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Determine the economic threshold level for *Helicoverpa armigera* Hubner infesting sunflower

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Abstract
Effective and economic suppression of insect pests in sunflower ecosystem by the judicial use of pesticides on the basis of economics threshold levels (ETL) is very essential. Investigations on economic threshold level for *Helicoverpa armigera* Hubner were carried out in College of Agriculture Latur, Maharashtra during *rabi*, 2020. On the basis of equality of management cost and revenue of sunflower yield which was saved from pest damage as suggested by Stone and Pedigo (1972) [12] and further modified by Ogunlana and Pedigo (1974) [6], the Economic Threshold Level worked out for *H. armigera* on sunflower was 0.77 larvae/plant.

Keywords: economic threshold level, *Helicoverpa armigera* Hubner, sunflower

Introduction
Sunflower (*Helianthus annuus* L.) belongs to family Compositae or Asteraceae originated in Mexico and Peru, introduced into India in 16th century. Sunflower is one of the important oilseed crops. Sunflower also known as "Surajmukhi" and grown in all the seasons of the country. Sunflower contains 32 to 44 per cent oil, 20 to 24 per cent vitamins, 18 to 22 per cent carbohydrates and 4 to 6 per cent salts. Its oil is considered as premium because of its high polyunsaturated fatty acid content with high level of Linoleic acid and absence of linolenic acid. Its oil contains high percentage of poly-unsaturated fatty acids (60 per cent), accepted largely in diet to reduce cholesterol in blood and prevents heart diseases (Razi and Assad, 1998) [8]. The high stearic-high oleic sunflower oils are utilized in variety of food formulations, including fillings, spreads, coatings and confectionary products (Salas *et al*., 2015) [10]. Sunflower stalks and their liquors are potential inducing sources for the xylanase production, compared with the commercial purified xylan (Sousa *et al*., 2020) [11].
Key insect pest, capitulum borer alone causes up to 50% yield loss by directly inflicting damage to flower buds, ovaries and developing seeds (Lewin *et al*., 1973) [5]. Crop loss due to capitulum borer is more if star bud and bloom stage of the crop coincides with peak activity of the pest. Panchabhavi and Krishnamurthy (1978) [7] reported yield loss of 120 kg/ha due to *H. armigera* damage in Karnataka. Now-a-days economic damage levels caused by insects and their impacts on crop production are the most discussed parameters in the insect management. The economic threshold level is the basic concept for decision making in integrated pest management programs. The economic thresholds would reduce unnecessary use of management tactics in general and insecticides in particular (Chiranjeevi and Patange, 2017) [3]. Therefore, the present study was aimed to work out the economic threshold level for *H. armigera*, the key pest of sunflower.

Material and Methods
The experiment was carried out at the research farm of Department of Agricultural Entomology, College of Agriculture, Latur during *Rabi*, 2020 to determine economic threshold level for *H. armigera* infesting sunflower. The variety Morden was sown on 9th November, 2020 with 60x30cm^2 row to plant spacing, 4.8x4.5m^2 plot size in R.B.D. Insecticide used for spraying was Quinalphos 25 EC @ 1000 ml/ha. Detailed spray schedules given below.

Detailed spray schedules given below

Spray Schedule			
Tr. No.	**Treatment**	**Spray schedule**	**Tentative (DAE)**
T1	Control	Without any spray (Untreated)	---
T2	1 Spray	Before button stage	30
T3	2 Sprays	Before button stage, 15 days after 1st spray	30, 45
T4	3 Sprays	Before button stage, 15 days after 1st spray, 30 days after 1st spray,	30, 45, 60
T5	4 Sprays	Before button stage, 15 days after 1st spray, 30 days after 1st spray, 45 days after 1st spray. (Complete Protection)	30, 45, 60, 75

DAE* Days after emergence.

Five plants from each treatment were selected and labeled for recording observations on *H. armigera*. The number of eggs laid by *H. armigera* per plant as well as the larval count per plant from each treatment was recorded from selected observation plants before each spray and 1, 3, 7, 10 days after the spray was recorded and from this mean was be worked out.

Yield

- The yield of net plot from each treatment was converted to quintal per hectare. The 'additional yield' for each treatment was worked out by subtracting the yield of control plot from the yield of treatment. The value of additional yield was considered as 'revenue'.
- Cost of insecticide application (cost of insecticide, labour charge, rent of sprayer etc.) and price of sunflower declared by Govt. of Maharashtra/market price for the year was used for calculating the ETL Gautam *et al.* (2013) [4].
- The EIL was determined as suggested by Stone and Pedigo (1972) [12] and further modified by Ogunlana and Pedigo (1974) [6]. The economic threshold level (ETL) was then calculated as 75% of EIL Gautam *et al*. (2013) [6].

Mathematical procedures & Steps

$$\text{Gain threshold (GT)} = \frac{\text{Management cost (Rs/ha)}}{\text{Market value (Rs/Qtl)}}$$

$$\text{Calculated Economic injury level (EIL)} = \frac{\text{Gain threshold (Qtl/ha)}}{\text{Regression coefficient}}$$

Regression coefficient were worked out between yield and pest data using WASP 2.0 statistical analysis software.

Actual Economic injury level = Calculated EIL +UI.

Where,
UI = Unavoidable infestation observed in complete protection treatment.

Management cost = Cost of insecticide application.

Final ETL for the pest was determined based on equality of management cost and revenue of sunflower yield which was saved from pest damage.

Table 1: Computation of gain threshold, EIL and ETL on the basis of number of *Helicoverpa armigera* on sunflower

TN	Quinalphos 25 EC @ 1000 ml/ha.	Sunflower price (Rs/q)	Gain threshold (q/ha)	EIL No of larva/Plant	Actual EIL	ETL No of larva/Plant	Mean number of pest infestation	Yield (q/ha)	Additional yield (q/ha)	Revenue (Rs.)	Protection Cost (Rs.)
T1	Untreated control	4000	0.00	0.00	0.00	0.00	1.5	15.64	0.00	00	00
T2	1 Spray	4000	0.76	0.18	0.68	0.51	1.1	16.80	1.16	4640	3025
T3	2 Sprays	4000	1.51	0.35	0.85	0.64	0.8	17.80	2.16	8640	6050
T4	3 Sprays	4000	2.27	0.53	1.03	0.77	0.8	18.02	2.38	9520	9075
T5	4 Sprays	4000	3.03	0.71	1.21	0.91	0.5	20.18	4.54	18160	12100

In present investigation on determination of ETL, the EIL was determined as suggested by Stone and Pedigo (1972) [12] and further modified by Ogunlana and Pedigo (1974). The economic threshold level (ETL) was then calculated as 75% of EIL. The data from Table revealed that mean *H. armigera* population per plant in untreated control treatment was 1.5, while it was 1.1 for treatment T1 (one spray) which goes on reducing and in treatment T5 (four sprays) the *H. armigera* population reported was 0.5 per plant. The regression equation obtained for number of *Helicoverpa armigera* was Y = 21.710 + (-4.279) X+0.530. The value of actual EIL varies from 0.68 *H. armigera* per plant for one spray to 1.21 *H. armigera* per plant for four sprays. The value of ETL ranged from as low as 0.51 *H. armigera* per plant for one spray to as high as 0.91 *H. armigera* per plant for complete protection i.e. four sprays. On the basis of equality of management cost and revenue of sunflower yield which was saved from pest damage, the final ETL worked out was 0.77 *H. armigera* per plant of sunflower. The previous literature on determination of ETL for *H. armigera* in sunflower is wanting; hence the findings of present study cannot be discussed in the light of previous research work. However, the work on determination of ETL for *H. armigera* in other different crops was carried out by many scientists. Among them, Reddy *et al.* (2001) [9] reported 6.0 *H. armigera* larvae is the ETL in pigeonpea while Zahid *et al.* (2008) [13] computed 0.9 and 0. 73 *H. armigera* larvae per m row as the ETL in 2004-05 and 2005-06, respectively and Akanksha and Singh (2019) [1] computed 2.08 and 1.56 larvae per meter row, as the ETL during 2016-17 and 2017-18, respectively in chickpea. In tomato, Sousa *et al.* (2020) [11] determine the EIL for *H. armigera* infesting tomato crop as 1.41 to 1.72 and from 2.11 to 2.58 larvae per row meter of plants in 2017 and 2018 cropping seasons, respectively. In safflower, Biradarpatil and Jagginavar (2018)

[2] stated that the economic injury level of *H. armigera* was 0.53 larvas per plant for A-1 variety of safflower.

Conclusion

The value of actual EIL varies from 0.68 *H. armigera* larvae per plant for one spray to 1.21 *H. armigera* larvae per plant for four sprays. The value of ETL ranged from as low as 0.51 *H. armigera* larvae per plant for one spray to as high as 0.91 *H. armigera* larvae per plant for complete protection i.e. four sprays. On the basis of equality of management cost and revenue of sunflower yield which was saved from pest damage, the final ETL worked out was 0.77 *H. armigera* larvae per plant of sunflower.

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