Bioassay of new chemistry insecticides against pod borer, *Helicoverpa armigera* on chickpea

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Abstract

Toxicity of different insecticides was evaluated against 2nd and 3rd instar larvae of Helicoverpa armigera *under laboratory conditions by leaf dipping method. The insecticides* viz*., thiodicarb 75WP, novaluron 10EC, spinetroam 11.7EC, indoxacarb 15.8EC, quinalphos 25EC, rynaxypyr 18.5SC, emamectin benzoate 5SG and cypermethrin 25EC were tested. Spinetoram was found most effective in managing the 2nd instar larvae of* H. armigera *and it was followed by novaluron 10EC and indoxacarb 15.8EC as compared to cypermethrin 25EC. Emamectin benzoate 5SG @ 1 x 10^{-7} to 1 x 10^{-9} per cent concentrations recorded 100% mortality against 2nd instar larvae and LC_{50} values for 3rd instar larvae was 0.00000000045%. Insecticides novaluron 10EC, spinetoram 11.7EC and cypermethrin 25EC did not show promising and consistent results against 3rd instar larvae of* H. armigera *at 24 hrs. The LT_{50} of novaluron 10EC at 0.00005% concentration was 19.861 hrs and it was 28.144 hrs at 0.000001% against 2nd instar larvae of* H. armigera.

Keywords: Bioassay, chickpea, *Helicoverpa armigera*, insecticides

Introduction

In India, among the food grains, gram (*Cicier arietinum* L.) is one of the most preferred pulse food crops after green gram and pigeonpea. Majority of the world's chickpea is grown in South Asia, and India has the largest share in world's chickpea area (9.6 million ha), production (8.83 million tones) with average yield of 920 kg per ha (FAO, 2014). Gram pod borer, *Helicoverpa armigera* (Hub.) is the most important pest of the crop and is the main reason for the decrease in the productivity (Singh and Yadav, 2009; Choudhury *et al*., 2013). *H. armigera* is distributed throughout India and is responsible for 50 to 60 per cent losses in grain yield (Balikai *et al*., 2001). Gram pod borer feeds voraciously from seedling stage to maturity of the crop. In India, losses caused by *H. armigera* on chickpea and pigeonpea fields exceeded 12,000 million per year as per survey carried out by ICRISAT (ICRISAT, 1996). Hazards and harmful effects of insecticides as chemical control especially the wide application of conventional insecticides necessitate the use of new chemistry insecticides which are more effective, safer for humans and less toxic to our ecosystem (Korrat *et al*., 2012). These new chemistry insecticides are, more specific for a particular insect pest management. To enhance the crop productivity with multiple pest situations, new insecticides may be used to delay development of insecticide resistance (Attique *et al*., 2006; Ahmad *et al*., 2009). Multiple applications of an average dosage are generally more effective than a single application in overdose. Rotation of insecticides with different modes of action is also recommended to avoid selection for resistant populations. The indiscriminate use of insecticides, particularly during 80s and 90s contributed to the emergence of insecticide resistance in *H. armigera*. Control of this pest was not always adequate probably due to the development of resistance. Moderate to high level of resistance to pyrethroids and organophosphorus insecticides was recorded in field population of *H. armigera* (Ahmad *et al*., 1995). Novaluron is known to be a reduced risk insecticide acting as an insect growth regulator, which does not kill the insect immediately and particularly effective against foliage feeding insects. LT_{50} of this insecticide provide basic information regarding per cent mortality against different time periods. Although a number of insecticides have been recommended by various workers (Thobi and Singh, 1978; Sinha, 1984) for the control of this pest, only a limited amount of work has been reported on laboratory evaluation of insecticides against *H. armigera* (Chari *et al*., 1985 and Mote and Kadam, 1985). The knowledge on the bioassay of new chemistry

insecticides will certainly be helpful in formulating the management strategies for *H. armigera*. Keeping this in view, the present study was undertaken.

Materials and methods

The study was conducted at Pesticide Resistance Management Laboratory, Department of Entomology, CCS Haryana Agricultural University, Hisar during 2013-14. The bioassay of new chemistry insecticides at their LC_{50} values was tested against a laboratory population of *H. armigera*. The second and third instar laboratory reared larvae of *H. armigera* were used for this bioassay study. Large numbers of larvae were collected from the pigeonpea field and rearing of this pest was done on artificial diet under controlled conditions (26±1 ºC temperature and 75% relative humidity) for two consecutive years.

Bioefficacy of test insecticides

Proprietary formulations of the respective insecticides were obtained from different sources. Seven insecticides i.e. indoxacarb (Avant 15.8EC, E.I Dupont. India Ltd.), rynaxypyr (Coragen 18.5SC, E.I Dupont. India Ltd.) quinalphos (Ekalux 25EC, M/s Syngenta India Ltd.), thiodicarb (Larvin 75WP, Bayer Crop Science Ltd.), novaluron (Rimon 10EC, Indofil Chemical Company), spinetoram 11.7EC (not registered in India) and cypermethrin (Root 25EC, Safex Chemicals India Ltd.) were evaluated in terms of LC_{50} values, which were determined in Laboratory experiment. Five to seven concentrations of each insecticide were prepared in distilled water. The mortalities were recorded at 24 h after release. The per cent corrected mortalities were worked out with the help of Abbott's formula (Abbott, 1925), if there was any mortality in control.

Laboratory bioassay was carried out with 5 to 7 concentrations of each insecticide to find out concentration-probit mortality curve against second and third instar larvae of chickpea pod borer, *H. armigera* following leaf dipping method. Different concentrations of the insecticides were prepared in distilled water and two small twigs of the chickpea were then dipped in the solution for one minute and kept in shade for drying of the leaves. Plastic mazenta boxes were used for bioassay studies. Ten per cent agar-agar solution was boiled in 100 ml distilled water and after cooling at room temperature, this solution was poured into plastic magenta boxes making slant position. Chickpea twigs were then inserted into solidified agar-agar medium availing them turgid. Ten second and third instar larvae were transferred on chickpea twigs in each mazenta boxes with the help of wet camel hair brush. Mortality of the larvae was recorded at 24 hrs. Two different sets for second and third instar larvae along with control were taken. For novaluron, bioassay was worked out at different concentrations against 2nd instar larvae at 6, 12, 24, 30, 36, 48 and 72 hr after release. The experiment was replicated thrice. The data were subjected to probit analysis (Finney, 1971).

Results and discussion

The regression equations and data on LC_{50} values,

Table 1. Relative toxicity of insecticides against 2nd instar larvae of *H. armigera* on chickpea

Insecticide	Heterogeneity* χ^2	Regression equation (Y=)	LC_{50}	Fiducial limits	Relative toxicity
Spinetoram 11.7%	4 = 0.254	1.3047 x + 3.1172	0.0000000277	0.0000000169 0.00000004546	1489169.7
Novaluron 10EC	6 = 4.78	1.5553 x + 2.2863	0.00005557	0.00003753 0.00006228	742.3
Indoxacarb 15.8EC	4 = 0.2235	0.4136 x +3.3995	0.00007409	0.00001773 0.0003095	556.8
Rynaxypyr 18.5SC	4 = 0.237	0.9631 x + 2.5209	0.003749	0.0034 0.04099	11.1
Thiodicarb 75WP	5 = 0.123	1.8595 x + 1.22	0.01072	0.007095 0.01619	3.8
Quinalphos 25EC	4 = 3.455	1.4456 x + 2.5003	0.053602	0.03524 0.08152	0.8
Cypermethrin 25EC	5 = 2.1239	1.7107 x + 2.2366	0.04125	0.029246 0.058167	1.0

*In none of these case, the data were found to be significantly heterogenous at P = 0.05; Y = Probit kill; X = log concentration;
LC_{50} = Concentration calculated to give 50% mortality

fiducial limits and relative toxicities (Table 1) of different insecticides revealed that the LC_{50} values of spinetoram, novaluron, indoxacarb, rynaxypyr, thiodicarb, quinalphos and cypermethrin were 0.000000277, 0.0000557, 0.00007409, 0.003749, 0.01072, 0.053602 and 0.04125 per cent, respectively, against second instar larvae of *H. armigera*. The relative toxicities of these insecticides in decreasing order taking cypermethrin as unit were 1489169.7, 742.3, 556.8, 11.1, 3.8 and 0.8 times for spinetoram, novaluron, indoxacarb, rynaxypyr, thiodicarb and quinalphos, respectively. Among all the insecticides tested against 2nd instar larvae of *H. armigera*, spinetoram was 1489169.7 times toxic in comparison to cypermethrin and the next best toxic insecticide was novaluron which was 742.3 times toxic than cypermethrin, however, it was 2006.15 times less toxic as compared to spinetoram. Hence, from the research findings, it is clear that the LC_{50} value of cypermethrin (0.04125) was much higher than its general application at 25EC. Emamectin benzoate tested at 3 x 10^{-7} to 1 x 10^{-9} concentration caused 100 per cent mortality of 2nd instar larvae.

Emamectin benzoate was 273044444.4 times toxic as compared to quinalphos 25EC keeping the value of 1.0 against 3rd instar larvae of *H. armigera* (Table 2). The next most toxic insecticide was indoxacarb with its relative toxicity value of 17.6. LC_{50} value of emamectin benzoate and indoxacarb was 0.00000000045 and 0.007038%, respectively. Insecticides novaluron, spinetoram and cypermethrin did not show promising results against 3rd instar larvae of *H. armigera* after 24 h feeding.

The LT_{50} value of novaluron presented in Table 3 and Fig. 1 revealed that 0.00005 per cent concentration against 2nd instar larvae showed 100 per cent mortality at 48 h. While in case of 0.00001 per cent concentration, it caused 80 per cent mortality at 72 h. The LT_{50} values for second instar larvae of *H. armigera* was recorded at 19.86 h at 0.00005% concentration whereas at 0.00001% concentration, it was achieved at 28.14 h with 12.90 to 30.58 and 22.17 to 35.74 h fiducial limit of 0.00005% and 0.00001% concentrations, respectively.

Cypermethrin 25EC and quinalphos 25EC were found least effective in managing the larval population of *H. armigera*. Pyrethroids were least effective (Sufian *et al*., 2013) due to their high LC_{50} values as compared to new chemistry insecticides. Toxicity against third instar larvae of *H. armigera* was also tested by Samad *et al.,* (2003) and they found that chlorpyriphos and spinosad were more effective insecticides against 3rd instar larvae of cotton bollworm as compared to abamectin based formulated materials. On the basis of LC_{50}, monocrotophos and quinalphos were found to be highly toxic; DDVP, phosalone, fenitrothion and endosulfan were moderately toxic and malathion was the least toxic compound against third instar larvae of *H. armigera* under laboratory studies (Debnath *et al*., 1989).

It can be inferred from the present study that the new molecule insecticides can effectively manage the larval population of *H. armigera*. Among the tested insecticides spinetoram and emamectin benzoate could be the first choice for management of *H. armigera* in chickpea crop.

Table 2. Relative toxicity of insecticides against 3rd instar larvae of *H. armigera* on chickpea

Insecticide	Heterogeneity* χ^2	Regression equation (Y=)	LC_{50}	Fiducial limits	Relative toxicity
Emamectin benzoate 5SG	4 = 0.9839	0.8753 x + 4.4203	0.00000000045	0.0000000039 0.00000000019	273044444.4
Indoxacarb 15.8EC	5 = 0.792	0.795 x + 2.7363	0.007038	0.002892 0.017125	17.6
Quinalphos 25EC	4 = 0.489	1.3029 x + 2.2776	0.12287	0.1545 0.09776	1.0

Table 3. Relative toxicity of Novaluron 10EC against 2nd instar larvae of *H. armigera* on chickpea

Insecticide	Concentration	Heterogeneity* χ^2	Regression equation (Y=)	LT_{50}	Fiducial limits
Novaluron	0.00005%	5 = 1.4068	1.3413 x + 1.9177	19.861 h	12.899 h 30.581 h
Novaluron	0.00001%	6 = 1.3461	2.1065 x + 0.1596	28.144 h	22.169 h 35.742 h

*In none of these cases, the data were found to be significantly heterogenous at P = 0.05; Y = Probit kill; X = log concentration;
LC_{50} = Concentration calculated to give 50% mortality; LT_{50} = Time taken to give 50% mortality

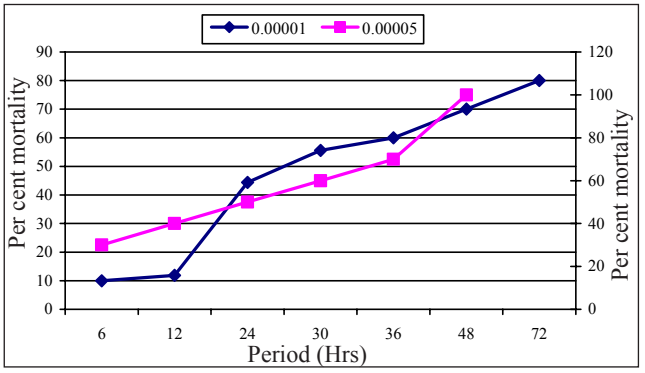

Figure 1. Per cent mortality of 2nd instar larvae of *H. armigera* at two different concentrations of Novaluron 10EC

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