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Comparative Toxicity of IGRs and New Chemistry Insecticides against Cabbage Butterfly (*Pieris Brassicae Nepalensis*)

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ABSTRACT

An experiment was conducted to study the toxicity of IGRs lufenuron (Match 5% EC), emamectin benzoate (Proclaim 1.9 EC) and new chemistry insecticides namely, chlorantraniliprole (Coragen 20% SC) and chlorantraniliprole + thiamethoxam (Voliam Flexi 300 SC) against different larval instars of *P. brassicae nepalensis* during 2020-21. The field population collected from Faisalabad was tested using leaf dip bioassay method under laboratory conditions. Overall results showed that a new chemistry insecticide chlorantraniliprole + thiamethoxam (Voliam Flexi 300 SC) was most toxic insecticide against all larval instars of *P. brassicae nepalensis* followed by chlorantraniliprole (Coragen 20% SC). IGRs (Lufenuron and emamectin benzoate) have been found least effective insecticides. Lufenuron (Match 5% EC) was found most less toxic insecticide.

Keywords: Cabbage Butterfly, *Pieris brassicae,* IGR, Voliam Flexi, Coragen, Lufenuron, Emamectin benzoate, comparative toxicity

Introduction

Among winter cole crops, Cabbage (*Brassica oleracea:* Cruciferae/ Brassicaceae) is an important nutritive and second most economical cooked vegetable **(Stewart et al., 2011)**. In Pakistan, it is cultivated on 4983 hectares having 77233 tones production. It is a rich source of vitamins including vitamin B1 (9%), vitamin B2 (7%), vitamin B3 (4%), vitamin B6 (20%), vitamin C (69%) and vitamin K (79%). It also includes minerals including magnesium (6%), iron (6%), calcium (6%), phosphorous (7%), copper (9%), potassium (11%), manganese (17%), selenium (6%), fiber (16%) and proteins (5%) **(Drewnowski, 2013)**.

Cabbage is attacked by both sucking and chewing insect pests, which are cabbage butterfly, army worm, cabbage semi looper, diamond back moth, cabbage bag worm, aphid, cutworms, root maggots and flea beetles **(Munthali *et al.,* 2004)**. Among which, cabbage butterfly *Pieris brassicae nepalensis* (Lepidoptera: Pieridae) is a major insect pest. There are many species found in cabbage and cauliflower some of which important are *P. b. nepalensis, P. candida* L. and *P. rapae* L. **(Thapa, 1987)**. Its larvae usually cause 4-13% damage to leaves and 23-58% on plants depending upon the cabbage varieties **(Ahmed, 2008)**. Its larvae can destroy crucifer crops convivially and also make hole in to the curds. Its larvae feeds on foliage, in severe infestation only stems and large veins are visible in fields and can destroy the whole crop up to 100 %. In less heavily infested fields plants become stunted and contaminated with dark green faecal pellets **(Capinera, 2014)**.

Now days due to ecological disturbances and climate changes, efficacy of natural control is reduced to a great extent. That is why, the emphasis has been given to develop an effective applied control which must be easy to apply, economic and acceptable to farmers **(Deshmukh et al., 2015).** It is need of time to test the insecticides in laboratory and field conditions to select the best and safe insecticides to manage this destructive insect pest of cabbage. In Pakistan, farmers consider the pesticides application as main tool to control the pests. Due to which it has developed resistance against many insecticides which make it an important insect pest of cabbage **(Mota-Sanchez et al., 2002)**. The malathion, fenvalerate, dichlorvos, phosalone and phosphamidon showed poor efficacy against this noxious pest due to resistance development **(Devjani and Singh, 2001).** One of the major reasons for the resistance development to insecticides against this pest is due to the increase in number of sprays. Farmers mostly use the broad spectrum organophosphates, pyrethroids and many other conventional insecticides **(Kumar, 1995)**. Environment friendly and effective new insecticides are also obtainable in the local pesticide markets of Pakistan. This study was planned to find out most effective new chemistry and IGRs insecticide against larval stages of cabbage butterfly management.

Materials & Methods

Field Collection

Field population of cabbage butterfly was collected from cabbage/cauliflower fields of AARI, Faisalabad during 2020-21. Eggs and caterpillars were collected. These were kept in plastic jars along with host plant leaves for their safe transportation to laboratory.

Laboratory Rearing of Cabbage Butterfly

The larvae were kept at 25+2 ^{o}C, 65% RH with 16 hour photo phase in plastic jars (2kg) having cabbage leaves as feed. Pupae were collected on daily basis. Adults were provided with 10% honey solution. 3-4 leaves were kept in jars for egg laying. Bioassays were accomplished afterward completion of one generation of laboratory reared to reduce the chances of field residual effect and to obtain abundant number of larvae for bioassay.

Bioassay

Two new chemistry insecticides viz., chlorantraniliprole +Thiamethoxam (Voliam Flexi 300 SC; Syngenta Pakistan Limited Karachi), chlorantraniliprole (Coragen 20% SC; FMC United (Pvt) Limited Lahore) and two IGRs viz., Emamectin Benzoate (Procalim 1.9 EC; Syngenta Pakistan Limited Karachi) and Lufenuron (Match 5 EC; Syngenta Pakistan Limited Karachi) were tested. Top film (Helb Pesticides & Chemicals Pakistan (Pvt) Limited Multan) was used as a surfactant at rate of 5 ppm to increase adhesiveness to leaf surface during the preparation of insecticide solutions and also during control. Standard leaf disc bioassay method was adapted during bioassay (**Sayyed et al., 2008**). Cabbage leaves were collected from that fields having no pesticide spray, washed in a good way with water, dried and dipped in a test solution for 10-15 seconds and then kept to dry for one hour at room temperature. After completing the drying process, the leaf discs were kept in those petri dishes which have moisturized filter paper.

Data Analysis

Mortality rate of cabbage butterfly larvae were noted after 48 and 72 hours exposure to insecticide. Larvae were considered dead when they could not indicate any movement with moderate touch with blunt needle. The corrected mortality was calculated by using the Abbott's formula **(Abbott, 1925)** and analyzed by Probit analysis (Finney, 1971) using POLO-PC software **(LeOra software, 1987)**.

Results and Discussion

Comparison of LC_{50} values of IGRs lufenuron (Match 5% EC), emamectin benzoate (Proclaim 1.9 EC) and new chemistry insecticides namely, chlorantraniliprole (Coragen 20% SC) and chlorantraniliprole + thiamethoxam (Voliam Flexi 300 SC) against first instar larvae of *P. brassicae nepalensis* population collected from Faisalabad revealed that new chemistry inseceticide chlorantraniliprole + thiamethoxam (Voliam Flexi 300 SC) proved to be the most effective insecticide with least LC_{50} (265 and 193) value after 48 and 72 hours followed by chlorantraniliprole (Coragen 20% SC) having LC_{50} (663 and 444) and while IGRs (Lufenuron and emamectin benzoate) have been found least effective insecticides. Emamectin benzoate was found less toxic insecticide having highest LC_{50} value (959 and 598). Similarly at 2nd, 3rd and 4th larval instars chlorantraniliprole + thiamethoxam (Voliam Flexi 300 SC) was most toxic insecticide with least LC_{50} (265, 178, 584, 450 and 355, 274) values after 48 and 72 hours followed by chlorantraniliprole (Coragen 20% SC) having LC_{50} (480, 342, 598, 709 and 685, 584) values after 48 and 72 hours while both IGRs have found less toxic due to high LC_{50} values while Lufenuron was found least effective insecticide with highest LC_{50} (663, 444, 1200, 833 and 1042, 687) values. Overall results showed that chlorantraniliprole + thiamethoxam (Voliam Flexi 300 SC) was most toxic insecticide against all larval instars after 48 and 72 hour with least $LC_{50,}$ CF 1 and CF 2 values (Table 1.)

Comparison of all four insecticides reveals that chlorantraniliprole + thiamethoxam (Voliam Flexi 300 SC) was also most toxic insecticide against 1st, 2nd, 3rd and 4th larval instars of *P. brassicae nepalensis* population collected from Faisalabad with least CF 2 value after 48 and 72 hr respectively followed by chlorantraniliprole (Coragen 20% SC), emamectin benzoate (Proclaim 1.9 EC) and lufenuron (Match 5 % EC) while IGR lufenuron (Match 5 % EC) was least effective insecticide against 2nd, 3rd and 4th larval instars with highest CF2 value after 48 and 72 hr while against 1st larval instar emamectin benzoate (Proclaim 1.9 EC) was least effective insecticide with highest CF2 value (Table 1.). So it is concluded that new chemistry insecticide voliam flexi 300 SC is most effective insecticide for management of larval stages of cabbage butterfly (*P. brassicae nepalensis*) followed by coragen 20% SC and IGRs are less effective against this pest.

Tested population showed susceptibility level relatively more than that used by as local reference strain **(Rafiq, 2005)**. This variation may be by less usage of these insecticides due to less incidence of this pest in this area. Due to less pest pressure, the no of insecticide applications may have decreased on cabbage and cauliflower and less exposure of new chemistry insecticides may have produced number of susceptible individuals in the field population. This can be the probable reason of variation in the larval instars against these insecticides **(Mazlan and Mumford, 2005).**

In different insect pest populations, variation in susceptibility to insecticides is considered as an important factor **(Rafiq, 2005)**. In mostly comparison toxicity of insecticides research, insecticide to insecticides is compared with LC_{50} or mortality percentage with a reference population for field and laboratory experiments (**Vastrad et al., 2003**). This study can be helpful to find areas of crop having susceptible to resistant tested insect populations. This important insect pest can be managed on area wise by using this information regarding less resistance to cabbage butterfly in field population. Though, present reasonably variable reaction for different larval instars tested against the four insecticides which may be due to variation in rate of

exposure, size and feeding potential. This study suggests among all tested insecticide the use of new chemistry insecticides Chlorantraniliprole +Thiamethoxam (Voliam Flexi 300 SC) followed by chlorantraniliprole to manage this important insect pest particularly in vegetable fields of cabbage/cauliflower. This can also be applied in other cash crops grown areas particularly cotton zone where have to rely on chemical control.

Table 1: Toxicity of four different insecticides to four larval instars of field collected *Pieris brassicae*

Insecticide	**Strain**	**Instar**	**Time (hr)**	**LC50 (FL at 95%)**	**Slope ±SE**	**CF1**	**CF2**
Emamectin benzoate (Procalim 1.9 EC)	FSD	1st	48	959 (352-2429)	0.99±0.36	1.52	3.62
			72	598 (158-1142)	1.09±0.37	1.07	3.36
		2nd	48	632 (143-1278)	1.01±0.36	1	2.38
			72	559 (216-950)	1.33±0.38	1	3.14
		3rd	48	855 (126-1636)	1.07±0.37	1.35	3.23
			72	961 (391-1560)	1.49±0.40	1.72	5.40
		4th	48	960 (390-1559)	1.49±0.40	1.52	3.62
			72	848 (387-1309)	1.76±0.44	1.52	4.76
Lufenuron (Match 5 % EC)	FSD	1st	48	663 (326-1990)	1.07±0.36	1	2.50
			72	563 (255-1467)	1.06±0.36	1.27	3.16
		2nd	48	663 (326-1990)	1.07±0.36	1	2.50
			72	444 (170-979)	1.06±0.36	1	2.49
		3rd	48	1200 (629-2720)	1.19±0.37	1.81	4.53
			72	833 (368-1589)	1.19±0.37	1.88	4.68
		4th	48	1042 (412-2839)	0.99±0.36	1.57	3.93
			72	687 (249-1232)	1.19±0.37	1.55	3.86
Chlorantraniliprole (Coragen 20 % SC)	FSD	1st	48	663 (326-1990)	1.06±0.36	1.38	2.50
			72	444 (170-979)	1.06±0.36	1.30	2.49
		2nd	48	480 (176-1215)	0.99±0.36	1	1.81
			72	342 (86-710)	1.01±0.36	1	1.92
		3rd	48	598 (158-1142)	1.09±0.37	1.25	2.26
			72	709 (254-1347)	1.13±0.37	2.07	3.98
		4th	48	685 (173-1420)	1.01±0.36	1.43	2.58
			72	584 (208-1027)	1.25±0.38	1.71	3.28
Chlorantraniliprole +Thiamethoxam (Voliam Flexi 300 SC)	FSD	1st	48	265 (130-796)	1.07±0.36	1	1
			72	193 (86-415)	1.12±0.36	1.08	1.08
		2nd	48	265 (130-796)	1.07±0.36	1	1
			72	178 (68-392)	1.06±0.36	1	1
		3rd	48	584 (282-2314)	1.01±0.36	2.20	2.20
			72	450 (204-1174)	1.06±0.36	2.53	2.53
		4th	48	355 (136-783)	1.06±0.36	1.34	1.34
			72	274 (69-568)	1.01±0.36	1.03	1.54

CF1, compared with least value of each insecticide

CF2, compared with least value of all insecticides

FSD= Faisalabad

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