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Bio-efficacy of different insecticides against head borer (*Helicoverpa armigera)* on sunflower

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Abstract
An inspection was undertaken to study the bio-efficacy of different insecticides against head borer (*Helicoverpa armigera)* on sunflower under field condition during *Kharif*, 2019 at research farm of Oilseed Research Station, Latur, Maharashtra, India. The observations on total number of head borers were recorded on five randomly selected plants from each treatment at one day before and 3, 7 and 14 days after first and second application of insecticides. The treatments of different insecticides *viz.*, indoxacarb 0.019 percent, emamectin benzoate 0.006 percent, quinalphos 0.03 percent, chlorantraniliprole 0.024 percent, cypermethrin 0.03 percent and profenophos 0.06 percent were evaluated against head borer, *Helicoverpa armigera* revealed that emamectin benzoate 0.006 percent was found most effective treatment in reducing the population of head borer (0.00 and 0.07 larvae per five plants per plot at 3 days after first and second spray respectively), followed by chlorantraniliprole 0.024 percent. Significantly higher seed yield (2846 kg/ha) of sunflower was recorded in treatment emamectin benzoate 0.006 percent, it was followed by treatment chlorantraniliprole 18.5 percent (2656 kg/ha). The highest ICBR (1:15.31) was recorded with treatment emamectin benzoate 0.006 percent which was followed by cypermethrin 0.03 percent (1:11.55).

Keywords: Head borer *Helicoverpa armigera*, bioefficacy, sunflower, insecticides

Introduction
Sunflower (*Helianthus annuus* L.) originated in Mexico and Peru, belongs to family Asteraceae (Compositae). In 16th century, sunflower was introduced into India. Sunflower is an important oilseed crops in the world as it ranks third in area after soybean and groundnut. Sunflower oil is a rich source of linoleic acid (64 percent) which helps in reducing the cholesterol deposition in the coronary arteries of heart and thus good for heart patients. The oil is used for culinary purposes, in the manufacture of paints, soaps, cosmetics and for the preparation of margarine. Sunflower contains 32 to 44 percent oil, 18 to 22 percent carbohydrates, 20 to 24 percent vitamins and 4 to 6 percent salts.

In India, during 2017-18 sunflower was grown on an area of 0.33 million hectares with 0.23 million metric tonnes of production and 0.70 metric tonnes per hectare of productivity (Anonymous, 2019) [1]. The total production of sunflower in *kharif*, 2018-19 was estimated at 0.93 lakh tonnes (4th advanced estimate, DACFW, GoI) and the production in *Kharif*, 2019-20 was estimated at 0.67 lakh tonnes (1st advanced estimate, DACFW, GoI). In India, sunflower crop is damaged by different species of insect pests. 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) [8]. 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) [10] reported yield loss of 120 kg/ha due to *H. armigera* damage in Karnataka.

According to several reports many of the recommonded insecticides used earlier against head borer could not gave effective results. So, these recommonded insecticides should have to be re-examined against head borer of sunflower for effective insect-pests management.

Materials and Methods
The field experiment with sunflower crop using variety 'LSFH-171' in *Kharif*, 2019 was conducted at Oilseeds Research Station, Latur under Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, M.S., India.

The experiment was conducted in a randomized block design (RBD) with seven treatments including untreated control with three replications. Sunflower crop was sown on 01 August, 2019 in a gross plot of 4.8 m x 4.2 m maintaining net plot of 4.2 m x 3.9 m. The row to row distance of 60 cm and plant to plant distance of 30 cm was maintained. The dose of fertilizer at the rate of 60 kg N, 30 kg P_2O_5 and 30 kg K_2O per hectare was given at the time of sowing. The crop was grown with all recommended package of practices recommended by V.N.M.K.V., Parbhani except insect-pests management. The first spray of particular insecticidal treatment was made on appearance of pest and successive spray was given at 15 days interval using manually operated knapsack sprayer. The observations on total number of head borer larvae (*Helicoverpa armigera*) were recorded on five randomly selected plants from each plot at one day before spray and 3, 7 and 14 days after first and second application of insecticides.

Results and Discussion

The bio-efficacy data recorded for head borer, *Helicoverpa armigera* during *Kharif*, 2019 on sunflower.

Head borer (*Helicoverpa armigera*)

First spray

Data relating to the effect of different insecticides on larval population of sunflower head borer, *Helicoverpa armigera* after first spray are presented in Table 1 and Fig. 1 revealed that there were no significant differences observed among various treatments before one day of the spray. The results disclosed that all the insecticides were found significantly superior over untreated control in reducing population of sunflower head borer at 3, 7 and 14 days after first spray.

Table 1: Effect of different insecticides on the larval population of sunflower head borer (First spray)

Tr. No.	Treatment	Concentration used (%)	Mean population of head borer larvae/five plants/plot			
			1 day before Spraying	Days after spraying		
				3	7	14
T1	Indoxacarb 14.5% SC	0.019	1.27 (1.33)*	0.33 (0.90)	0.47 (0.98)	0.53 (1.01)
T2	Emamectin benzoate 5% SG	0.006	1.20 (1.30)	0.00 (0.71)	0.13 (0.79)	0.20 (0.83)
T3	Quinalphos 25% EC	0.03	1.33 (1.34)	0.80 (1.13)	0.93 (1.19)	1.00 (1.22)
T4	Chlorantraniliprole 18.5% SC	0.024	1.27 (1.33)	0.13 (0.79)	0.27 (0.87)	0.33 (0.91)
T5	Cypermethrin 25% EC	0.03	1.53 (1.42)	0.47 (0.98)	0.80 (1.14)	0.73 (1.11)
T6	Profenophos 50% EC	0.06	1.33 (1.34)	0.60 (1.05)	0.73 (1.11)	1.07 (1.25)
T7	Untreated Control	-	1.40 (1.37)	1.53 (1.43)	1.67 (1.47)	1.73 (1.49)
	S.E. ±		0.10	0.05	0.06	0.05
	C.D. at 5%		NS	0.16	0.19	0.16
	C.V. (%)		12.74	8.96	9.95	8.02

*Figures in parentheses are square root(x + 0.5) transformed values. NS: Non significant

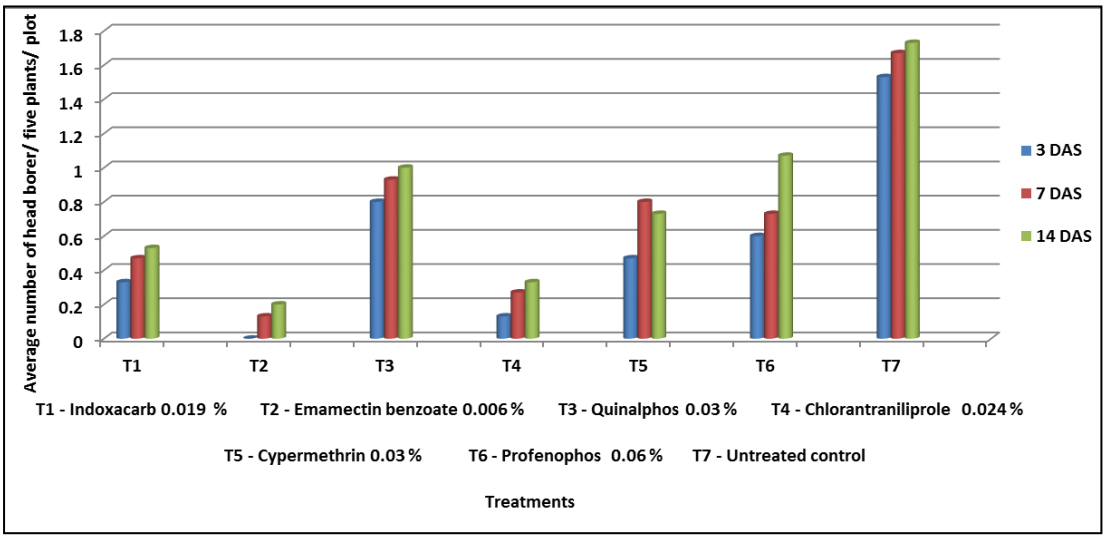

Fig 1: Effect of different insecticides on the larval population of sunflower head borer at first spray

At three days after first spray, treatment T2 i.e. emamectin benzoate 5 SG @ 0.006 percent recorded significantly lowest population of head borer to the tune of 0.00 larvae/five plants/plot which was followed by treatment T4 i.e. chlorantraniliprole 18.5 SC @ 0.024 percent (0.13 larvae/five plants/plot) in reducing head borer population. Both of these treatments were found statistically at par with each other. The next best treatment observed was treatment T1 i.e. indoxacarb 14.5 SC @ 0.019 percent which recorded 0.33 larvae/five plants/plot. The next effective treatments in reducing head borer population were treatment T5 i.e. cypermethrin 25 EC @ 0.03 percent (0.47 larvae/five plants/plot) followed by treatment T6 i.e. profenophos 50 EC @ 0.06 percent (0.60 larvae/five plants/plot) and both these treatments were found statistically at par with each other. The highest head borer population (1.53 larvae/five plants/plot) was recorded in treatment T7 i.e. untreated control. The rest of the treatment T3 i.e. quinalphos 25 EC @ 0.03 percent (0.80 larvae/five plants/plot) was intermediate.

At seven days after first spray, significantly lowest population of head borer was noted in treatment T1 i.e. emamectin benzoate 5 SG @ 0.006 percent (0.13 larvae/five plants/plot) followed by treatment T4 i.e. chlorantraniliprole 18.5 SC @ 0.024 percent (0.27 larvae/five plants/plot) which was again

followed by treatment T1 i.e. indoxacarb 14.5 SC @ 0.019 percent (0.47 larvae/five plants/plot) and all these three treatments were found statistically at par with each other. The next effective treatment was treatment T6 i.e. profenophos 50 EC @ 0.06 percent (0.73 larvae/five plants/plot) which was followed by treatment T5 i.e. cypermethrin 25 EC @ 0.03 percent (0.80 larvae/five plants/plot) in reducing head borer population. Both of these treatments were found statistically at par with each other. The next best treatment observed was treatment T3 i.e. quinalphos 25 EC @ 0.03 percent which recorded 0.93 larvae/five plants/plot. Significantly highest head borer population (1.67 larvae/five plants/plot) was observed in treatment T7 i.e. untreated control.

At fourteen days after first spray, significantly lowest population of head borer (0.20 larvae/five plants/plot) was recorded in the plots treated with treatment T2 i.e. emamectin benzoate 5 SG @ 0.006 percent which was found at par with treatment T4 i.e. chlorantraniliprole 18.5 SC @ 0.024 percent (0.33 larvae/five plants/plot). The next effective treatment observed was treatment T1 i.e. indoxacarb 14.5 SC @ 0.019 percent which recorded 0.53 larvae/five plants/plot. The next best treatment was treatment T5 i.e. cypermethrin 25 EC @ 0.03 percent (0.73 larvae/five plants/plot) which was followed by treatment T3 i.e. quinalphos 25 EC @ 0.03 percent (1.00 larvae/five plants/plot) and both of these treatments were found statistically at par with each other. The highest head borer population (1.73 larvae/five plants/plot) was recorded in treatment T7 i.e. untreated control. The rest of the treatment T6 i.e. profenophos 50 EC @ 0.06 percent (1.07 larvae/five plants/plot) was intermediate.

Thus, after first spray it can be concluded that the head borer population was decreased for only initial three days after the spray and thereafter the population slowly increased. Also, the plots treated with emamectin benzoate 5 SG @ 0.006 percent recorded significantly lowest population of head borer on sunflower to the extent of 0.00, 0.13 and 0.20 larvae/five plants/plot, respectively at 3, 7 and 14 days after spraying and found effective over rest of the treatments.

Second spray

The results in concern with the effect of different insecticides on larval population of head borer after second spray are presented in Table 2 and Fig. 2. The data disclosed that similar trend was observed after second spray also and all the insecticides under inspection were observed to be significantly superior over untreated control in reducing the population of head borer on sunflower at 3, 7 and 14 days after second spray.

Table 2: Effect of different insecticides on the larval population of sunflower head borer (Second spray)

Tr. No.	Treatment	Concentration used (%)	Mean population of head borer larvae/five plants/plot			
			1 day before Spraying	Days after spraying		
				3	7	14
T1	Indoxacarb 14.5% SC	0.019	1.40 (1.37)*	0.27 (0.87)	0.40 (0.94)	0.53 (1.01)
T2	Emamectin benzoate 5% SG	0.006	1.33 (1.35)	0.07 (0.75)	0.13 (0.79)	0.20 (0.83)
T3	Quinalphos 25% EC	0.03	1.47 (1.40)	0.73 (1.10)	0.87 (1.17)	1.00 (1.22)
T4	Chlorantraniliprole 18.5% SC	0.024	1.53 (1.42)	0.20 (0.83)	0.27 (0.87)	0.33 (0.91)
T5	Cypermethrin 25% EC	0.03	1.60 (1.44)	0.47 (0.98)	0.60 (1.05)	0.73 (1.11)
T6	Profenophos 50% EC	0.06	1.20 (1.30)	0.60 (1.05)	0.80 (1.14)	1.07 (1.25)
T7	Untreated Control	-	1.27 (1.32)	1.47 (1.40)	1.60 (1.45)	1.73 (1.49)
	S.E. ±		0.10	0.06	0.05	0.05
	C.D. at 5%		NS	0.19	0.15	0.16
	C.V. (%)		12.18	10.94	8.18	8.02

*Figures in parentheses are square root(x + 0.5) transformed values. NS: Non significant

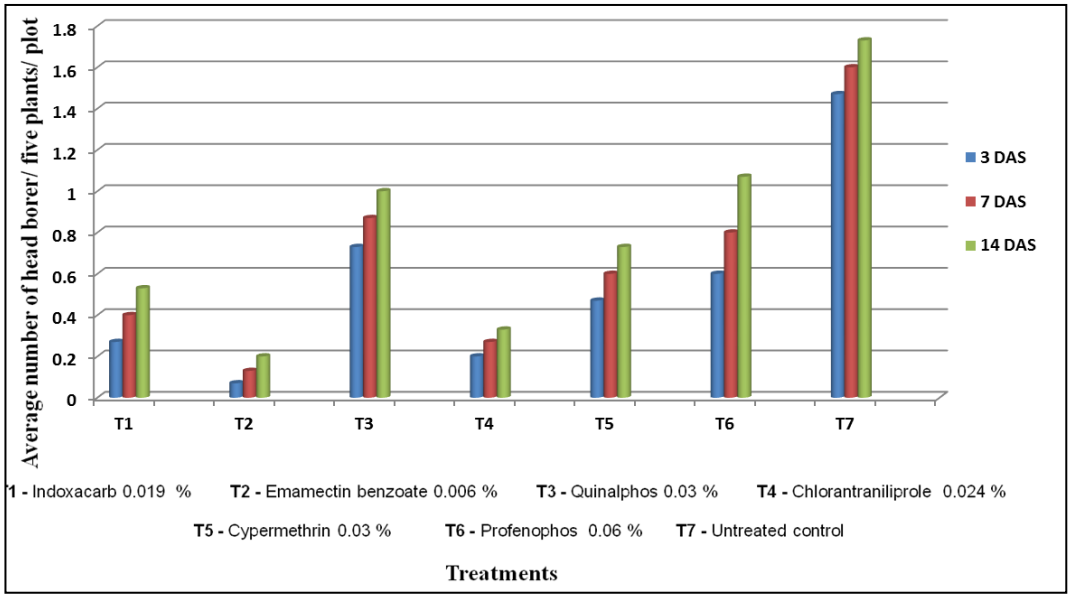

Fig. 2: Effect of different insecticides on the larval population of sunflower head borer at second spray

At three days after second spray, treatment T2 i.e. emamectin benzoate 5 SG @ 0.006 percent treated plot evidenced significantly lowest population of head borer (0.07 larvae/five plants/plot) which was followed by treatment T4 i.e.

chlorantraniliprole 18.5 SC @ 0.024 percent (0.20 larvae/five plants/plot) and treatment T1 i.e. indoxacarb 14.5 SC @ 0.019 percent (0.27 larvae/five plants/plot) and all these three treatments were found statistically at par with each other. The next best treatment observed was treatment T5 i.e. cypermethrin 25 EC @ 0.03 percent (0.47 larvae/five plants/plot). Treatment T6 i.e. profenophos 50 EC @ 0.06 percent (0.60 larvae/five plants/plot) and treatment T3 i.e. quinalphos 25 EC @ 0.03 percent (0.73 larvae/five plants/plot) were observed as next effective treatments. The highest population of head borers i.e. 1.47 larvae/five plants/plot was observed in treatment T7 i.e. untreated control.

At seven days after second spray, Subsequent order of effectiveness observed was treatment T2 i.e. emamectin benzoate 5 SG @ 0.006 percent (0.13 larvae/five plants/plot), treatment T4 i.e. chlorantraniliprole 18.5 SC @ 0.024 percent (0.27 larvae/five plants/plot) and treatment T1 i.e. indoxacarb 14.5 SC @ 0.019 percent (0.40 larvae/five plants/plot) and all these three treatments were found statistically at par with each other in reducing head borer population. The next best treatment observed was treatment T5 i.e. cypermethrin 25 EC @ 0.03 percent which recorded 0.60 larvae/five plants/plot. The next effective treatment in reducing head borer population was treatment T6 i.e. profenophos 50 EC @ 0.06 percent (0.80 larvae/five plants/plot) which was followed by treatment T3 i.e. quinalphos 25 EC @ 0.03 percent (0.87 larvae/five plants/plot). Both of these treatments were found statistically at par with each other. The highest population of head borer (1.60 larvae/five plants/plot) was recorded in treatment T7 i.e. untreated control.

At fourteen days after second spray, significantly lowest population of head borer (0.20 larvae/five plants/plot) was recorded in the plots treated with treatment T2 i.e. emamectin benzoate 5 SG @ 0.006 percent which was found at par with treatment T4 i.e. chlorantraniliprole 18.5 SC @ 0.024 percent (0.33 larvae/five plants/plot). Treatment T1 i.e. indoxacarb 14.5 SC @ 0.019 percent (0.53 larvae/five plants/plot) and treatment T5 i.e. cypermethrin 25 EC @ 0.03 percent (0.73 larvae/five plants/plot) were observed as next effective treatments. The next best treatment was treatment T3 i.e. quinalphos 25 EC @ 0.03 percent (1.00 larvae/five plants/plot) which was followed by treatment T6 i.e. profenophos 50 EC @ 0.06 percent (1.07 larvae/five plants/plot). Both of these treatments were found statistically at par with each other in reducing head borer population. The highest population of head borer (1.73 larvae/five plants/plot) was recorded in treatment T7 i.e. untreated control.

Thus overall after second spray, the plots treated with emamectin benzoate 5% SG @ 0.006 percent recorded significantly lowest population of head borer on sunflower to the extent of 0.07, 0.13 and 0.20 larvae/five plants/plot at 3, 7 and 14 days after spraying, respectively over rest of the insecticides.

The effectiveness of emamectin benzoate as foliar spray against head borer on sunflower was earlier proved by Dake *et al*., (2017) [4] and Muhammad Aftab *et al*., (2020) [9]. Thus regardless of the formulation, the bio-efficacy of emamectin benzoate against head borer, as observed in present study, was proven by these earlier workers. Effectiveness of emamectin benzoate on gram pod borer in chickpea was also reported by Babar *et al*., (2012) [2], Chaukikar *et al*., (2017) [3] and Rani *et al*., (2018) [13]. The effectiveness of emamectin benzoate against *H. armigera* in chilli was also proved by Tatagar *et al*., (2009) [18]. On cotton, Patel Yogesh (2013) [11] found emamectin benzoate effective against cotton bollworm (*H. armigera*). Thus, all these earlier workers support the present finding of effectiveness of emamectin benzoate against *H. armigera*. In present study, the next best treatment observed in management of head borer was chlorantraniliprole 18.5 SC @ 0.024 percent. Gadhiya *et al*., (2014) [5] mentioned chlorantraniliprole effective against *H. armigera* on groundnut. Sapkal *et al*., (2018) [16] and Sarukh *et al*., (2018) [17] found chlorantraniliprole effective against *H. armigera* on tomato. Effectiveness of chlorantraniliprole was also proved by Rani *et al*., (2018) [13], Kumar and Sarada (2015) [7] on *H. armigera* in chickpea while Roopa and Kumar (2014) [15] on *H. armigera* in chilli. The treatment of chlorantraniliprole was followed by indoxacarb in the present study which was found effective by Ravi *et al*., (2007) [14] for *H. armigera* on sunflower. Patra *et al*., (2015) [12] reported effectiveness of indoxacarb for *H. armigera* on tomato. Thus, the present finding of bio-efficacy experiment are in line with the findings of all these earlier workers.

Conclusion

The present study concluded that among the seven treatments, all the insecticidal treatments were effective than untreated control in reducing the larval population of head borer, *Helicoverpa armigera* and emamectin benzoate 0.006 percent was found most effective insecticide in controlling the larval population of head borer on sunflower.

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