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COMPARATIVE TOXICITY OF SOME IGRs, A MINERAL OIL AND CARBOSULFON AGAINST CANOLA APHID UNDER LABORATORY CONDITION

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ABSTRACT

Canola is an important oil seed crop of the world while insect pest's infestation plays a limiting factor in canola production. The canola aphids are serious pests of this crop and cause maximum damage. Insect growth regulators (IGRs) are compounds which target those metabolic processes that affect growth of insects. Present study was carried out to evaluate the toxicity of some IGRs like, lufenuron, triflumuron, methoxyfenozid, buprofezin, pyriproxyfen and amineral oil (Diver®) in comparison with carbosulfon against aphid. Ten concentrations (0.0625, 0.125, 0.25, .025, 1.0, 2.0, 4.0, 8.0, 8.0, 16.0 and 32.0) of each insecticide were used under laboratory conditions. All the insecticides showed dose dependent toxic effects on both (male and female) aphid population and caused maximum mortality at highest concentration. Methoxyfenzide, lufenuron, pyriproxyfen, triflumuron, buprofezin, Diver® and carbosulfan caused 96.6, 89.9, 90.6, 69.5, 83.4, 84.9 and 78.2% mortality, respectively. The LC50 values show that all the tested insecticides are comparatively less toxic for female and more toxic for male aphids. Though, the used IGRs are reported toxic to the non-target organisms but they show low toxicity as compare to the synthetic insecticides. Thus, the use of these insecticides in aphid control programs will provide positive control with less toxicity to the environment.

Keywords: Canola aphids, Efficacy, IGRs, Mineral oil

INTRODUCTION

Different insect pest including aphids, armyworm, cabbage butterfly, loopers, whitefly, mustard sawfly, pea leaf miner, painted bug, green bug, hairy caterpillar, diamond back moth and cricket attack rape and mustard (Buntin and Raymer, 1994; Brown *et al.*, 1999; Hashmi, 1994; Hainan *et al.*, 2007). The canola aphids are serious pest of fall- and spring-seeded canola prior to and during bloom periods of canola in various canola growing tract of Pakistan (Sarwar, 2013). Indirectly, they cover the infested plants with honeydew which encourages the growth of black sooty mould, thereby plummeting the rate of photosynthesis of plants and generally decreasing plant vigour (Razaq *et al.,* 2011; Griffin and Williamson, 2012; Sarwar, 2013). They also spread many viral diseases by transmitting respective viruses in many plant species as vectors (Sarwar, 2013). Their infestation at vegetative, flowering and pod formation stages result in leaves curling, abortion of flower buds and deformation of developing pods without seed formation, respectively (Razaq *et al*., 2011; Opfer and McGrath, 2013). The highly infested plants lose their vitality, vigor and development (Sarwar *et al*., 2011). Canola aphids result in yield losses of upto 40-50 percent in untreated fields (Razaq *et al*., 2011). Presence of aphid's colony on the underside of leaves results in distinctive distortion of leaf causing crinkling and blistering (Hines and Hutchison, 2013; Sarwar, 2013). Aphids' damage to canola plants by their feeding, honeydew secretion and viruses' transmission may reduce one third of total yield potential of canola plants (Berlandier *et al*., 2010; Sarwar, 2013). These losses cannot be reduced without application of the insecticides in Pakistan (Sarwar, 2013).

.Besides all other alternative control measures, seed treatment, soil application and foliar spray of insecticides as chemical control of insect pests is inevitable in the world (Gogi *et al.*, 2006; Sarwar, 2013). Canola growers use

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insecticides intensively for the control of aphids, but blind useof conventional insecticides has resulted in resistance development in aphids (Owain *et al*., 2008) to insecticides including methomyl, emamectin benzoate, pyrethroids (cypermethrin, lambdacyhalothrin, bifenthrin and deltamethrin) and neonicotinoids (imidacloprid, acetamiprid, and thiamethoxam)(Ahmad and Akhtar, 2013), magnification of toxic residues in canola seeds as well as in other canola based products like canola oils, mortality of beneficial arthropods associated with predation or parasitism (Gogi *et al*., 2006; Desneux *et al*., 2007), environmental pollution and health hazards. There is need to explore biorational based molecules/insecticides to handle these issues.

Insect growth regulators (IGRs) are compounds which target those metabolic processes that affect growth of insects. These compounds, not being neurotoxins, are not only arthropod-specific but also less harmful to man and other vertebrates than conventional insecticides (Fox, 1990). These chemicals suffer prompt degradation and metabolism to innocuous metabolites in soils, plants, insects, and animals. They reveal no clinical signs of toxicosis and teratological effects in higher animals (Wright, 1976). Different types of IGRs have been evaluated against a varieties of aphids (Hatakoshi *et al*., 1991; Kerns and Stewart, 2000; Sadeghi *et al*., 2009; Bahmani *et al*., 2011) but very little literature is available on the evaluation of IGRs against canola aphids on canola crop. Present study was carried out to evaluate the toxicity of some IGRs (lufenuron, triflumuron, methoxyfenozid, buprofezin, pyriproxyfen) a mineral oil (Diver®) in comparison with carbosulfon against aphid.

MATERIALS AND METHODS

Culture of aphid population

Canola aphids were collected from the field of brassica and cultured in the glass cages in IPM laboratory on the top most branches of canola plants clipped from the fields. The old, weak and dried branches were replaced with new and fresh branches at weekly interval.

Insecticides

The insecticides given in Table 1 were evaluated against canola aphids.

Preparation of concentrations

Ten concentrations (0.0625, 0.125, 0.25, 0.5, 1.0, 2.0, 4.0, 8.0, 16.0 and 32.0) of each IGR were prepared from the stock solution. The determined quantity of formulation of each insecticide was mixed in water up to required volume to prepare 32% stock solution. The half of this volume was taken into another graduated beaker and volume was made up to original to prepare 16% solution from stock solution. In this way all further concentrations were prepared from the stock solution.

Experimental Layout

The experiment was laid out in completely randomized design having three repeat under laboratory conditions. Twig dip method was used for the evaluation of toxicity of IGRs. Two feet long twig having immature pods and few leaves were clipped from the field, brought into IPM laboratory, rinsed in water, air-dried and dipped in respective test solutions for five minutes. These twigs were taken out of solution and air-dries. The treated twigs were fixed in circular thermopore sheet which was then adjusted in the plastic cups having nutritive solution. Twenty wingless adult aphids (10 males and10 females) were inoculated on the treated twigs and detained with the help of perforated polythene bag covering the treated twigs. A card tray was adjusted on the lower side of cups to accommodate the killed aphid which might fall down of the treated twigs. After three days of exposure, the aphids were observed. All the aphids were disturbed with the camel hair brush and movement of their body appendages like legs and antennae were observed under microscope. The aphids showing no movement of their appendages were considered dead. The dead aphids were counted to calculate percentage mortality.

Statistical analysis

The mortality data were transformed into present corrected mortality if mortality was observed in control as described by Henderson and Tilton (1955) using following formula:

$$\text{Corrected \%} = \left(1 - \frac{\text{n in Co before treatment} \times \text{n in T after treatment}}{\text{n in Co after treatment} \times \text{n in T before treatment}}\right) \times 100$$

List of insecticides

Active ingred ients	Trade name	Company	Formulation	Category
Lufenuron	Match®	Syngenta	50%EC	IGRs
Triflumuron	Capture®	Warble pvt Ltd	20% SC	IGRs
Methoxyfenozide	Runner®	Dow agro sciences	240 SC	IGRs
Buprofezin	Viper®	Agri. Top	25% w/w	IGRs
Pyriproxyfin	Priority®	Kanzo	1.8% EC	IGRs
carbosulfan	Advantage	FMC	20 % EC	Carbamate
Aliphatic hydrocarons	Diver®			

Where: n = Insect population, T = treated, Co = control
The percent corrected mortality, fecundity and longevity data were subjected to ANOVA techniques and Tukey HSD test.

RESULTS

Impact of different concentrations of various insecticides on the mortality of male canola aphids

A significant variation in the mortality of males of canola aphids was observed when exposed to various concentrations of insecticides (P < 0.05). In all tested insecticides, the mortality increased with increasing concentrations. Methoxyfenozide, lufenuron, pyriproxyfen, triflumuron, buprofezin, Diver® and carbosulfan explained mortality in male aphids ranging from 16.7% to 96.5%, 20.0% to 89.9%, 15.0% to 88.0%, 16.6% to 60.3%, 22.2% to 84.0%, 20.0% to 86.8% and 13.3% to 76.7%, respectively, being higher at 32% concentration and lower at 0.0625% concentration. At highest concentration (32%), maximum mortality in males of canola aphids was exhibited by methoxyfenozide (96.5%) followed by lufenuron (89.9%), pyriproxyfen (88.0%), Diver® (86.8%), buprofezin (84.0%), carbosulfan (76.7%) and triflumuron (60.3%). All IGRs (except triflumuron) and Diver® performed better than carbosulfan which was used as standard (Table 1).

Impact of different concentrations of various insecticides on the mortality of female canola aphids

Concentrations of insecticides had a significant effects on the mortality of female canola aphids (P < 0.05). In all tested insecticides, a concentration dependent increase in the mortality of female canola aphids was observed as mortality increased with increasing concentrations. A mortality in female canola aphids ranging from 13.3% to 96.7%, 16.6% to 90.0%, 16.6% to 93.2%, 16.6% to 79.0%, 16.7% to 82.8%, 18.3% to 83.0% and 17.3% to 17.7% was demonstrated by methoxyfenozide, lufenuron, pyriproxyfen, triflumuron, buprofezin, Diver® and carbosulfan, respectively, being higher at 32% concentration and lower at 0.0625% concentration. At highest concentration (32%), maximum mortality in females of canola aphids was exhibited by methoxyfenozide (96.7%) followed by pyriproxyfen (93.2%), lufenuron (90.0%), Diver® (83.0%), buprofezin (82.8%), carbosulfan (79.7%) and triflumuron (79.0%). All IGRs, (except triflumuron) and Diver® performed better than carbosulfan which was used as standard (Table 2).

LC_{50} of various insecticides for canola aphids

The LC_{50} values show that all the tested insecticides are comparatively less toxic for females and more toxic for male aphids as LC_{50} values of these insecticides were less for male and higher for female aphids. Methoxyfenozide, lufenuron, pyriproxyfen, buprofezin and Diver® exhibited similar performance as their LC_{50} values were observed statistically nonsignificant in case of both male and female aphids. Methoxyfenozide, lufenuron, pyriproxyfen, buprofezin and Diver® were more effective than triflumuron and carbosulfan as they demonstrated 1.7, 1.4, 1.6, 1.7 and 1.5 times less LC_{50}

Table 1
Mortality of male canola aphids caused by different insecticides at their various concentrations.

Concentrations	Percent Mortality						
	Methoxyfenozide	Lufenuron	Pyriproxyfen	Triflumuron	Buprofezin	Diver®	Carbosulfan
0.0625 %	16.7 cd	20.0 de	15.0 de	16.6 a	22.2b	20.0 de	13.3 cd
0.125 %	20.3 bcd	23.7 de	17.0 de	27.7 a	24.0 b	23.3 de	20.0 cd
0.25 %	24.3 bcd	30.6 cde	27.0 cde	30.8 a	26.3 b	33.4 cde	30.0 bcd
0.5 %	27.4 bcd	37.8 bcde	27.0 cde	34.0 a	32.0 ab	33.5 cde	30.0 bcd
1 %	47.6 abcd	51.3 abcd	39.3 bcde	47.6 a	37.3 ab	43.4 bcd	43.3 abc
2 %	48.0 abcd	58.0 abcd	57.0 abcd	47.5 a	43.0 ab	53.4 abcd	46.6 abc
4 %	58.0 abc	65.5 abc	58.6 abcd	54.6 a	48.6 ab	63.3 abc	50.0 abc
8 %	62.0 abc	66.0 abc	65.4 abc	55.3 a	52.0 ab	70.0 abc	53.3 abc
16 %	68.8 ab	75.7 ab	73.5 ab	57.7 a	53.0 ab	76.7 ab	66.7 ab
32 %	96.5 a	89.8 a	88.0 a	60.3 a	84.0 a	86.8 a	76.7 a

Table 2
Mortality of female canola aphids caused by different insecticides at their various concentrations.

Concentrations	Percent Mortality						
	Methoxyfenozide	Lufenuron	Pyriproxyfen	Triflumuron	Buprofezin	Diver®	Carbosulfan
0.0625 %	13.3 ef	16.6 ef	16.6 ef	16.6 cd	16.7 cd	18.3 de	17.3 bc
0.125 %	20.3 def	16.7 ef	16.6 ef	16.7 cd	16.5 cd	20.7 de	17.3 bc
0.25 %	30.6 cdef	40.0 de	20.0 def	23.8 bcd	31.8 bcd	27.4 de	31.0 abc
0.5 %	33.7 bcde	40.0 de	30.3 cde	27.3 bcd	34.4 abcd	34.000 cde	30.4 abc
1 %	51.3 bcde	53.3 cd	46.6 bcde	51.3 abc	42.6 abcd	47.9 bcd	59.0 ab
2 %	58.0 abcd	53.5 cd	46.7 abc	54.7 abc	47.5 abc	59.0 abc	60.2 ab
4 %	65.8 abc	63.2 bcd	50.0 bcd	55.4 abc	56.0 abc	69.0 abc	62.3 ab
8 %	79.0 ab	76.7 abc	50.0 bcd	65.2 ab	68.4 ab	79.8 ab	66.0 ab
16 %	79.5 ab	80.0 ab	56.8 bc	65.7 ab	72.7 ab	72.2 ab	76.0 a
32 %	96.7 a	90.0 a	93.2 a	79.00 a	82.8 a	83.0 a	79.7 a

values than carbosulfan and 1.4, 1.2, 1.4, 1.5 and 1.2 times less LC_{50} values than triflumuron, respectively, in case of male aphids; whereas, 2.1, 1.8, 1.9, 2.1 and 1.8 times less LC_{50} values than carbosulfan and 1.8, 1.6, 1.7, 1.9 and 1.5 times less LC_{50} values than triflumuron, respectively, in case of female aphids (Fig. 1).

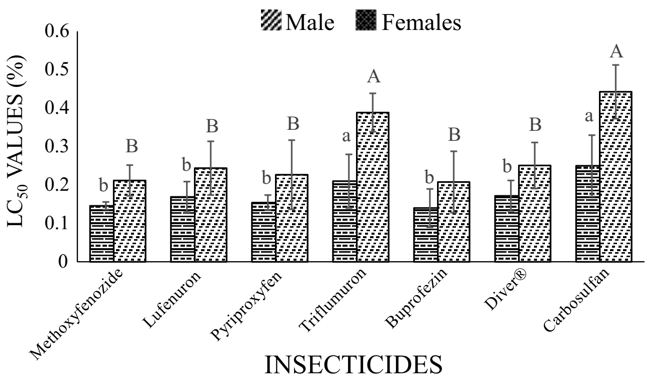

Fig. 1
LC50 values of different insecticides for male and female aphids (bars showing similar letters in same case do not differ significantly from each other at probability value of 0.05).

DISCUSSION

During the last decades, many researchers have studied toxicity of pesticides on sap-sucking insects including aphid. The present study was carried out under lab conditions for the assessment of toxicity of a mineral insecticides, diver® (aliphatic hydrocarbon) and some IGRs (lufenuron, triflumuron, methoxyfenozid, buprofezin, pyriproxyfen) at different concentrations on canola aphids (male and female) in comparison with carbosulfan used as standard. All the IGRs, diver® and standard showed different toxic effects to the aphid. The difference in toxicity of the tested pesticides observed in the present study might be due to the difference in their mode of action and formulation.

All the insecticides revealed dose dependent toxicity on aphids. Triflumuron was the only insecticides which caused significant mortality in both sexes, while all the other insecticides showed almost same toxic effect on both (male and female) aphids. Methoxyfenozide showed maximum mortality of aphid at highest concentration as compare to any other insecticide used. Evidence collected to date indicates that methoxyfenozide has been an excellent margin of safety to non-target organisms, including a wide range of non-target and beneficial insects (Carlson *et al*., 2001) which makes this insecticide suitable for the management of insects especially aphid. The second most toxic pesticides were lufenuron and pyriproxyfen. They cause almost 90% mortality in aphid population with slight difference at highest concentration. Similarly, buprofezin and diver® also showed dose dependent aphid mortality. The LC_{50} values show that all the tested insecticides are comparatively less toxic for females and more toxic for male aphids as LC_{50} values of these insecticides were less for male and higher for female aphids. This shows that female aphids are more resistant to insecticides then male aphids. Less mortality in female aphids might be attributed to more quantity of fat bodied in their bodies as compared to male aphids.

The pesticides can be used to control the aphid without adversely affecting their predators (Vasquez *et al*., 1987). Methoxyfenozide, lufenuron, pyriproxyfen, buprofezin and Diver® exhibited similar performance as their LC_{50} values were observed statistically nonsignificant in case of both male and female aphids. Evidence collected to date indicates that methoxyfenozide has an excellent margin of safety to non-target organisms, including a wide range of non-target and beneficial insects (Carlson *et al.,* 2001). Similarly, other tested IGR's may or may not have toxic effects to the non-target organisms which should be evaluated. The most interesting phenomenon is that the diver® also showed the toxic effects to the exposed aphids and caused almost 80% mortality. These results are not in agreement with Hansen and Nielsen (2011) who reported that mineral oil and insecticides applied to potato crops each week for a 6-week period as protection to Potato virus Y (PVY) by *Myzus persicae* Sulzer in potato filed. This difference might be due to the factor that we studied the effect in the laboratory. But, it will be interesting to use the mixtures of IGR's with diver® against aphid to evaluate the synergistic and antagonistic effects of the mixture of both. If the IGRs show synergistic or additive effects, then they will become highly effective against aphid population even at low doses.

In conclusion, this study provided the basis to control canola aphid effectively without causing damage to the beneficial fauna and the environment.

REFERENCES

Ahmad, M. and S. Akhtar, 2013. Development of insecticide resistance in field populations of *Brevicoryne brassicae* (Hemiptera: Aphididae) in Pakistan. J. Econ. Entomol., 106: 954-958.

Bahmani, S., A.A. Keyhanian and H. Farazmand, 2011. The Effect of pyriproxyfen, hexaflumuron and flufenoxuron on the cabbage aphid, *Brevicoryne brassicae* L. (Hem., Aphididae), in canola field. J. Entomol. Res., 3(2): 133-141.

Berlandier, F., D. Severtson and P. Mangano, 2010. Aphid management in canola crops. Department of Agriculture and Food, Note 440.

Brown, J., J.P. Mccaffrey, B.L. Harmon, J.B. Davis, A.P. Brown and D.A. Erickson. 1999. Effect of late season insect infestation on yield, yield components and oil quality of *Brassica napus, B. rapa, B. juncea* and *Sinapis alba* in the Paci®c Northwest region of the United States. J. Agric. Sci., Cambridge, 132: 281-288.

Buntin, G.D. and P.L. Raymer, 1994. Pest status of aphids and other insects in winter canola in Georgia. J. Econ. Entomol., 87: 1097-1104.

Carlson, G.R., T.S. Dhadialla , R. Hunter, R.K. Jansson, C.S. Jany, Z. Lidert and R.A. Slawecki, 2001. The chemical and biological properties of methoxyfenozide, a new insecticidal ecdysteroid agonist. Pest Manag. Sci., 57(2):115-9.

Desneux, N., A. Decourtye, and J.M. Delpuech. 2007. The sublethal effects of pesticides on beneficial arthropods. Ann. Rev. Entomol., 52:81-106.

Fox, P., 1990. Insect Growth Regulator. Agrow, PJB Publications, Richmond, UK.

Gogi, M.D., R.M. Sarfraz, L.M. Dosdall, M.J. Arif, A.B. Keddie and M. Ashfaq, 2006. Effectiveness of two insect growth regulators against Bemisia tabaci (Gennadius) (Homoptera:Aleyrodidae) and Helicoverpa armegera (Hubner) (Lepidoptera:Noctuidae) and their impact on population densities of arthropod predators in cotton in Pakistan. Pest Manag. Sci., 62: 982-990.

Griffin, R.P. and J. Williamson, 2012. Cabbage, broccoli and other cole crop insect pests. HGIC 2203, Home & Garden Information Center. Clemson Cooperative Extension. Clemson University, Clemson, SC.

Hainan, G., G.P. Fitt and G.H. Baker, 2007. Invertebrate pests of canola and their management in Australia: a review. Aust. J. Entomol., 46: 231–243.

Hansen L.M. and S.L. Nielsen, 2011. Efficacy of mineral oil combined with insecticides for the control of aphid virus vectors to reduce potato virus Y infections in seed potatoes (Solanum tuberosum). Acta Agriculturae Scandinavica, Section B - Soil & Plant Science, 62,2:132-137.

Hashmi, A.A., 1994. Insect Pest Management: Cereal and Cash Crops. National Agricultural Research Centre, PARC, Islamabad, 317 pp.

Hatakoshi, M., Y. Shono, H. Yamamoto and M. Hirano, 1991. Effects of the juvenile hormone analog pyriproxyfen, on *Myzus persicae* and *Unaspis yanonesis*. Appl. Entomol. Zool., 26: 412-414.

Henderson, C. F. and E. W. Tilton, 1955. Tests with acaricides against the brow wheat mite, J. Econ. Entomol. 48:157-161.

Hines, R.L. and W.D. Hutchison, 2013. Cabbage aphids. VegEdge, vegetable IPM resource for the Midwest. University of Minnesota, Minneapolis, MN.

Kerns, D.L. and S.D. Stewart, 2000. Sublethal effects of insecticides on the intrinsic rate of increase of cotton aphid. Entomol. Exper. Appl., 94: 41-49.

Opfer, P. and D. McGrath, 2013. Oregon vegetables, cabbage aphid and green peach aphid. Department of Horticulture. Oregon State University, Corvallis, OR.

Owain, R.E.A.E., B.B. Franzmann and C.M. Deborah, 2008. Insecticide resistance and implications for future aphid management in Australian grains and pastures: a review. Austr. J. Exper. Agric., 48 (12): 1523-1530.

Razaq, M., M. Aslam, M. Amer and S.A. Shad, 2011. Insect pest status of aphids on oilseed brassica

Razaq, M.M. Aslam, M. Amer and S.A. Shad. 2011. Insect pest status of aphids on oilseed brassica crops and need for chemical control. Crop Environ., 2(2): 60-63.

Sadeghi, A., E.J.M. Van Damme and G. Smagghe, 2009. Evaluation of the susceptibility of the pea aphid, *Acyrthosiphon pisum*, to a selection of novel biorational insecticides using an artificial diet. J. Insect Sci., 9(65): 1-8.

Sarwar, M., 2013. Comparative suitability of soil and foliar applied insecticides against the aphid *Myzus persicae* (Sulzer) (Aphididae: Hemiptera) in canola *Brassica napus* L. Int. J. Sci. Res. Environm. Sci., 1(7): 138-143.

Sarwar, M., N. Ahmad and M. Tofique, 2011. Impact of soil potassium on population buildup of aphid (Homoptera: Aphididae) and crop yield in canola (*Brassica napus* L.) field. Pak. J. Zool., 43 (1): 15-19.

Vasquez, E.A., E.N. Bernardo and M.F. Carino, 1987. Contact toxicity of decamethrin and permethrin on black bean aphid and its coccinellid predators. Ann. Trop. Res. Philippines, 9: 117-136.

Wright, J.E., 1976. Environmental and toxicological aspects of insect growth regulators. Environ. Health Perspets, 14: 127-132.