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Determination of economic injury level for *Helicoverpa armigera* Hubner on *Bt* cotton

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ABSTRACT: A field experiment on determination of economic injury level for *Helicoverpa armigera* on *Bt* cotton hybrid (NCS 145 BG I) was conducted in nylon net house for two consecutive years (*Kharif*, 2008 and 2009) at Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, *H. armigera* 3rd instar larvae (@ 1 to 5/ plant) were released at 90, 110 and 125 days after germination in separate sets of experiments. The results indicated that the damage potential of 0.96 to 1.69 and 1.80 to 3.08 per cent of green fruiting bodies/larva with survival up to 28 to 34 and 28 to 36 days after release during 2008– 2009 and 2009–2010 was noticed, respectively. An average EIL of 2.71 larvae/ plant for *H. armigera* was worked out on *Bt* cotton.

Key words: *Bt* cotton, economic injury level, *Helicoverpa armigera*

Bt cotton is widely grown in India, since 2002, which offered protection against bollworms. It helps to sustain millions of resource poor farmers and rural communities. The American bollworm, *Helicoverpa armigera* was most serious pest of conventional cotton, now it becomes a minor pest of *Bt* cotton. However, large scale use of *Bt* cotton throughout the country by ignoring the refugia (non *Bt*), the workers reported survival of H. armigera on *Bt* cotton (Gujar *et al.,* 2011, Kolhe *et al.,* 2012). This pest also indicated resistance against Cry 1Ac expressing *Bt* cotton in China under field conditions (Liu *et al.,* 2008 and Liu *et al.,* 2010). Hence, it is necessary to work out the economic damage level of H. armigera on *Bt* cotton for undertaking management decision.

The assessment of insect damage and concept of development of economic injury level (EIL) is one of the IPM principle (European Commission, 2009 a, b ; Damos and Soultani , 2012). The EIL is further used to define the economic threshold, which is the operational criterion used by plant protection advisors and farmers to define the population density at which control measures should be initiated to prevent an increasing pest population from reaching the EIL (Pedigo *et al.,* 1996). Besides the effective management of the pests, EIL also facilitate judicious and need based use of chemical insecticides. Looking to these points the present investigation was undertaken to assess the economic injury level (EIL) of *H. armigera* infesting *Bt* cotton.

MATERIALS AND METHODS

A field experiment was conducted in randomized block design with 6 treatments and four replications on NCS 145 BG I hybrid for two consecutive years (*kharif,* 2008 and 2009) at Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra. The plot size was 3.60 x 1.80 m and 3.60 x 2.70 m whereas; row to plant spacing was 120 x 60 cm and 120 x 90 cm during *kharif,* 2008 and 2009, respectively. These spacing are widely adopted by the farmers in Vidarbha region, hence variations in damage level, if any, the different spacing was considered at each year. All agronomical practices were undertaken as per recommendations. Three foliar sprays of recommended systemic insecticides were undertaken as a cover spray against major sucking pests. From the beginning, field experiment was conducted under fine nylone net house, erected with help of bamboos to prevent entry/exit of bollworms larvae/ infestation. Three similar sets of field experiment were conducted separately during aforesaid years to release the larvae of *H. armigera* at 90, 110 and 125 days after sowing, respectively. The third instar larvae collected from most preferred weed host *kapalphodi* (*Cardiospermum helicacabum* L.) were released @ 0, 1, 2, 3, 4 and 5 larvae/plant in each treatment plot and replicated four times. Soon after the release of the larvae in respective set, the observations on survival of larvae (No./ plant) and their damage to green fruiting bodies (%) in each plot was recorded at biweekly interval till the larval population lasts. The data was then consolidated and cumulative mean was worked out separately for each set of experiment. Similarly, seed cotton yield was also noted and damage potential of larva was also worked out.

The EIL is based on the relation of five primary variables and can be estimated according to the following formula EIL = C/ VIDK, in which C represents the cost of management tactic/production unit, V is the price of commodity, I is the injury units/pest, D is the damage/unit of insect injury, and K is the proportionate reduction of injury averted by the application of a tactic (Buntin, 1996 ; Damos and Soultani, 2012 and Damos, 2014).

The variables I and D are related to each other and are the biological characteristics of the function by representing the yield loss associated/pest. The parameters D and I can be obtained from the slope of the yield, or damage function (Y = a + bx), where Y = yield loss; a = 0, x = number of pests/sampling unit; and b = yield loss/pest, representing the loss/ insect, which is equal to I*D or D' (Damos and Soultani, 2009).

The cost of seed cotton, insecticides and their application cost was considered as per existing market rates.

RESULTS AND DISCUSSION

During *kharif,* 2008, per cent damage to green fruiting bodies in various treatment plots where 1, 2, 3, 4 and 5 larvae/ plant were released at 90, 110 and 125 days after sowing (DAS) was significantly higher (0.91 to 3.85 , 1.49 to 6.07 and 2.67 to 5.58 per cent, respectively) than control plot (0.00 %) where no larvae were released. (Table 1).

At 90 DAS, damage in the treatment plots where 1, 2 and 3 larvae/ plant released was lowest (0.91 to 1.88 %) and being *on par* followed by statistically equal treatment plots with 4 and 5 larvae/plant released (3.46 to 3.85 %). The release of 1 larva/plant in treatment plot at 110 DAS was significantly superior over rest of the treatments in terms of per cent damage. The treatment plot with 2 and 3 larvae/ plant were equal followed by the plots with 4 and 5 larvae/plant. At 125 DAS, the per cent damage in green fruiting bodies amongst various treatment plot was *on par* with each other. The correlation between number of larvae/plant and per cent damage was positive and significant with "r" value of 0.97 and 0.91 at 90 and 110 DAS, respectively. At 125 DAS, the correlation between number of larvae/ plant and per cent damage was positive and non significant.

The seed cotton yield in various treatment plots including control did not differed significantly, however, there was 21.95 to 32.18 , 0.29 to 22.12 , 20.64 to 31.08 per cent reduction in yield over control was noticed at 90, 110 and 125 DAS, respectively. The correlation between number of larvae/ plant and seed cotton yield was negative and significant with "r" value of - 0.94 and - 0.93 at 90 and 125 DAS, respectively. The correlation between number of larvae/ plant and per cent reduction in yield over control was positive and significant with "r" values of 0.94 and 0.93 at 90 and 125 DAS, respectively. However, at 110 DAS, the correlation between number of larvae/ plant and seed cotton yield as well as per cent reduction in yield over control was non-significant. From the regression equation, yield reduction/larva (b) 0.56, 0.74 and 0.63 at 90, 110 and 125 DAS, respectively with gain threshold value of 1.47 was calculated. Hence, EIL of 2.63, 1.99 and 2.33 larvae/ plant at 90, 110 and 125 DAS, respectively was worked out with an average of 2.32 larvae/ plant during *kharif*, 2008.

In *kharif* 2009, per cent damage to green fruiting bodies in control plot where no larvae released (0.00%) was differed significantly from the treatment plots where 1, 2, 3, 4 and 5 larvae/ plant released at 90, 110 and 125 DAS. Such damage in treatment plots at 90, 110 and 125 DAS was ranged between 2.16 to 5.92, 3.69 to 12.98 and 3.39 to 11.28 per cent, respectively (Table 1).

At 90 DAS, per cent damage in treatment plots which received 1 and 2 larvae/ plant were on par and lowest (2.16 to 3.88 %) followed by the treatment plots which received 3, 4 and 5 larvae/ plant (4.27 to 5.92 %). The treatment plots where 1 and 2 larvae/ plant released were *on par* and significantly superior over equal treatment plots where 3 and 4 larvae/ plant released followed by treatment plot where 5 larvae/ plant was released at 110 DAS. At 125 DAS, the plots released with 1 and 2 larvae/ plant noted lowest damage (3.39 and 4.45 %) and was *on par* followed by rest of the treatments (7.54 to 11.24 %). The correlation between number of larvae/ plant and per cent damage was positive and significant with "r" of 0.94, 0.98 and 0.99 at 90 , 110 and 125 DAS, respectively.

The data on cotton yield in various treatment plots including control plot was *on par*, however, the reduction in cotton yield over control was ranging between 28.33 to 68.21 ,

Table 1. Per cent *H. armigera* damage and yield of seed cotton in *Bt* cotton during 2008-2009 and 2009-2010

No. of larvae released/ plant	*Kharif* 2008-2009										*Kharif* 2009-2010									
	H. armigera damage in green fruiting bodies (%)			Mean damage potential/ larva (%)	Seed cotton yield (q/ha)			Per cent yield reduction over control			*H. armigera* damage in green fruiting bodies (%)			Mean damage potential/ larva (%)	Seed Cotton Yield (q/ha)			Per cent yield reduction over control		
	90 DAG	110 DAG	125 DAG		90 DAG	110 DAG	125 DAG	90 DAG	110 DAG	125 DAG	90 DAG	110 DAG	125 DAG		90 DAG	110 DAG	125 DAG	90 DAG	110 DAG	125 DAG
1	0.91 (0.93)	1.49 (1.19)	2.67 (1.54)	1.69	7.09	6.70	6.36	8.04	3.21	5.71	2.16 (1.46)	3.69 (1.92)	3.39 (1.76)	3.08	4.88	3.48	3.21	28.83	21.67	19.31
2	1.82 (1.34)	3.81 (1.94)	4.19 (2.01)	1.64	6.98	6.91	6.16	6.35	0.29	2.31	3.88 (1.93)	5.02 (2.24)	4.85 (2.18)	2.29	4.44	3.06	2.37	35.25	31.05	40.52
3	1.88 (1.35)	5.69 (2.37)	5.58 (2.26)	1.46	5.12	6.84	4.62	21.95	1.28	23.21	4.27 (1.99)	7.89 (2.78)	7.54 (2.74)	2.18	3.57	2.99	2.34	47.86	32.62	41.29
4	3.46 (1.85)	6.07 (2.46)	3.78 (1.84)	1.11	4.65	6.26	4.78	29.16	9.59	20.64	4.35 (2.07)	8.74 (2.95)	8.52 (2.88)	1.80	3.40	2.96	2.07	50.34	33.48	47.91
5	3.85 (1.89)	6.07 (2.45)	4.47 (2.09)	0.96	4.45	5.39	4.15	32.18	22.12	31.08	5.92 (2.39)	12.98 (3.58)	11.24 (3.30)	2.00	2.18	2.73	2.17	68.21	38.52	45.43
Control (No release of larvae)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)		6.57	6.93	6.02				0.00 (0.00)	0.00 (0.00)	0.00 (0.00)		6.85	4.44	3.98	-	-	-
SE (m+)	0.19	0.15	0.23		1.15	0.48	0.70				0.158	0.125	0.281		0.97	0.88	0.51			
C.D. (p=0.05)	0.59	0.44	0.68		-	-	-				0.477	0.376	0.886		-	-	-			

Figures in the parenthesis are square root values

21.67 to 38.52 and 19.31 to 47.91 per cent at 90, 110 and 125 DAS, respectively. The correlation between number of larvae/ plant with seed cotton yield was negative and significant with "r" value of -0.98 and -0.93 at 90 and 110 DAS, respectively and the correlation between number of larvae/ plant and reduction in cotton yield over control was positive and significant with "r" value of 0.98 and 0.93 at 90 and 110 DAS, respectively. However, the correlation of number of larvae/ plant with seed cotton yield and as regards reduction in cotton yield over control was non significant at 125 DAS. From the regression equation, yield reduction/larva (b) was 0.42, 0.45 and 0.30 at 90, 110 and 125 DAS, respectively with gain threshold value of 1.17 was calculated. Hence, EIL of 2.81, 2.62 and 3.85 larvae/ plant at 90, 110 and 125 DAS, respectively was worked out with an average of 3.09 larvae/ plant in *kharif*, 2009.

After averaged out of EIL during the both years, an EIL of 2.71 larvae/ plant for *H. armigera* was worked on *Bt* cotton. These finding are in the agreement with work conducted by Alavi and Gholizadeh (2010) who reported EIL of *H. armigera* for the first, second and third generations were 2.23, 1.58 and 2.13 neonate larvae/plant, respectively. However, in the present study third instar larvae were used to determine EIL.

The data in Table 1 indicated that due to release of *H. armigera* 3rd instar larvae @ 1 to 5 larvae/ plant at 90,110 and 125 DAS can cause damage up to 6.07 and 12.98 per cent with 0.29 to 32.18 and 19.31 to 68.21 per cent reduction in cotton yield during 2008-2009 and 2009-2010, respectively and average damage potential of 0.96 to 1.69 and 1.80 to 3.08 per cent/ larva was computed on *Bt* cotton at 90 to 125 DAS, during 2008-2009 and 2009-2010, respectively. The yield in the present study was non significant may be due to the effectiveness of transgenic cotton against *H. armigera*, however, yield reductions was noted with increase in larval population as per the treatments. The yield cannot be compared due to limited work on EIL of *H. armigera* on *Bt* cotton.

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