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Bio-Efficacy, Persistence And Residual Toxicity Of Different Insecticides Against Head Borer (*Helicoverpa Armigera* (Hubner)) Of Sunflower

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ABSTRACT

An investigation was undertaken to study the bio-efficacy, persistence and residual toxicity of different newer insecticides against head borer of sunflower at research farm of department of Agril. Entomology College of agriculture Latur. The observations on total number of larva of head borer were recorded on five randomly selected plants from each treatment at one day before and 1, 3, 7 and 14 days after application of insecticides. All insecticide treatments were found significantly superior over untreated control in minimizing the incidence of larva of head borer. On 14th DAS, the population of larva of head borer were ranged 0.67 to 1.47 larva/plant. Emamectin benzoate 0.002 per cent was exhibited most effective insecticide in minimizing the population of larva of head borer (0.67 larva per plant) flubendiamide 0.007 per cent (1.00 larva per plant) chlorantraniliprole 0.005 per cent (1.07 larva per plant), indoxacarb 0.005 per cent and spinosad 0.007 per cent (1.33 larva per plant), fenpropathrin 0.01 per cent (1.40 larva per plant) and imidacloprid 0.003 per cent (1.47 larva per plant) were effective treatments.Among different insecticides, Emamectin benzoate, flubendiamide and chlorantraniliprole exhibited highest efficacy against sunflower larva of head borer. The residual toxicity of seven label recommended insecticides viz., Emamectin benzoate 0.002 per cent, flubendiamide 0.007 per cent, chlorantraniliprole 0.005 per cent, indoxacarb 0.005 per cent, spinosad 0.007 per cent, fenpropathrin 0.01 per cent and imidacloprid 0.003 per cent was evaluated against head borer Helicoverpa armigera (Hubner) infesting sunflower. Emamectin benzoate 0.002 per cent revealed the highest persistent toxicity index (PT) value of 944.55 and LT_{50} values 8.18 days against head borer Helicoverpa armigera (Hubner) after application of insecticides as compared to the other insecticides.

KEY WORDS: *Head borer Helicoverpa armigera, sunflower, insecticides, management*

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INTRODUCTION

Sunflower (*Helianthus annuus* L.) belongs to family compositae originated in Mexico and Peru, introduced into India in the 16th century. Sunflower is one of the most important oilseed crops. The oil is used for culinary purposes, in the preparation of vanaspati ghee and in the manufacture of paints, soaps and cosmetics. The seed yield and oil content are important parameters in sunflower because sunflower oil is a good source of vegetable oil, for cooking and manufacture of margarine. Sunflower ranks third in the total area cultivated and fourth in total production. In India, during 2012-13 sunflower was cultivated in 8.22 lakh ha area with a production of 0.58 MT. In India the average yield is 705 kg/ha. Maharashtra ranks third in area and production. In Maharashtra, during 2012-2013 sunflower was grown on an area of 0.51 lakh ha with the productivity of 382 kg/ha (Anonymous, 2014). Amongst several factors responsible for low productivity of sunflower, the damage caused by insect-pests is major one. Sunflower serves as host for more than fifty insect-pests in India. However, twenty insect-pests were reported to feed on sunflower in Marathwada (Bilapate *et al*., 1994). The major insect-pests which drew the attention of both farmers and scientists capitulum or head borer, *Helicoverpa armigera* (Hubner). Larvae of head or capitulum borer (*Helicoverpa armigera*) feed on capitulum or seed and caused yield loss to the tune of 20-25 per cent at normal and 40-45 per cent during severe infestation (Ranasingh and Mahalik, 2008).

Several insecticides have been recommended against sunflower insect-pests for their effective management. But according to several reports many of these label claimed insecticides could not gave effective results. Hence these label claimed insecticides with some new insecticides should have to be reevaluated against larvae of head or capitulum borer of sunflower for effective insect-pests management.

MATERIAL AND METHODS

The field experiment with sunflower crop using variety LSFH-171 was conducted at Research Farm of Department of Agril. Entomology, College of Agriculture, Latur (VasantraoNaikMarathwada Krishi Vidyapeeth, Parbhani) (MS)-India during summer 2014. The experiment was conducted in a randomized block design (RBD) with three replications each replication has selected five plants. The eight treatments viz.T1: Fenpropathrin 0.01 per cent, T2: Indoxacarb 0.005 per cent, T3: Imidacloprid 0.003 per cent, T4: Spinosad 0.007 per cent, T5: Flubendiamide0.007 per cent, T6: Emamectin benzoate 0.002 per cent, T7: Chlorantraniliprole 0.005 per cent and T8: control used for investigation. Effectiveness of insecticides was judged on the basis of level of larval population of head borer on randomly selected five plants of sunflower. The pre-count of larva was recorded on a day prior to application and post-counts at 1, 3, 7 and 14 days after spray. The mortality was worked for 1, 3, 7 and 14 days after application of insecticides. The generated data on survival of larva was transformed into dn+1values and subjected for statistical analysis.

Bioassay procedure

The toxicity of different insecticides was assessed on head borer *Helicoverpa armigera* (Hub) on sunflower at 1, 3, 7 and 14 days after application of insecticides. Due care was taken to cover the entire plants while application of insecticides. The required number of fresh flowers receiving application of insecticides was tagged for investigation on residual toxicity of insecticides. The number of test insects used for the bioassay studies was ten for each treatment in each replication. The treated part of head were brought in to the laboratory at specified intervals. The treated part of head were kept in to the plastic container separately. The numbers of dead or moribund test insects were counted after 24 hours of exposure. Similarly, control mortality of test insects was also observed by releasing them on untreated substrates of sunflower plant.

Statistical treatment of data

Correction on percentage mortality

The observations on mortality of test insects were converted into percentage mortality. The average percentage mortality was calculated from the observations in 3 replications. The observations on percentage mortality thus obtained were corrected with Abbot's (1925) formula as follows.

$$P = \frac{T - C}{100 - C} \times 100$$

Where as, **P** = Corrected percentage mortality, **T** =Percentage mortality in treatment, **C**= Percentage mortality in control.

LT_{50} values

The values of LT_{50} (time required to give 50 per cent mortality) for different insecticides applied on sunflower plants were calculated by using software of probit analysis as suggested by Finney (1971).

PT values

The product (PT) of average residual toxicity (T) and the period (P) for which the toxicity persisted was used as an index of persistent toxicity. The values of corrected percentage mortalities at various specified periods were added. This sum was then divided by number of observations in order to obtain residual toxicity (T). The procedure followed by Saini (1959) and elaborated further by Pradhan (1967), Sarup *et al.* (1970) and Bhamare *et al.* (2015) was utilized.

RESULTS AND DISCUSSION

Statistically non-significant difference was noted in larva of head borer population prior to spraying. Larval population ranged from 1.33 to 1.80 larva per head/plant at one day before application. All insecticide treatments were significantly superior over untreated control in minimizing the incidence of larva of head borer on 1, 3, 7 and 14 day after spray.

The plots treated with emamectin benzoate 0.002 per cent observed significantly minimum population of larva on sunflower to the extent of 0.27, 0.33, 0.53 and 0.67 per leaf at 1, 3, 7 and 14 days after over rest of the insecticides.

At one day after spray, significantly minimum population of head borer (0.27 per plant) was recorded from the plots treated with emamectin benzoate 0.002 per cent followed by flubendiamide 0.007 per cent

(0.33 per plant). Both these treatments were found to be statistically at par with each other. Chlorantraniliprole 0.005 per cent (0.47 larva per plant), indoxacarb 0.005 per cent (0.60 larva per plant), spinosad 0.007 per cent (0.67 larva per plant), fenpropathrin 0.01 per cent (0.73 larva per plant) and imidacloprid 0.003 per cent (0.93 larva per plant) were subsequently effective treatments. At three days after third spray, emamectin benzoate 0.002 per cent recorded significantly minimum population of head borer (0.33 per plant). Subsequently effective treatments in reducing population of head borer were flubendiamide 0.007 per cent (0.53 per plant), chlorantraniliprole 0.005 per cent (0.72 per plant), indoxacarb 0.005 per cent (0.73 per plant), fenpropathrin 0.01 per cent (0.87 per plant), spinosad 0.007 per cent (1.00 per plant) and imidacloprid 0.003 per cent (1.07 per plant). At seven days after third spray, significantly lowest population of head borer (0.53 per plant) was evidenced in emamectin benzoate 0.002 per cent followed by flubendiamide 0.007 per cent (0.73 per plant). Both these treatments were found to be statistically at par with each other. Chlorantraniliprole 0.005 per cent (0.87 larva per plant), indoxacarb 0.005 per cent (1.00 larva per plant), spinosad 0.007 per cent (1.13 larvae per plant), fenpropathrin 0.01 per cent (1.20 larvae per plant) and imidacloprid 0.003 per cent (1.40 larvae per plant) were found next effective treatments. At 14 days after third spray, emamectin benzoate 0.002 per cent observed significantly lowest population of head borer (0.67 per plant) on the sunflower. Flubendiamide 0.007 per cent (1.00 larva per plant) and chlorantraniliprole 0.005 per cent (1.07 larvae per plant) were next effective treatments. Both these treatments were found to be statistically at par with each other. However, indoxacarb 0.005 per cent (1.33 larvae per plant), spinosad 0.007 per cent (1.33 larvae per plant), fenpropathrin 0.01 per cent (1.40 larvae per plant) and imidacloprid 0.003 per cent (1.47 larvae per plant) were subsequently effective treatments. These results are analogous to the findings of Khan *et al*. (2014) who proved that emamectin benzoate and spinosad were highly effective treatments against *Helicoverpa armigera* on sunflower. However, Ravi *et al.* (2007) documented that indoxacarb 14.5 SC at the rate of 500 ml per ha was most effective chemical in checking the larval population of *H. armigera* on sunflower and was at par with spinosad 45 SC at the rate of 150 ml per ha. Similarly, Aghav *et al.* (2009) reported that spinosad 45 per cent SC 168 g a.i./ha was most effective insecticide in suppressing larval population of *H. armigera* on sunflower. However, Duraimurugan *et al.* (2007) and Raghuraman *et al.* (2008) indicated that emamectin benzoate at the rate 11 g a.i. per ha was effective insecticides in reducing larval population of bollworm. Similarly, Gaikwad *et al.* (2009) evaluated that emamectin benzoate 5 per cent SC at the rate of 6.75 g a.i./ha and spinosad 45 SC at the rate of 75 g a.i./ha were most effective treatments for controlling the bollworms. According to Parmar and Borad (2009) indoxacarb 14.5 SC (0.0075 per cent), emamectin benzoate 5 WG (0.001 per cent) and diafenthiuron 75 WP (0.05 per cent) performed better to against *H. armigera* on okra. While, Murali Baskaran *et al.* (2010) indicated that emamectin benzoate 5 per cent SG at the rate 220 g per ha was effective treatment in managing the *H. armigera* on cotton. According to Mutkule *et al.* (2010) spinosad 45 per cent SC was significantly superior treatment against defoliators on groundnut followed by emamectin benzoate 5 per cent SC, thiodicarb 75 per cent WP, indoxacarb 14.5 per cent SC, quinalphos 25 per cent and endosulfan 35 per cent EC. In the studies of Ameta *et al.* (2010) flubendiamide 480 SC at the rate of 100 and 75 ml/ha were found significantly superior in reducing larval population of *H. armigera*. While, Thilagam *et al.* (2010) observed marked reduction in the larval population of *H. armigera* with flubendiamide 60 g a.i. per ha and Vinothkumar *et al.* (2010) reported effectiveness of flubendiamide 480 SC at the rate of 48 g a.i./ha against tomato fruit borer. Analogously, Ameta *et al*. (2011) and Priyadarshini *et al.* (2013) noted significant reduction in lepidopteran pod borers due to flubendiamide 480 SC. Whereas, Prasad and Rao (2010) reported that chlorantraniliprole at the rate of 40 g a.i/ha and 30 g a.i/ha, spinosad 75 g a.i./ha and indoxacarb 75 g a.i./ha were effective insecticides against *H. armigera.* While, Mohanraj *et al.* (2012) documented minimum survival of larval population of *H. armigera, M. testulalis* and *Lampides* spp. in chlorantraniliprole 20 per cent SC at the rate of 20, 25 and 30 g a.i./ha. Similarly, Gadhiya *et al.* (2014) recorded chlorantraniliprole (0.006 per cent), spinosad (0.018 per cent) and emamectin benzoate (0.002 per cent) were effective against *H. armigera* and *S. litura* on groundnut. While, Sreekanth *et al.* (2014) reported effectiveness of chlorantraniliprole 20 SC, flubendiamide 480 SC and spinosad 45 SC against pod borer. Thus the observations recorded in the present investigation are in close agreement with the findings of above workers. The data on the persistence of different insecticides in/on sunflower against larvae of head borer receiving spray recorded at 1, 3, 7 and 14 days intervals all the insecticides under investigation exhibited mortality of larvae of head borer but amongst them emamectin benzoate 0.002 per cent and flubendiamide 0.007 per cent concentration showed comparatively high percentage mortality of larvae of head borer at 1 day after application of insecticides. However, its persistence was reduced to lowest extent on sunflower showing 31.03 per cent mortality of larvae of head borer at 14 days after application of emamectin benzoate 0.002 per cent. The residual efficacy of emamectin benzoate 0.002 per cent, flubendiamide 0.007 per cent, chlorantraniliprole 0.005

per cent, fenpropathrin 0.01 per cent, indoxacarb 0.05 per cent, spinosad 0.007 per cent and imidacloprid 0.003 per cent based on PT index was 977.55, 921.09, 897.75, 831.46, 747.70, 697.02 and 599.16, respectively. The data on LT_{50} values of insecticides against larvae of head borer on sunflower. Residual toxicity in terms of LT_{50} value was found to be highest to the tune 8.18 days due to application of emamectin benzoate 0.002 per cent against larvae of head borer on sunflower. The relative order of residual efficacy of insecticides in days was found to be emamectin benzoate 0.002 per cent (8.18) > flubendiamide 0.007 per cent (7.59) > chlorantraniliprole 0.005 per cent (7.32) > fenpropathrin 0.01 per cent (6.07) > indoxacarb 0.05 per cent (5.11) > spinosad 0.007 per cent (4.36) > imidacloprid 0.003 per cent (2.90). These findings are in agreement with the results of Kanwar *et al.* (2012) who documented that flubendiamide 480 SC and indoxacarb 14.5 SC were highly toxic insecticides against 3 to 4 day old larvae of *Helicoverpa armigera*. Whereas, Yogi and Kumar (2013) indicated highest persistent toxicity of emamectin benzoate 5 SG (3102.72) followed by spinosad 45SC (2862.72). According to the Gadhiya *et al*. (2014) chlorantraniliprole (0.006 per cent), spinosad (0.018 per cent) and emamectin benzoate (0.002 per cent) observed equally effective against *H. armigera* on groundnut. However, Chankapue *et al.* (2015) reported that flubendiamide 39.35 per cent SC @ 0.01 per cent obtained 83.33, 86.66, 93.33, 96.33 and 96.33 per cent mortality of *H. armigera* larvae after 24, 48, 72, 96 and 168 hrs after spray, respectively. Thus the observations recorded in the present investigation are in close agreement with the findings of above workers.

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Table 01: Effect of different insecticides on the population of sunflower head borer (third spray)

Treatments	Mean number of larva per plant (head)				
	1 day before treatment	Days after treatment			
		1	3	7	14
Fenpropathrin 0.01 per cent	1.60 (1.44)*	0.73 (1.11)	0.87 (1.16)	1.20 (1.30)	1.40 (1.37)
Indoxacarb 0.005 per cent	1.47 (1.40)	0.60 (1.05)	0.73 (1.11)	1.00 (1.23)	1.33 (1.37)
Imidacloprid 0.003 per cent	1.60 (1.44)	0.93 (1.19)	1.07 (1.25)	1.40 (1.37)	1.47 (1.41)
Spinosad 0.007 per cent	1.33 (1.36)	0.67 (1.07)	1.00 (1.23)	1.13 (1.27)	1.33 (1.35)
Flubendiamide 0.007 per cent	1.53 (1.42)	0.33 (0.91)	0.53 (1.01)	0.73 (1.11)	1.00 (1.23)
Emamectin benzoate 0.002 per cent	1.60 (1.44)	0.27 (0.87)	0.33 (0.91)	0.53 (1.01)	0.67 (1.07)
Chlorantraniliprole 0.005 per cent	1.47 (1.41)	0.47 (0.98)	0.72 (1.10)	0.87 (1.16)	1.07 (1.25)
Untreated Control	1.80 (1.52)	1.93 (1.53)	2.00 (1.58)	2.20 (1.64)	2.60 (1.76)
S.E. ±	0.11	0.03	0.02	0.03	0.03
C.D. at 5%	N.S.	0.08	0.07	0.09	0.09
C.V. (%)	4.45	4.18	3.85	4.02	3.88

*Figures in parentheses are square root transformed values (? x + 0.5)
N.S.- Non significant

Table: Persistence of different insecticides in/on head of sunflower applied as third spray against head borer

Insecticides	Corrected percentage mortality after different intervals (days)				P	T	PT	R.E.	O.R.E.
	1	3	7	14					
Fenpropathrin 0.01per cent	89.29	75.87	51.72	20.68	59.39	14	831.46	1.39	4
Indoxacarb 0.05 per cent	82.14	68.97	48.28	17.24	53.41	14	747.70	1.25	5
Imidacloprid 0.003 per cent	64.29	55.18	41.38	10.34	42.79	14	599.16	1.00	7
Spinosad 0.007 per cent	75.00	65.52	44.83	13.80	49.79	14	697.02	1.16	6
Flubendiamide 0.007 per cent	94.43	79.31	62.07	27.59	65.85	14	921.09	1.54	2
Emamectin benzoate 0.002 per cent	100	82.75	65.52	31.03	69.82	14	977.55	1.63	1
Chlorantraniliprole0.005per cent	94.43	79.31	58.62	24.14	64.12	14	897.75	1.50	3

Table : Relative efficacy of different insecticides against head borer on sunflower applied as third spray

Insecticides	Heterogeneity		Regression Equation (y=……)	Log LT_{50} ± S.Em	LT_{50} (days)	Fiducial Limit (days)	R.E.	O.R.E.
	d.f.	χ^2						
Fenpropathrin 0.01per cent	2	0.461	$y = 0.1567 - 1.8367x$	0.7831±0.1320	6.07	3.23 16.11	2.09	4
Indoxacarb 0.05 per cent	2	0.897	$y = 0.1263 - 1.5617x$	0.7083±0.1473	5.11	2.32 15.59	1.76	5
Imidacloprid 0.003 per cent	2	0.574	$y = -0.1043 - 1.0899x$	0.4625±0.2098	2.90	0.01 11.81	1.00	7
Spinosad 0.007 per cent	2	0.930	$y = 0.0629 - 1.3494x$	0.6399±0.1650	4.36	1.46 16.03	1.50	6
Flubendiamide 0.007 per cent	2	0.418	$y = 0.20450 - 2.1610x$	0.8803±0.1211	7.59	4.43 19.61	2.62	2
Emamectin benzoate 0.002 per cent	2	0.410	$y = 0.3155 - 2.5464x$	0.9127±0.1074	8.18	5.03 19.14	2.82	1
Chlorantraniliprole 0.005per cent	2	0.230	$y = 0.1717 - 2.1848x$	0.8649±0.1188	7.32	4.28 18.03	2.52	3

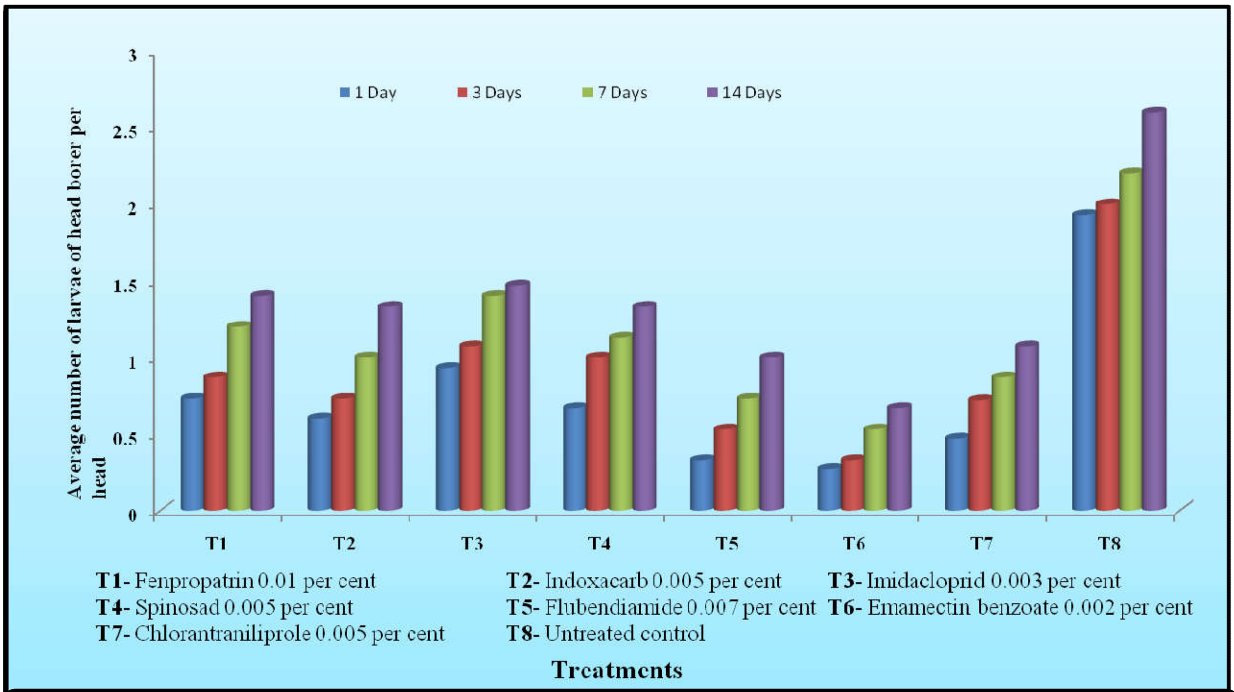

Fig. : Effect of different insecticides on the population of sunflower head borer (third spray)

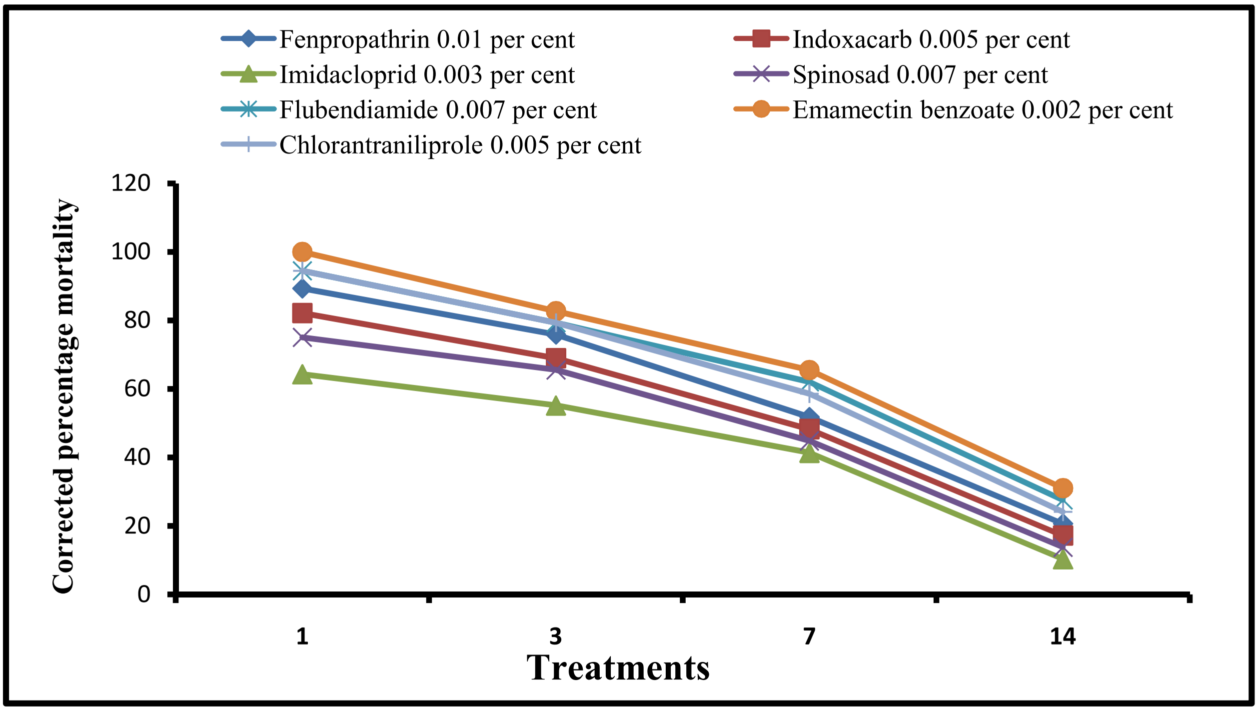

Fig. : Effect of different insecticides on mortality of first instar larvae of *Helicoverpa armigera* (Hubner) on sunflower head

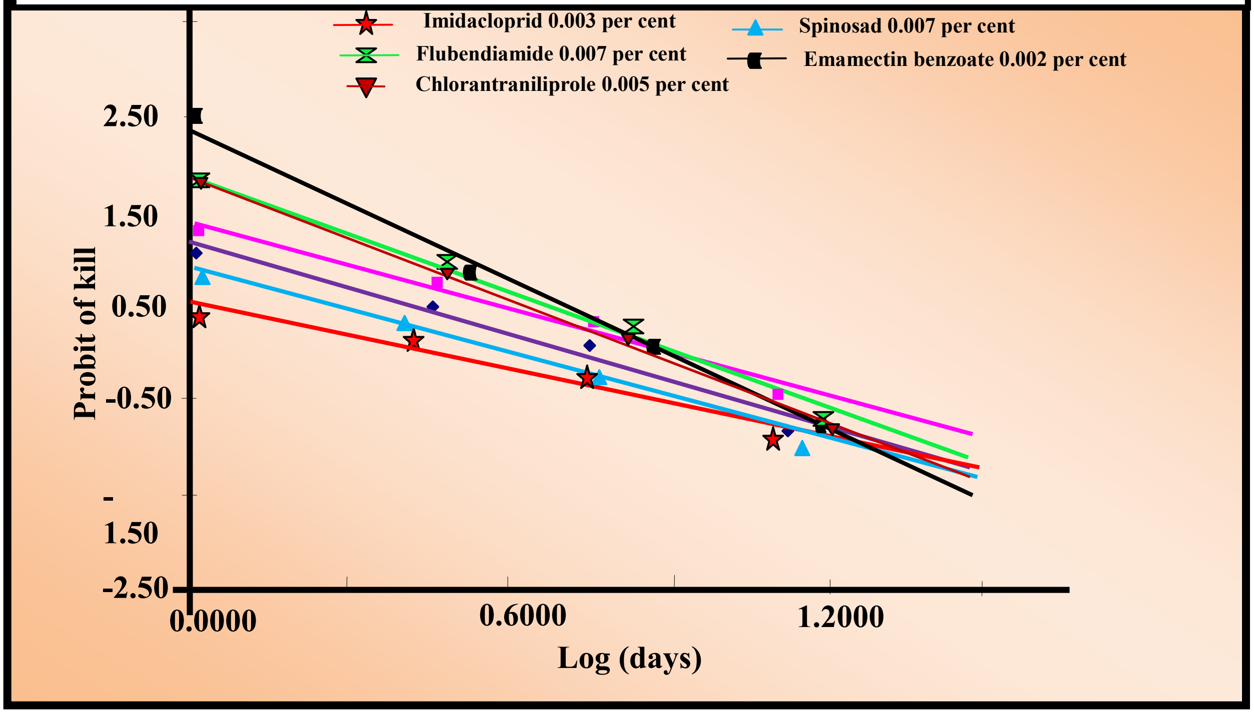

Fig. : Log (days) probit kill regression lines for different insecticides applied as spray against first instar larvae of *Helicoverpa armigera* (Hubner) on sunflower

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