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Efficacy of different insecticides against sunflower capitulum borer (*Helicoverpa armigera*)

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Abstract
A field experiment for the management of sunflower capitulum borer (*Helicoverpa armigera*),was conducted at the instructional farm, Department of Agronomy, College of Agriculture, Dapoli, Dist. Ratnagiri, during the *Rabi* 2021-22. Various insecticidal treatments including deltamethrin, emamectin benzoate, indoxacarb, lambda cyhalothrin, thiamethoxam, imidacloprid and azadirachtin were tested for their efficacy against sunflower capitulum borer. The overall larval population over control after two sprays revealed that the treatment deltamethrin 2.8 EC was superior and most effective treatment which recorded the least mean population 2.20 larvae per five selected plants followed by indoxacarb 14.5 SC with a larval population of 2.47. Then next best treatments were emamectin benzoate, lambda cyhalothrin, azadirachtin 1 per cent, imidacloprid and thiamethoxam with recorded larval populations of 2.77, 2.89, 3.24, 3.84, and 3.86 larvae per five selected plants respectively. However, all the treatments were significantly superior over control.

Keywords: Sunflower, capitulum borer, *Helicoverpa armigera*, insecticides, management

1. Introduction
Sunflower, *Helianthus annuus* (L.) is grown as an oilseed crop for its edible oil and edible fruits in temperate and tropical climate worldwide. Among oilseeds sunflower ranks fifth after soybean, rapeseed, cotton and peanuts. It belongs to the Asteraceae (Compositae) family. In Greek, helio means sun and anthos means flower. The flower is a clump of flowers pressed together in a head.

Sunflower can be grown throughout the year as it is a photo-insensitive crop. This crop is valuable from both an economic and a visual perspective. It is a rich source of edible oil containing about 40-52 per cent of good quality oil with 20-30 per cent of oleic acid and 55-65 per cent of linoleic acid which helps in reducing the risk of cardiac diseases. The oil cake prepared from sunflower is being used as cattle as well as poultry feed and it is abundant in high grade protein (40-44%). It also contains lecithin, tocopherols, and furfural among many other nutrients. It is also used in cosmetics and pharmaceuticals production.

In India the total area under oilseeds is about 19 per cent of the world's total area, but the total production of oilseeds of India is only 10 per cent of the world's total oilseeds production. After cereals oilseeds having the second largest share in agricultural commodity with 13 per cent of gross cropped area of the country which accounting 3 per cent of gross national product and 10 per cent of the value of all agricultural products (Shahbandeh, 2021) [9].

Despite of having the several high yielding varieties and hybrids the production of the sunflower crop is very low and the sunflower yields per hectare are lower than those obtained elsewhere in the world and the less productivity of the sunflower crop is due to several biotic and abiotic stresses. A large number of insect pests attacks the crop at different crop growth stages which leads to the reduction of productivity of the crop. Sunflower acts as a host for several insect pests, globally as many as 251 insect species have been observed on sunflower (Rajmohan, 1976) [8].

In India more than 50 insect species have been recorded damaging the sunflower crop at different crop growth stages. All the pests infecting sunflower are injurious to the sunflower crop. Sucking pests and defoliators combinely causes a yield loss upto 25 per cent. The sucking pests, defoliators, and head borer causes loss of yield upto 40 per cent while the capitulum borer (*H. armigera*) causes yield loss of upto 60 per cent. (Daliwal and Arora, 1994) [2].

Major insect pest, capitulum borer alone causes up to 50% yield loss by directly damaging the flower buds, ovaries and developing seeds (Lewin *et al.* 1973) [5]. Crop loss due to capitulum borer are more if star bud and bloom stage of the crop coincides with peak activity of the pest. The yield loss of 120 kg/ha due to *H. armigera* damage in Karnataka was reported by Panchabhavi and Krishnamurthy (1978) [7].
Several reports showing the results of different known insecticides used against capitulum borer So, these some newer insecticides should have to be checked against capitulum borer of sunflower for effective insect-pests management.

2. Materials and Methods

2.1 Location

The experiment for the management of sunflower capitulum borer (*Helicoverpa armigera*),was conducted at the instructional farm, Department of Agronomy, College of Agriculture, Dapoli, Dist. Ratnagiri, in field conditions during the *Rabi* 2021-22.

2.2 Experimental Details

An Experiment was laid on Randomized Block Design (RBD) with three replications. The experiment consisted of eight treatments and three replications during *Rabi* season of 2021-22 to study the efficacy of different insecticides against sunflower capitulum borer. Seven different insecticides *viz.*, Deltamethrin 2.8 EC, Emamectin Benzoate 5 SG, Indoxacarb 14.5 SC, Lambda Cyhalothrin 5 EC, Thiamethoxam 25 WG, Imidacloprid 17.8 SL and Azadirachtin 10000 ppm along with untreated control were evaluated. Morden variety of sunflower was used for the study.

2.3 Method and period of insecticide application

The quantity of spray suspension required for each treatment was calibrated by spraying water over the untreated controlled plot prior to application of insecticides. The spray suspension of desired strength of each insecticide was prepared and applied using manually operated knapsack sprayer. The spraying of insecticides was done twice. First spray of each insecticide was applied in February 2022 when the peak incidence of pest was noticed, while second spray was taken at an interval of 15 days after first spray in the month of March 2022.

2.4 Method of recording observations

The infestation of the sunflower capitulum borer (*H. armigera*) was recorded by counting the number of larvae present on the five randomly selected and marked plants from each treatment. The precount of number of larvae was taken one day before spraying, and after spraying on the second, seventh and fifteenth day was recorded. The observations at 15th day after first spray were considered as pre-count observations for second spray. Then an average pest population was calculated.

2.5 Statistical methods

The data obtained were subjected to square root transformation ($\sqrt{x+1}$) and statistically analyzed.

3. Results and Discussion

The efficacy of various tested insecticides against *H. armigera* showed the significant reduction in the larval population of *H. armigera* and the detailed results are presented below,

3.1 First spray

The data on the overall mean larval population of *H. armigera* per five selected plants after the first spray (Table 1.) indicated that among all the treatments, the treatment T_1- deltamethrin 2.8 EC @ 0.5 ml lit^{-1} was found to be the most effective, with a mean larval population of 2.68 larvae per five selected plants. The treatments T_3- indoxacarb 14.5 SC @ 0.5 ml lit^{-1} with a larval population of 3.01 and T_2- emamectin benzoate 5 SG @ 0.4 gm lit^{-1} with a 3.24 mean larval population was at par with each other. The treatment T_4- lambdacyhalothrin 5 EC @ 1.0 ml lit^{-1} recorded a 3.38 mean larval population and was at par with T_7- azadirachtin 1 % @ 2 ml lit^{-1} with 3.63 larvae per five selected plants, respectively. The treatments T_6- imidacloprid 17.8 SL @ 0.2 ml lit^{-1} with 4.47 and T_5- thiamethoxam 25 WG @ 0.4 gm lit^{-1} with 4.68 mean larval population were at par with each other while the greatest mean larval population of 4.71 per five selected plants was observed in T_8- untreated control.
The data revealed that the least larval population over untreated control was observed in treatment T_1- deltamethrin 2.8 EC (2.68) followed by T_3- indoxacarb 14.5 SC (3.01),T_2- emamectin benzoate 5 SG (3.24), T_4- lambdacyhalothrin 5 EC (3.38), T_7- azadirachtin 1 % (3.63), T_6- imidacloprid 17.8 SL (4.47) and T_5- thiamethoxam 25 WG (4.68).

3.2 Second spray

The data on the overall mean larval population of *H. armigera* per five selected plants after the second spray (Table 1.) indicated that among all the treatments, the treatment T_1- deltamethrin 2.8 EC @ 0.5 ml lit^{-1} was found to be the most effective, with a mean population of 1.73 larvae per five selected plants. The next best treatment was T_3- indoxacarb 14.5 SC @ 0.5 ml lit^{-1} with a larval population of 1.92 per five selected plants. The treatments T_2- emamectin benzoate 5 SG @ 0.4 gm lit^{-1} with a larval population of 2.30 and T_4- lambdacyhalothrin 5 EC @ 1.0 ml lit^{-1} with 2.40 mean larval population were at par with each other, while T_7- azadirachtin 1 % @ 2 ml lit^{-1} recorded 2.85 larvae per five selected plants. The treatment T_5- thiamethoxam 25 WG @ 0.4 gm lit^{-1} recorded a 3.32 mean larval population and was at par with T_6- imidacloprid 17.8 SL @ 0.2 ml lit^{-1} which recorded 3.45 larvae per five selected plants, respectively. The highest mean larval population of 4.71 per five selected plants was recorded in the untreated control.
The data revealed that the least larval population over untreated control was observed in treatment T_1- deltamethrin 2.8 EC (1.73) followed by T_3- indoxacarb 14.5 SC (1.92), T_2- emamectin benzoate 5 SG (2.30), T_4- lambdacyhalothrin 5 EC (2.40), T_7- azadirachtin 1 % (2.85), T_5- thiamethoxam 25 WG (3.32) and T_6- imidacloprid 17.8 SL (3.45).

3.3 Overall spray

The results regarding the overall mean population of *H. armigera* of two sprays (Table 1.) revealed that, the treatment T_1- deltamethrin 2.8 EC @ 0.5 ml lit^{-1} was found to be the superior amongst all treatments, which recorded the least mean population of 2.20 larvae per five selected plants followed by T_3- indoxacarb 14.5 SC @ 0.5 ml lit^{-1} with a larval population of 2.47 per five selected plants. The treatments T_2- emamectin benzoate 5 SG @ 0.4 gm lit^{-1}

recording a larval population of 2.77, and T_4- lambdacyhalothrin 5 EC @ 1.0 ml lit^{-1} with a 2.89 mean larval population, were at par with each other followed by T_7- azadirachtin 1 % @ 2 ml lit^{-1} which recorded 3.24 larvae per five selected plants. The treatment T_6- imidacloprid 17.8 SL @ 0.2 ml lit^{-1} recorded 3.84 while T_5- thiamethoxam 25 WG @ 0.4 gm lit^{-1} recorded 3.86 larvae per five selected plants, respectively were at par to each other. The highest mean larval population of 4.43 recorded in untreated control.

The data revealed that the least larval population over untreated control was observed in treatment T_1- deltamethrin 2.8 EC (2.20) followed by T_3- indoxacarb 14.5 SC (2.47), T_2- emamectin benzoate 5 SG (2.77), T_4- lambdacyhalothrin 5 EC (2.89), T_7- azadirachtin 1 % (3.24), T_6- imidacloprid 17.8 SL (3.84) and T_5- thiamethoxam 25 WG (3.86).

Present results were discussed in the light of following workers.

Gangappa *et al.* (1993) [3] also applied various pyrethroids including 0.002 percent deltamethrin or 0.005 percent cypermethrin or 0.005 percent fenvalerate on the sunflower crop at the bud stage for controlling the Head borer, *H. armigera*

Hussain and Bilal (2007) [4] tested six different pesticides for their efficiency against *H. armigera* infestations in Tomato and observed Imidachloprid 0.03 per cent was more effective in controlling the *H. armigera* followed by deltamethrin and fluvalinate.

Yogeeswarudu and Venkatakrishna (2014) [10] who evaluated the efficacy of different insecticides viz., indoxacarb 14.5 SC @ 0.5 ml/l, profenofos 50 EC @ 2.0 ml/l, imidacloprid 17.8 SL @ 1 m/l, novaluron 10 EC @ 1.5 ml/l, fipronil 5 SC @ 2.0 ml/l and lambda cyhalothrin 5 EC @ 1 ml/l against *H. armigera* larvae and found that indoxacarb 14.5 SC @ 0.5 ml/l was found best with minimum population of *H. armigera*.

Chandra Shekhara *et al.* (2017) [1] observed that among the several treatments for controlling *H. armigera* , most superior insecticide observed was spinosad 45 SC followed by cypermethrin 25 EC, indoxacarb 15.8 EC and neem oil respectively.

The effect of azadirachtin was also found in the results. The obtained results were supported by Mane *et al.* (2013) [6] who revealed that the foliar spray of azadirachtin 1500 ppm @ 2 ml per lit. of water reduces the larval population of *H. armigera* in sunflower.

Table 1: Cumulative efficacy of insecticides against sunflower capitulum borer (*H. armigera*)

Sr. No	Treatments	Dose per Lit. (ml/g)		Mean larval population of *H. armigera*								Overall Mean
			Pre count	First Spray				Second Spray				
				1 DAS**	7 DAS	14 DAS	Mean	1 DAS	7 DAS	14 DAS	Mean	
1	Deltamethrin 2.8 EC	0.5	4.71 (2.39)*	3.03 (2.01)	2.14 (1.77)	2.88 (1.97)	2.68 (1.92)	2.14 (1.77)	1.98 (1.73)	1.06 (1.44)	1.73 (1.64)	2.20 (1.78)
2	Emamectin Benzoate 5 SG	0.4	4.87 (2.42)	3.28 (2.07)	2.38 (1.84)	4.06 (2.25)	3.24 (2.05)	3.41 (2.10)	2.26 (1.81)	1.24 (1.50)	2.30 (1.80)	2.77 (1.93)
3	Indoxacarb 14.5 SC	0.5	4.41 (2.33)	3.14 (2.04)	2.27 (1.81)	3.63 (2.15)	3.01 (2.00)	2.47 (1.86)	2.19 (1.79)	1.10 (1.45)	1.92 (1.70)	2.47 (1.85)
4	Lambdacyhalothrin 5 EC	1.0	4.53 (2.35)	3.32 (2.08)	2.68 (1.92)	4.13 (2.27)	3.38 (2.09)	3.44 (2.11)	2.49 (1.87)	1.27 (1.51)	2.40 (1.83)	2.89 (1.96)
5	Thiamethoxam 25 WG	0.4	4.68 (2.38)	4.17 (2.27)	4.37 (2.32)	4.68 (2.38)	4.41 (2.32)	3.80 (2.19)	3.49 (2.12)	2.67 (1.92)	3.32 (2.08)	3.86 (2.20)
6	Imidacloprid 17.8 SL	0.2	4.35 (2.31)	3.98 (2.23)	4.25 (2.29)	4.47 (2.34)	4.23 (2.29)	3.84 (2.20)	3.65 (2.16)	2.87 (1.97)	3.45 (2.11)	3.84 (2.20)
7	Azadirachtin 1 %	2	4.79 (2.41)	3.48 (2.12)	3.17 (2.04)	4.23 (2.29)	3.63 (2.15)	3.27 (2.07)	3.09 (2.02)	2.18 (1.78)	2.85 (1.96)	3.24 (2.05)
8	Untreated control	-	4.52 (2.35)	4.58 (2.36)	4.64 (2.38)	4.91 (2.43)	4.71 (2.39)	4.97 2.44)	4.31 (2.30)	3.14 (2.04)	4.14 (2.26)	4.43 (2.33)
C.D.(p=0.05)			NS	0.06	0.05	0.07	0.06	0.05	0.04	0.03	0.04	0.05
SEm(±)			0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.02

* Figures in parenthesis are √n+1 values

** DAS: Days after spraying

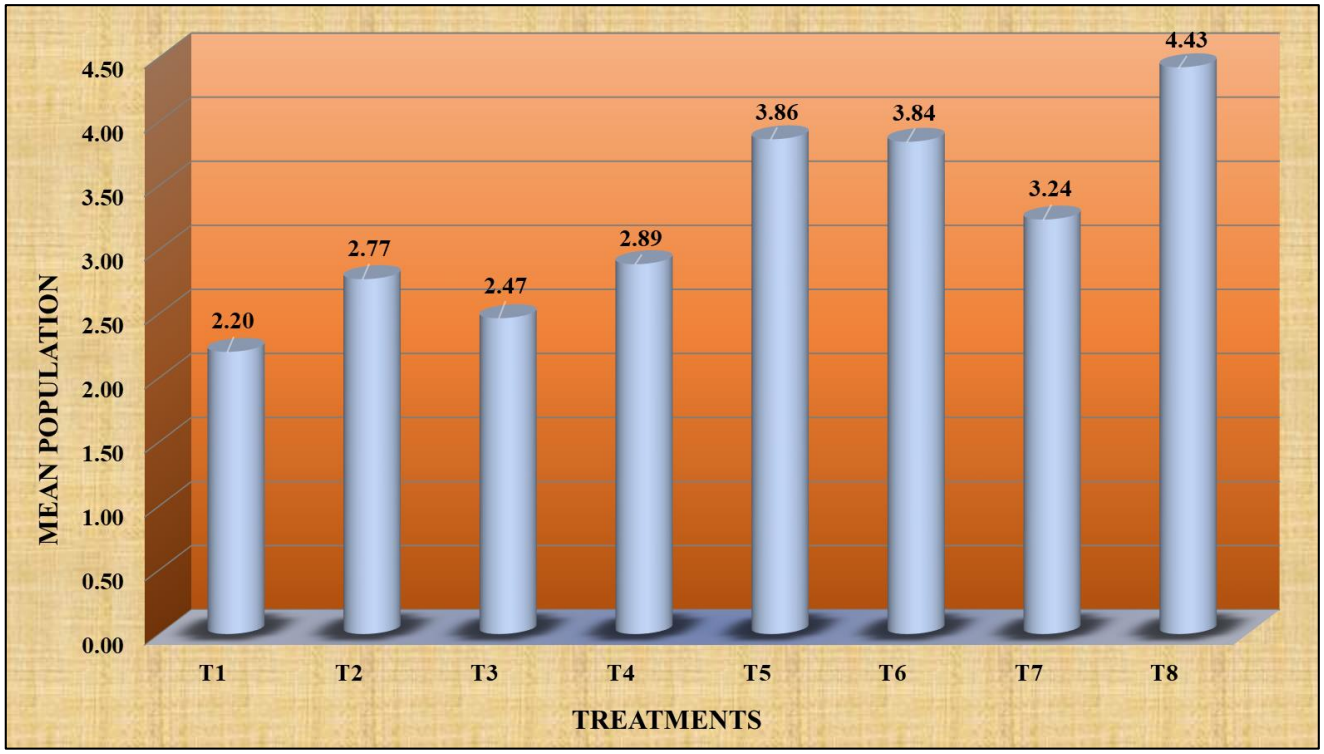

Fig 1: Cumulative efficacy of insecticides against sunflower capitulum borer (*H. armigera*)

4. Conclusion

The overall results revealed that, even though *H. armigera* is the key pest of sunflower, it can be managed very effectively by following spray schedule as experienced in the present findings. The insecticide deltamethrin 2.8 EC was found to be the best insecticide in reducing the larval population of sunflower capitulum borer. Indoxacarb 14.5 SC, emamectin benzoate 5 SG and lambdacyhalothrin 5 EC were also proved promising. The present investigation results are based on one season and one location data. Therefore, in order to arrive a sound conclusion, it is necessary to continue the studies with long duration trail including improved pest management practices based on IPM techniques to keep the pest infestation at low level and to get higher returns of yield.

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