Indian Journal of Entomology 86(3): 963-965 (2024) DoI. No.: 10.55446/IJE.2023.1298

ECONOMIC THRESHOLD LEVEL FOR GRAM POD BORER IN CHICKPEA

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ABSTRACT

The economic threshold level is the key decision-making tool in any IPM programme. A field experiment was conducted to determine the economic threshold level for gram pod borer *Helicoverpa armigera* (Hubner) in chickpea at Agricultural Research Station, Anand Agricultural University, Derol, Dist. Panchmahals, Gujarat, India during the rabi in 2016-17, 2017-18 and 2018-19. The economic injury level for *H. armigera* was found to be 0.67 larva/ plant, whereas the economic threshold level was 0.60 larva/ plant.

Key words: *Helicoverpa armigera*, economic injury level, economic threshold level, chickpea, gram pod borer, IPM,larva per plant, infestation

Chickpea is an important rabi season pulse crop in Gujarat state. The major reasons for low yield of chickpea are biotic and abiotic stresses prevalent in different growing areas of the country. Biotic stresses of more than 50 pathogens, including viruses, and 54 insect pests have been reported on chickpea from different parts of the world (Vanrheenen, 1991; Kumar et al., 2008). The gram pod borer *Helicoverpa armigera* (Hubner) is the single most important limiting factor in chickpea production, which deters the farmers from growing chickpea. It causes 10-60% loss in yield (Srivastava, 2003). IPM is the most effective tool for the management of *H. armigera*. Economic thresholds level (ETL) is one of the cornerstones of IPM and it is the key decision-making tool. The ETL would reduce unnecessary use of management tactics in general and insecticides in particular (Chiranjeevi and Patange, 2017). The ETL is defined as the pest population density at which control measures should be initiated to prevent an increasing pest population from exceeding the economic injury level (EIL). Theoretically, ETL is highly variable as it depends on the cost of insecticide treatment, damage and market value of the final product. Because of its variable nature, there is a need to determine the ETL for the middle Gujarat Agroclimatic Zone and hence the present study determine the ETL.

MATERIALS AND METHODS

The study was carried out at the Agricultural Research Station, Anand Agricultural University, Derol, Dist. Panchmahal, Gujarat, India. The experiment was conducted during rabi 2016-17, 2017-18 and 2018-19. The experiment was laid out in a randomized block design with four replications. The variety was GG 1 and the spacing was 45 x 10 cm. The gross plot size was 5.0 x 3.6 m, whereas the net plot size was 4.6 x 2.7 m. All agronomic practices were followed to raise the crop. There were six treatments consisting of different larval population densities viz., (1) Spray application of insecticide at ≥ 0.25 larva of *H. armigera* per plant, (2) Spray application of insecticide at ≥ 0.50 larva of *H. armigera* per plant, (3) Spray application of insecticide at ≥ 0.75 larva of *H. armigera* per plant, (4) Spray application of insecticide at ≥ 1.00 larva of *H. armigera* per plant, (5) Spray application of insecticide at ≥ 1.25 larva of *H. armigera* per plant and (6) Control (No application of insecticides).

To record the observations on the larval incidence 10 plants were randomly selected from each net plot area and the number of larvae was counted. Based on this mean value/ plant was calculated. These were with the value of larval density fixed for the respective treatment. If the mean larval cocint was higher or equal to the fixed value for that treatment, the spray application of flubendiamide 480SC 0.01% (2 ml/ 10 ℓ water, 48 g a.i./ ha) was carried out in all four plots for that treatment. In the remaining plots spray was not applied. Every week, the mean larval count were taken and compared with a fixed value for that treatment and based on that decision to spray was made. During all three years, the spray application of insecticide in the treatment of ≥ 1.00 and 1.25 was not done as the larval counts remained low. Before the harvest, 10 plants were randomly selected from each net plot area and the number of healthy as well as damaged pods was counted. Based on that % pod damage was calculated. Yield gain for each treatment was worked out by deducting the yield of control (where no spray was carried out) from the yield of the respective treatment. The value of yield gain (monetary gain) was calculated based on the wholesale market price. Benefit-cost ratio (BCR) was worked out as the ratio of the monetary gain to the cost of insecticidal application. Based on this, regression equation Y = a + bX, was fitted between larval incidence and BCR (Zahid et al., 2008). The larval density corresponding to a BCR value of 1.00 was considered an economic injury level. The economic threshold level was fixed at the 90% of economic injury level (Riley, 2004).

RESULTS AND DISCUSSION

The data on pod damage due to *H. armigera* in chickpea are given in Table 1. Results show that during the year 2016-17, significantly lower pod damage (1.62%) was recorded in treatment with a spray application of insecticide at the larval population density of ≥ 0.25 larva/ plant, whereas higher pod damage of 10.16% was observed in control. The % pod damage significantly increased with the rise in larval density. Almost similar results were obtained during 2017-18 and 2018-19 as well as in pooled analysis. Data on chickpea grain yield given in Table 1 reveal that during 2016-17, a significantly higher grain yield (2104 kg/ ha) was obtained with insecticide at ≥ 0.25 larva of *H. armigera*/ plant which was at par with spray of insecticide at ≥ 0.50 larva of *H. armigera* per plant (2067 kg/ ha) and spray application of insecticide at ≥ 0.75 larva of *H. armigera*/ plant (2009 kg/ ha). During 2017-18, grain yield was not significantly affected by treatments. In the year 2018-19, a significantly higher grain yield (2024 kg/ ha) was recorded with insecticide at ≥ 0.25 larva/per plant and it was at par with a spray application of insecticide at ≥ 0.50 larva/ plant (1972 kg/ ha) and spray of insecticide at ≥ 0.75 larva of *H. armigera*/ plant (1914 kg/ ha). Pooled analysis indicated that significantly higher grain yield was obtained with insecticide at ≥ 0.25 larva of *H. armigera* per plant (2045 kg/ ha) which was at par with spray application of insecticide at ≥ 0.50 larva of *H. armigera* per plant (2003 kg/ ha); whereas significantly lower grain yield was obtained in control (1867 kg/ ha). EIL lies at the pest population where BCR would be 1.00 (Table 2). In order to determine EIL, a regression equation Y = a + bX was fitted between larval population levels and BCR. The regression equation derived was: Y = 0.6533 + 0.52X, where, X= larval population per plant, Y = BCR (Fig. 1). Thus, EIL was calculated as 0.67 larva/ plant. As per the reports of Riley (2004), the ETL can be fixed at 90% of EIL. Based on this, ETL of *H. armigera* in chickpea is 0.60 larva/ plant.

Earlier, several researchers established ETL for *H. armigera* in chickpea. Reddy et al. (2000) conducted field studies in Delhi during 1992-94 and calculated the ETL for *H. armigera* in chickpea at 0.74 larva/ meter. Zahid et al. (2008) also reported this as 0.81 larva/ meter. Akanksha and Singh (2018), based in

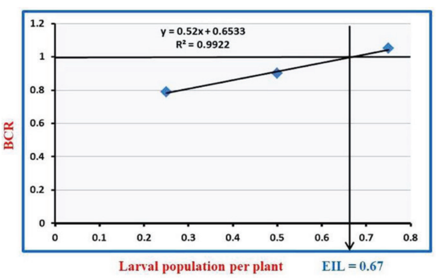

Fig. 1. Relationship between larval population and benefit cost ratio (BCR)

Table 1. Pod damage by *H. armigera* and grain yield of chickpea in treatments (pooled data)

Sr. No.	Treat-ments	Pod damage (%)			Pooled	Grain yield (kg/ ha)			Pooled
		2016-17	2017-18	2018-19		2016-17	2017-18	2018-19	
1	≥ 0.25	1.42#(1.62)	1.35(1.34)	1.58(2.00)	1.45(1.60)	2104	2008	2024	2045
2	≥ 0.50	1.72(2.46)	1.44(1.59)	1.91(3.13)	1.69(2.35)	2067	1968	1972	2003
3	≥ 0.75	2.36(5.24)	2.13(4.13)	2.35(5.04)	2.28(4.71)	2009	1910	1914	1944
4	≥ 1.00	3.07(9.11)	3.32(10.56)	3.60(12.45)	3.33(10.59)	1921	1840	1836	1866
5	≥ 1.25	3.25(10.08)	3.22(9.89)	3.67(13.00)	3.38(10.95)	1917	1821	1827	1855
6	Control+	3.24(10.16)	3.26(10.13)	3.53(11.96)	3.34(10.66)	1910	1850	1842	1867
SEm (±)	T	0.18	0.12	0.20	0.09	50	76.15	47.80	31.04
	Y	--	--	--	0.07	--	--	--	24.21
	T x Y	--	--	--	0.17	--	--	--	59.31
CD	T	0.53	0.35	0.60	0.26	150	NS	144.08	87.99
(p=0.05)	T x Y	--	--	--	NS	--	--	--	NS
CV %		13.97	9.45	14.44	13.00	5.00	8.02	5.02	6.15

#Figures outside parentheses $\sqrt{X+0.5}$ transformed values and those inside retransformed values; +No spray was made; larva/ plant

Table 2. Economics application of insecticide in chickpea

Sr. No.	Treatment	Quantity of insecticides required (litre/ ha)	Total No. of Sprays	Total cost of treatments including labour (Rs.)	Yield (kg/ ha)	Value of yield saved (Rs./ ha)	BCR
1	≥ 0.25	0.1	3	8376	2045	6580	0.79
2	≥ 0.50	0.1	2	5584	2003	5038	0.90
3	≥ 0.75	0.1	1	2792	1944	2944	1.05
4	≥ 1.00	-	-	-	1866	-	-
5	≥ 1.25	-	-	-	1855	-	-
6	Control+	-	-	-	1867	-	-

(1) Labour charge @ Rs. 318.4/ day x 2 labours = 636.8 Rs/ha and Rs. 178/ day x 2 labours= 356, 636 + 356 =992 Rs./ spray; (2) Price of chickpea grain Rs. 36/- per kg.; (3) Cost of insecticides (flubendiamide 480 SC) 18000 Rs./ ℓ; larva/ plant; + no spray

Punjab, calculated this as 1.56 larvae/ meter. According to Sousa et al. (2020), the EIL for tomato infested by *H. armigera* during 2017 and 2018 was 1.41 to 1.72 and 2.11 to 2.58 larvae/ metre, respectively. Singh et al. (2021) determined that the EIL and ETL of *H. armigera* in chickpea were 2.35 and 1.76 larvae/ metre, respectively. The ETL of *H. armigera* in sunflower was found 0.77 larva/ plant by Gore et al. (2021). According to Ogunlana and Pedigo (1974), for a given plant variety in a particular geographical area, the ETL would change with any change in: (1) the market value of the crop, (2) the cost of artificial control measures, and (3) the environment of the plant and the insect. Hence, the present findings might be useful to chickpea growers of the region in deciding the time of application of chemical insecticides for the management of *H. armigera.*

ACKNOWLEDGEMENTS

The authors thank the Director of Research and Dean, Post Graduate Studies, Anand Agricultural University, Anand for providing necessary facilities. The authors also thank the Unit Head, Agricultural Research Station, Anand Agricultural University, Derol for providing necessary facilities.

FINANCIAL SUPPORT

Anand Agricultural University, Anand, Gujarat (India).

CONFLICT OF INTEREST

No conflict of interest.

AUTHOUR CONTRIBUTION STATEMENT

All authors equally contributed.

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(Manuscript Received: May, 2023; Revised: September, 2023;
Accepted: September, 2023; Online Published: September, 2023)
Online First in www.entosocindia.org and indianentomology.org Ref. No. e23298