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PERSISTENCE AND RESIDUAL TOXICITY OF DIFFERENT INSECTICIDES AGAINST POD BORER, *HELICOVERPA ARMIGERA* (HUBNER) INFESTING PIGEONPEA

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KEYWORDS

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ABSTRACT

The residual toxicity of seven label recommended insecticides *viz*., quinalphos at the rate of 0.070 per cent, indoxacarb at the rate of 0.0105 per cent, emamectin benzoate at the rate of 0.0022 per cent, spinosad at the rate of 0.0070 per cent, flubendiamide at the rate of 0.0070 per cent, chlorantraniliprole at the rate of 0.0055 per cent and azadirachtin at the rate of 0.00015 per cent was evaluated against first instar larvae of pod borer, *Helicoverpa armigera* (Hubner) infesting pigeonpea. Emamectin benzoate at the rate of 0.0022 per cent revealed the highest persistent toxicity index (PT) value of (925.08, 920.52 and 898.60) and LT_{50} values 7.63, 7.52 and 7.27 days against first instar larvae of pod borer after first, second and third spray, respectively as compared to the other insecticides.

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INTRODUCTION

Pulses are an affordable alternative to more expensive animal-based protein, which makes them ideal for enhancing diets in poorer parts of the world, where protein sources from milk if often five time more expensive than protein sourced from pulses. Pulses also offer a great potential to lift farmers out of rural poverty, as they can yield two to three time higher prices than cereals, and their processing provides additional economic opportunities, especially for women. Hence, to raise awareness about important role of pulses the 68th UN General Assembly declared 2016 the International Year of Pulses (FAO, 2016). Pigeonpea is one of the major pulse crops of the tropics and sub-tropics. India accounts for about 75 per cent of world production. In India, the area under pigeonpea was 3.88 million hectares and the production was 3.17 million tonnes with average productivity of 817 kg per ha in 2013-14. The major pigeonpea growing states in India are Maharashtra, Uttar Pradesh, Madhya Pradesh, Karnataka, Gujarat, Andhra Pradesh, Tamil Nadu and Bihar (Anonymous, 2015). Maharashtra is the largest producer of pigeonpea, accounting for over 35 per cent of total production in the country. Major constraint in the production of pigeonpea is the damage caused by insect-pests. In India, nearly three hundred species of insect-pests are known to infest pigeonpea crop at its various growth stages (Lal and Singh, 1998). Pod borers caused 60 to 90 per cent loss in the grain yield under favourable conditions (Lal *et al*., 1992). As per Central Insecticide Board and Registration Committee, several label recommended chemical insecticides have been recommended and are being used extensively by farmers to control pod borer, *Helicoverpa armigera* (Hubner) infesting pigeonpea. But according to several reports many of these label recommended insecticides failed to achieve prolonged results. Hence, these label recommended insecticides should have to be reevaluated against pigeonpea pod borer for effective management. In addition, the residual toxicity resulting from foliar spray of insecticides could be of great significance in indicating an effective periods over which an insecticide could persist in biologically active stage and their periodic evaluation for the effectiveness is also essential under field condition. Under this background, the present investigation was undertaken to evaluate the persistence and residual toxicity of different insecticides against pod borer, *H. armigera* infesting pigeonpea.

MATERIALS AND METHODS

Test insecticides

Quinalphos (Ekalux 25 % EC, Syngenta India), indoxacarb (Avaunt 15.8 % EC, Dupont Crop Protection India), emamectin benzoate (Proclaim 5 % SG, Crystal Crop Protection Pvt. Ltd. India), spinosad (Spintor 45 % SC, Dow Agro Science India), flubendiamide (Fame 39.35 % SC, Bayer Crop Science India), chlorantraniliprole (Coragen 18.5 % SC, Dupont Crop Protection India) and azadirachtin (Neemark 0.03 % WSV, West Coast Group India) were used for conducting the present investigation.

Test insect

The investigation was carried out against first instar larvae of pod borer, *H. armigera* infesting pigeonpea at Post Graduate Laboratory, Department of Agricultural Entomology, College of Agriculture, Latur (VNMKV, Parbhani (MS) India) during *Kharif* 2014. The laboratory culture of pod borer, *H. armigera* was initiated by collecting infested pods along with large number of larvae during October to December 2014. The larvae of *H. armigera* were reared individually in 5 × 5 cm circular plastic vials. They were fed on fresh pods of pigeonpea daily in the morning until pupation. The newly emerged male and female moths of *H. armigera* were placed in oviposition cage made up of plastic containers having size of 19 cm height and 21 cm diameter for the purpose of egg laying. The cotton swab dipped into 50 per cent honey solution was kept in Petri dish and placed at the bottom of cage to serve as food for moths. The tender pigeonpea twigs with succulent leaves, buds, flowers and pods were placed in small conical flask containing water for egg laying. Such containers were covered with black cloth and tightened with rubber band. In order to maintain humidity in containers, the cover cloth was sprinkled with water to keep the cloth moist. The eggs laid by female moths on oviposition substrate or cloth were removed daily. The newly hatched larvae were reared in plastic boxes on fresh flower buds and pods. The first instar larvae of *H. armigera* were used for determination of residual toxicity of different insecticides.

Bioassay procedure

The toxicity of different insecticides was assessed on first instar larvae of pod borer *H. armigera* at 1, 3, 7 and 14 days after first (136 days), second (156 days) and third (175 days) application of insecticides. Due care was taken to cover the entire plants while application of insecticides. The required number of fresh flowers and green pods 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 pods were brought in to the laboratory at specified intervals. The treated pods were kept in to the plastic vials. The stalk of pod was covered with moistened cotton wool in order to retain their turgidity for 24 hours. 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 pigeonpea 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 Abbott'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 pigeonpea 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

Residual toxicity of different insecticides against *H. armigera* against first instar larvae

The data on the average percentage mortality of first instar larvae of pod borer on pigeonpea flowers and pods receiving first, second and third spray recorded at 1, 3, 7 and 14 days intervals are presented in Table 1.

First spray

The result of first spray evident that emamectin benzoate 0.0022 per cent, chlorantraniliprole 0.0055 per cent and flubendiamide 0.0070 per cent concentration showed comparatively high percentage mortality of larvae of *H. armigera* (27.61, 24.19 and 24.19 per cent, respectively) at 14 days after spraying. On the basis of PT values the descending order of persistent toxicity was emamectin benzoate 0.0022 per cent (925.08) > chlorantraniliprole 0.0055 per cent (864.36) > flubendiamide 0.0070 per cent (815.94) > spinosad 0.0070 per cent (766.62) > indoxacarb 0.0105 per cent (730.39) > quinalphos 0.070 per cent (685.66) > azadirachtin 0.00015 per cent (621.68). The LT_{50} values (Table 2) indicated that emamectin benzoate 0.0022 per cent showed highest LT_{50} value (7.63 days) followed by chlorantraniliprole 0.0055 per cent (6.60 days), flubendiamide 0.0070 per cent (5.88 days), spinosad 0.0070 per cent (5.07 days), indoxacarb 0.0105 per cent (4.53 days), quinalphos 0.070 per cent (3.89 days) and azadirachtin 0.00015 per cent (3.21 days) against first instar larvae of pod borer on pigeonpea receiving first application of insecticides.

Second spray

The result of second spray evident that emamectin benzoate 0.0022 per cent showed comparatively high percentage mortality of first instar larvae of *H. armigera* and persistent toxicity values (27.61 per cent and 920.52) followed by chlorantraniliprole 0.0055 per cent (27.61 per cent and 907.78) at 14 days after spraying. On the basis of PT values the descending order of persistent toxicity was emamectin benzoate 0.0022 per cent (920.52) > chlorantraniliprole 0.0055 per cent (907.78) > flubendiamide 0.0070 per cent (858.69) > spinosad 0.0070 per cent (809.64) > indoxacarb 0.0105 per cent (784.9) > quinalphos 0.070 per cent (734.63) > azadirachtin 0.00015 per cent (685.94). The highest LT_{50}

values of insecticides (Table 3) was found to be emamectin benzoate 0.0022 per cent (7.52 days) followed by chlorantraniliprole 0.0055 per cent (7.32 days), flubendiamide 0.0070 per cent (6.45 days), spinosad 0.0070 per cent (5.63 days), indoxacarb 0.0105 per cent (5.25 days), quinalphos (4.54 days) and azadirachtin (3.89 days) against first instar larvae of pod borer on pigeonpea receiving second application of insecticides.

Third spray

The result of third spray evident that emamectin benzoate 0.0022 per cent, chlorantraniliprole 0.0055 per cent and flubendiamide 0.0070 per cent revealed comparatively high percentage mortality of first instar larvae of *H. armigera* (25.05, 21.52 and 21.52 per cent, respectively) at 14 days after spraying. On the basis of PT values the descending order of persistent toxicity was emamectin benzoate 0.0022 per cent (898.60) > chlorantraniliprole 0.0055 per cent (835.89) > flubendiamide 0.0070 per cent (798.79) > spinosad 0.0070 per cent (748.44) > indoxacarb 0.0105 per cent (699.42) > quinalphos 0.070 per cent (674.68) > azadirachtin 0.00015 per cent (636.73). The LT_{50} values (Table 4) indicated that emamectin benzoate 0.0022 per cent showed highest LT_{50} value (7.27 days) followed by chlorantraniliprole 0.0055 per cent (6.23 days), flubendiamide 0.0070 per cent (5.66 days), spinosad 0.0070 per cent (4.90 days), indoxacarb 0.0105 per cent (4.21 days), quinalphos 0.070 per cent (3.88 days) and azadirachtin 0.00015 per cent (3.42 days) against first instar larvae of pod borer on pigeonpea receiving third application of insecticides.

The present findings on persistence and residual toxicity of emamectin benzoate 0.0022 per cent, chlorantraniliprole 0.0055 per cent and flubendiamide 0.0070 per cent against pod borer of pigeonpea are supported with the work of Isaac Ishaaya, *et al.* (2002) who reported that emamectin benzoate 25 mg a.i per l was a powerful compound for controlling the *H. armigera* resulted in over 90 per cent suppression of *H. armigera* larvae up to 28 day after treatment. Prasad *et al.* (2009) studied the residual and persistent toxicity of different insecticides against 4 to 5 days old larvae of *H. armigera* and reported that indoxacarb at the rate of 131 g a.i. per ha showed quick knock-down effect up to 3 days after spray and were equally effective resulting into 66.67 per cent mortality of the larvae. However, Kanwar *et al.* (2012) documented that flubendiamide 480 SC and indoxacarb 14.5 SC were highly toxic insecticides against 3 to 4 day old larvae of *H. armigera*. Whereas, Nain *et al.* (2013) revealed that maximum larval mortality of *H. armigera* (84.81 per cent) was obtained from spinosad followed by quinalphos (72.93 per cent). Similarly, Meena and Raju (2014) reported that spinosad 45% SC was most effective insecticides against tomato fruit borer. Yogi and Kumar (2013) indicated highest persistent toxicity of emamectin benzoate 5 SG (3102.72) followed by spinosad 45SC (2862.72) against gram pod borer. However, Chankapue *et al.* (2014) 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. Nikam *et al.* (2015) reported that spinosad, emamectin benzoate, chlorantranili prole, flubendiamide were most toxic insecticide against

Table 1: Persistence of different insecticides on pigeonpea pods applied as first, second and third spray against first instar larvae of pod borer, *Helicoverpa armigera*

Insecticides	Corrected percentage mortality after different intervals (days)												P value			T	PT value			RE			O.R.E
	I Spray				II Spray				III Spray				Spray				Spray			Spray			
	1	3	7	14	1	3	7	14	1	3	7	14	I^{ST}	II^{ND}	III^{RD}		I^{ST}	II^{ND}	III^{RD}	I^{ST}	II^{ND}	III^{RD}	
Quinalphos 0.0700 %	78.59	67.70	35.76	13.86	81.44	67.88	43.3	17.27	78.59	63.00	33.30	17.88	48.98	52.47	48.19	14	685.66	734.63	674.68	1.10	1.07	1.06	6
Indoxacarb 0.0105 %	82.12	70.00	39.29	17.27	85.22	75.05	43.3	20.68	82.12	66.67	36.7	14.35	52.17	56.06	49.96	14	730.39	784.9	699.42	1.17	1.14	1.10	5
Emamectin benzoate0.0022 %	100.0	86.70	50.00	27.61	96.33	85.76	53.30	27.61	96.47	85.22	50.00	25.05	66.08	65.75	64.19	14	925.08	920.52	898.6	1.49	1.34	1.41	1
Spinosad 0.0070 %	85.76	73.30	39.29	20.68	88.89	75.05	46.70	20.68	89.29	66.67	40.00	17.88	54.76	57.83	53.46	14	766.62	809.64	748.44	1.23	1.18	1.18	4
Flubendiamide 0.0070 %	89.29	76.70	42.93	24.19	92.56	78.59	50.00	24.20	89.29	74.11	43.30	21.52	58.28	61.34	57.06	14	815.94	858.69	798.79	1.31	1.25	1.25	3
Chlorantraniliprole 0.0055 %	96.47	80.00	46.47	24.19	96.33	82.12	53.30	27.61	92.83	77.78	46.70	21.52	61.78	64.84	59.71	14	864.36	907.78	835.89	1.39	1.32	1.31	2
Azadirachtin 0.00015 %	75.05	60.00	32.23	10.34	77.78	64.35	40.00	13.86	75.05	59.22	33.30	14.35	44.40	49.00	45.48	14	621.68	685.94	636.73	1.00	1.00	1.00	7

Table 2: Probit analysis LT_{50} and related value (First spray)

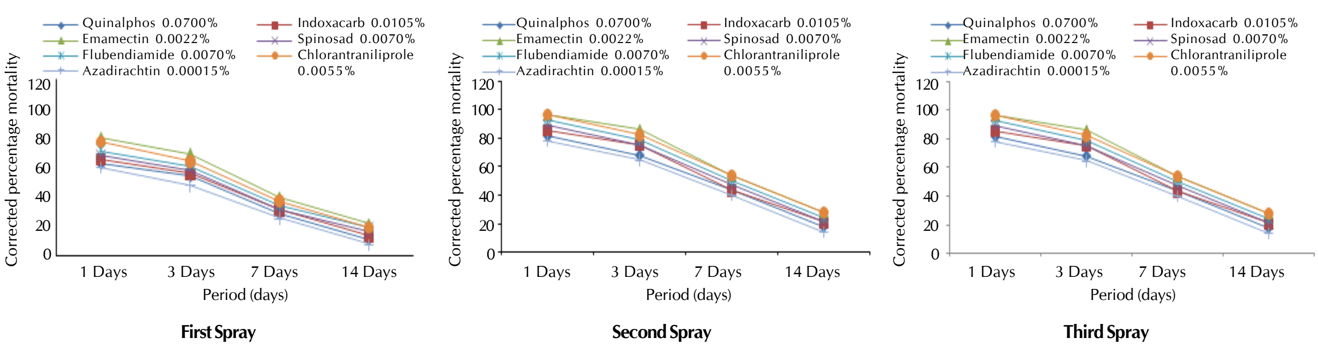
Insecticides	Heterogeneity d.f	c^2	Regression Equation (y = ...)	Log LT_{50} + S.Em	LT_{50} (days)	Fiducial Limit (days)	R.E.	ORE
Quinalphos 0.0700 %	2	0.566	y = 0.0104–1.646 x	0.5904+0.1398	3.89	1.63 (9.07)	1.21	6
Indoxacarb0.0105 %	2	0.440	y=0.0533–1.6655 x	0.6567+0.1384	4.53	2.07 (11.32)	1.41	5
Emamectin benzoate 0.0022 %	2	0.226	y=0.2199-2.7496 x	0.8825+0.0990	7.63	4.75 (15.59)	2.38	1
Spinosad 0.0070 %	2	0.299	y=0.0705-1.7452 x	0.7056+0.1343	5.07	2.51 (12.78)	1.58	4
Flubendiamide 0.0070 %	2	0.212	y=0.1076-1.8116 x	0.7696+0.1329	5.88	3.08 (15.61)	1.83	3
Chlorantraniliprole 0.0055 %	2	0.007	y=0.0745-2.2645 x	0.8197+0.1127	6.60	3.86 (14.42)	2.06	2
Azadirachtin 0.00015 %	2	0.537	y=-0.0575-1.6334 x	0.5060+0.1438	3.21	1.15 (6.97)	1.00	7

Table 3: Probit analysis LT_{50} and related value (Second spray)

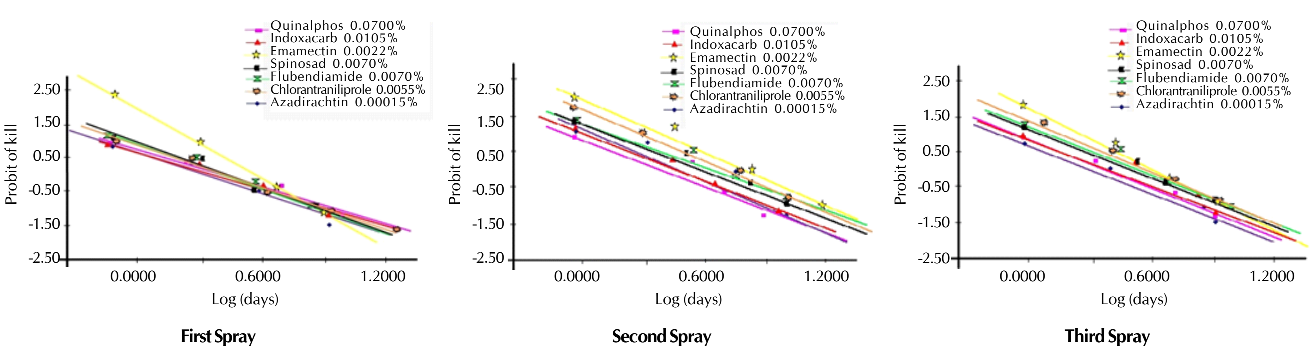
Insecticides	Heterogeneity d.f	c^2	Regression Equation (y = ...)	Log LT_{50} + S.Em	LT_{50} (days)	Fiducial Limit (days)	R.E.	ORE
Quinalphos 0.0700 %	2	0.440	y = 0.0533–1.6655x	0.6567+0.1384	4.54	2.07 (11.32)	1.17	6
Indoxacarb0.0105 %	2	0.539	y=0.0910– 1.7772 x	0.7209+0.1328	5.25	2.66 (13.19)	1.35	5
Emamectin benzoate 0.0022 %	2	0.182	y=0.1268-2.3046 x	0.8763+0.1143	7.52	4.48 (17.66)	1.93	1
Spinosad 0.0070 %	2	0.301	y=0.1020-1.8998 x	0.7506+0.1268	5.63	3.00 (13.51)	1.45	4
Flubendiamide 0.0070 %	2	0.169	y=0.1233-2.0121 x	0.8098+0.1238	6.45	3.61 (15.81)	1.66	3
Chlorantraniliprole 0.0055 %	2	0.043	y=0.1256-2.2154 x	0.8644+0.1174	7.32	4.29 (17.66)	1.88	2
Azadirachtin 0.00015 %	2	0.566	y=0.0104-1.6462 x	0.5904+0.1398	3.89	1.62(9.07)	1.00	7

Table 4: Probit analysis LT_{50} and related value (Third spray)

Insecticides	Heterogeneity d.f	c^2	Regression Equation (y =..............)	Log LT_{50} + S.Em	LT_{50} (days)	Fiducial Limit (days)	R.E.	ORE
Quinalphos 0.0700 %	2	0.392	y = - 0.0351-1.5568x	0.5887+0.1468	3.88	1.48 (9.33)	1.13	6
Indoxacarb0.0105 %	2	0.417	y = - 0.0100 - 1.7406x	0.6248+0.1336	4.21	1.94 (9.61)	1.23	5
Emamectin benzoate 0.0022%	2	0.260	y = - 0.0939-2.273x	0.8616+0.1125	7.27	4.32 (16.43)	2.13	1
Spinosad 0.0070 %	2	0.051	y = - 0.0102- 1.8972x	0.6897+0.1254	4.90	2.52 (10.94)	1.43	4
Flubendiamide 0.0070 %	2	0.259	y = - 0.0804 - 1.8442x	0.7527+0.1301	5.66	2.97 (19.12)	1.65	3
Chlorantraniliprole 0.0055%	2	0.191	y = - 0.0942 - 2.0418x	0.7942+0.1215	6.23	3.48 (14.60)	1.82	2
Azadirachtin 0.00015 %	2	0.341	y = - 0.0670 - 1.5132x	0.5345+0.1517	3.42	1.00 (5.60)	1.00	7



Effect of different insecticides on mortality of first instar larvae of *Helicoverpa armigera* on pigeonpea pods



Log (days) Probit kill regression lines for different insecticides against first instar larvae of *Helicoverpa armigera* on pods of pigeonpea

different larval instars of diamondback moth. Whereas, Kolhe *et al*. (2015) documented highest PT and LD_{50} values in quinalphos 0.07 per cent against first, second and third instar larvae of groundnut leaf miner.

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REFERENCES

Abbot, W. S. 1925. A method of computing the effectiveness of insecticide. *J. Econ. Ent.* **18(4):** 265-267.

Anonymous 2015. www.agricop.nic.in

Bhamare V. K., Dake, R. B. and Patil, P. V. 2015. Persistence and relative toxicity of different insecticides against Custard apple mealy bug, (*Maconellicocus hirsutus*). *Annals of Plant and Soil Res.* **17(6):** 482-485.

Chankapue, R. J., Undirwade, D. B. and Raut, A. M. 2014. Efficacy of new molecules of insecticides against *Helicoverpa armigera* (Hub.) in laboratory condition. *Trends in Biosci.* **7(18):** 2783- 2785.

FAO 2016. The International Year of Pulses-2016. http://www.fao.org/pulses-2016/about/en/.

Finney, D. J. 1971. Probit Analysis, Cambridge University Press, Cambridge. p. 333.

Isaac Ishaaya, Svetlana Kontsedalov and A. Rami Horowitz. 2002. Emamectin, a novel insecticide for controlling field crop pests. *Pest Manag Sci.* **58:** 1091-1095.

Kanwar, Naresh, Ameta, O. P., Pareek, Abhishek and Jain, H. K. 2012. Relative toxicity of insecticides against *Helicoverpa armigera*. *Indian J. Ent.* **74(3):** 233-235.

Kolhe, B. D., Bhamare, V. K., Sawant, C. G. and Naik, M. N. 2015. Residual toxicity of different insecticides against groundnut leaf miner (*Aproaerema modicella* Deventer). *Res. J. Agri. Sci.-An International J.* **6(6)**: 1271-1276.

Lal, C., Sharma, S. K. and Chahota, R. K. 1992. Oviposition response of pod fly (*Melanagromyza obtusa*) on resistant pigeonpea (*Cajanus cajan*) selections. *Indian J. Agricultural Sci.* **64:** 658-660.

Lal, S. S and Singh, N. B. 1998. In: Proceedings of National Symposium on Management of Biotic and Abiotic Stresses in Pulse Crops. *Indian Institute for Pulse Research, Kanpur, India*. pp. 65-80.

Nain, R., Dashad, S. S. and Singh, S. P. 2013. Bio-efficacy of newer insecticides against head borer, *Helicoverpa armigera* (Hubner) infesting sunflower. *Crop Res.* **46(1-3):** 130.

Nikam, T. A., Chandele, A. G. and Awasthi, N. S. 2015. Relative toxicity of some newer insecticides to diamondback moth, *Plutella xylostella* Linnaeus. *The Ecoscan.* **(7):** 105-108.

Meena, L. K. and Raju, S. V. S. 2014. Bio-efficacy of newer insecticides against tomato fruit borer, *Helicoverpa armigera* (Hubner) on tomato, *Lycopersicon esculentum* Mll under field condition. *The bioscan*. **9(1):** 347-350.

Pradhan, S. 1967. Strategy of integrated pest control. *Indian J. Ent.,* **29(1):** 105-122.

Prasad, R., Yadav, G. S. and Rohilla, H. R. 2009. Residual toxicity of some newer insecticides against *H. armigera* (Hub.) on pigeonpea. *J. Insect Sci.* **22(3):** 292-295.

Saini, M. L. 1959. Bioassay of persistence of spray residues on leaf surface of maize using just hatched larvae of *Chilo zonellus* (Swinhoe) as test insect. Assoc. I.A.R.I. Thesis, Indian Agricultural Research Institute, New Delhi (Unpublished).

Sarup, P., Singh, D. S., Amarpuri, S. and Rattan, L. 1970. Persistent and relative residual toxicity to some important pesticides to the adults of sugarcane leaf-hopper, *Pyrilla perpusilla* Walker (Lophopidae : Homoptera). *Indian J. Ent.* **32(3):** 256-267.

Yogi, K. and Kumar, A. 2013. Toxicological studies on the persistence toxicity of certain commonly recommended insecticides for the control of *Helicoverpa armigera* on Chickpea. *Pestology*. **37(2):** 48-50.