seed weight (g/plant)		
	2010-11	**2011-12**	**Pooled**
1 larva/plant	7.55 (15.93)	7.80 (16.19)	7.67 (16.06)
2 larvae/plant	6.62 (14.90)	5.7 (13.76)	6.13 (14.33)
3 larvae/plant	6.45 (14.69)	6.49 (14.75)	6.47 (14.72)
4 larvae/plant	5.80 (13.92)	5.20 (13.14)	5.48 (13.53)
5 larvae/plant	4.60 (12.34)	4.47 (12.18)	4.52 (12.26)
No larva/plant	12.50 (20.67)	14.17 (22.08)	13.30 (21.37)
Season means	**7.07**	**7.02**	
	SEm±	**CD (P=0.05)**	
Season means	**0.20**	**0.0**	
Treatment means	**0.34**	**0.99**	
S x T	**0.49**	**0.0**	

CV (A) = 6.25 CV (B) = 6.31
Figures in parenthesis are arc sin transformed values

larvae was 1.43/plant. The per cent reduction in seed weight caused by single third instar larvae per panicle was 40.23 compared to 0 in fully protected control. The equation for larval intensity vs capsule damage was, y = 1.60 +7.18 x *i.e.*, per cent capsules damaged per incremental larvae was 7.18/larva. The yield loss caused by single third instar larva was 100 kg/ha in 2010-11 and 116 kg/ha in 2011-12.

In the computation of EIL, the following results were obtained based on the procedure given by Stone and Pedigo (1972) and modified by Ogulana and Pedigo (1974).

Table 3: R reduction in seed weight (%) over control as influenced by different larval population of *H. armigera*

Treatment	Reduction in seed weight/plant		
	2010-11	2011-12	Pooled
1 larva/plant	38.87 (38.87)	44.70 (40.23)	41.75 (40.23)
2 larvae/plant	46.24 (42.79)	58.75 ((50.15)	52.61 (46.47)
3 larvae/plant	47.24 (43.38)	53.32 (46.90)	50.28 (45.14)
4 larvae/plant	52.63 (46.50)	62.82 (52.49)	57.85 (49.49)
5 larvae/plant	62.92 (52.52)	65.82 (54.25)	64.47 (53.98)
No larva/plant	0.00 (0.00)	0.00	0.000.0
Season means	36.73	42.99	
	SEm±	**CD (P=0.05)**	
Season means	**1.31**	**0.00**	
Treatment means	**1.21**	**3.49**	
S x T			

CV (A) = 16.39 CV (B) = 8.73

Figures in parenthesis are arc sin transformed values

EIL = Grain threshold / Yield reduction per larvae

Grain threshold = Management cost (Rs/ha) / Market value of grain (Rs/q)

Cost of one spray with flubendiamide (Fame 480 SC) @ 60 g a.i./ha for the management of *H. armigera* = Rs.1600 +330 = 1930

Market value of grain (Rs/q) = 1400

EIL= 1.37/1.43 = 0.95. one III instar larva/ panicle.

The tobacco seed yield loss in var. Siri due to a single third instar larva per panicle was found to be 116 kg/ha and the EIL was worked out as one third instar larva per panicle. The present findings are in conformity with those on chick pea (Zahid *et al.*, 2008) where an yield loss of 155-157 kg/ha of chickpea was reported when infested with one third instar larva of *H. armigera* per meter row and the EIL was determined as 0.95 larva per meter row. In pigeonpea, Meenakshisundaram and Gujar (1998) reported that one larva per plant reduces 4.95 green pods, 7.05 dry pods, 18.01 grains, 3.79 g pod weight and 2.05 g grain/plant. A unit increase in larva per plant resulted in 2.61 and 4.93% increase in pod damage at green and dry stages, respectively. Das *et al.* (2004) recorded a yield loss of 73.34, 37.78 and 55.47 kg/ha for each unit increase in *H. armigera* larval population and for every unit increase in green pods, dry pods and grain damage, respectively. In sunflower, Maragal (1990) reported that due to *H. armigera* infestation an average grain weight loss/capitulum ranged from 35-40 g and a loss of 8.49 - 9.32% and EIL 0.8 - 1 larva/capitulum due to the pest. All these studies ascertain that the procedure followed has correctly predicted the yield loss at specific larval population density. The present studies will provide dependable season specific values for EIL of the pest, which will help in decision making for management of *H. armigera* on tobacco seed crop. In estimating the EIL, a number of components can change the equation. These are price of the produce, cost of application and the efficacy of treatment. Hence, seasonally adjusted values for the price of tobacco seed and cost of application could provide dependable season specific values for the EIL.

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