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Acute Toxicity of Commonly used Insecticides to Red Pumpkin Beetle, *Aulacophora foveicollis*

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Acute toxicity of commonly used insecticides *viz*., fipronil, cyantraniliprole, fluxametamide, phenthoate and thiamethoxam were determined against Red pumpkin beetle, *Aulacophora foveicollis* collected from the unsprayed pumpkin fields in the orchard of Tamil Nadu Agricultural University, Coimbatore using filter paper disc bioassay method. Based on the LC_{50} values (ppm) of different insecticides, the order of toxicity was found to be fipronil (6.822) > fluxametamide (11.953) > phenthoate (14.732) > cyantraniliprole (14.793) > thiamethoxam (29.465) at 24 and 48 hours after treatment (HAT). The respective LC_{95} values were 65.396, 87.077, 42.090, 203.017 and 205.013 against *A. foveicollis* at 24 HAT and 46.585, 54.242, 37.445, 223.682 and 146.267 at 48 HAT for fipronil, cyantraniliprole, fluxametamide, phenthoate and thiamethoxam, respectively. The study results clearly indicated that the phenyl pyrazole insecticide, fipronil was highly effective against the pumpkin beetle, *A. foveicollis.*

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Keywords: Pumpkin beetle; insecticides; toxicity; median lethal concentrations.

1. INTRODUCTION

Cucurbits are commonly grown vegetable for both food and recreational purpose especially used as salad, desert, fruits and vegetable. Cucurbits belonging to family Cucurbitaceae designated as gourd family comprises of 118 genera and 825 species [1] and wide spread throughout the world. They are rich in nutritive and medicinal values. They possess good market value and hence farmers cultivate gourds in a larger scale. Cucurbits include cucumber, musk melon, water melon, squashes, gourds (bitter gourd, ash gourd, ribbed gourd, snake gourd, bottle gourd, etc) and pumpkin which are commonly grown in different parts of the world.

Numerous types of insects pose a threat to cucurbitaceous crops throughout different growth stages causing varying levels of harm to the crop. Among the pest menace in cucurbits, coleopteran insect red pumpkin beetle, *Aulacophora foveicollis* (Coleoptera: Chrysomelidae) is the predominant pest and is highly destructive causing 30-100 per cent yield loss in various crops [2]. The occurrence of this pest is noticed throughout the year. It is a polyphagous pest that inflicts significant harm to cucurbitaceous crops, particularly during their early growth stages.

Aulacophora foveicollis showed higher preference on pumpkin (*Cucurbita maxima* cv. Sitaphal), bottle gourd (*Lagenaria vulgaris* L. Sicerata cv. Lauki), cucumber (cv. Kerala) and musk melon (*Cucumis mpelo* cv. Kharbooza), respectively [3]. Adult beetles initiate their feeding on cotyledons, flowers and foliage leading to perforations in very young vine plants while grubs dwelling below the surface, cause root damage. In cases of early-sown cucurbitaceous plants, the damage will be very severe and even it leads to resowing of crop [4]. It causes 35-75% damage during seedling stage and 30-100% yield loss in the field conditions [5]. The grubs feed on roots and directly damage the young seedlings.

Farmers commonly rely on chemical pesticides to manage these pest outbreaks. Indiscriminate use of chemical insecticides leads to insecticide resistance, resurgence and residues. Hence, the present investigation was formulated with the intention of screening an effective insecticide for the management of red pumpkin beetle.

2. MATERIALS AND METHODS

The present study was carried out in the Laboratory of Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore.

2.1 Test Insects

The pumpkin beetles were collected manually during morning hours from the unsprayed pumpkin field in the orchard of Tamil Nadu Agricultural University Coimbatore and used for conducting toxicity bioassays. Uniform-sized adult beetles were utilized for bioassays.

2.2 Test Insecticides

The test insecticides used for the study include phenyl pyrazole, diamides, isoxazolines, organophosphates and neonicotinoids. The details of the insecticides used in the present study are given in Table 1. The insecticide formulations were procured locally from pesticide shop and the required concentrations of insecticides were prepared includewith water. A range of six test concentrations excluding control were prepared for each insecticides and each concentration was replicated four times. The filter paper treated with water alone served as a control.

2.3 Bioassay Method

The filter paper disc bioassay method [6] was adopted to assess the acute toxicity of insecticides commonly used in cucurbit crops to pumpkin beetles. The experiment was conducted in plastic containers with perforations to allow adequate aeration for the beetles. A preliminary range finding test was conducted and the obtained concentrations were used for bioassay. The Whatman No.1 filter paper discs were coated evenly with different insecticidal concentrations using a micropipette and allowed to dry. These shade-dried filter paper discs were placed in glass Petri plates and the pumpkin beetles were released at the rate of 10 per Petri plate and allowed to stay in contact with treated filter paper disc for one hour. After the exposure period, the beetles were transferred into perforated bioassay containers and provided with fresh uninfected leaves as feed. Mortality rates were observed at specific intervals of 24 and 48 h after treatment.

2.4 Statistical Analysis

The mortality counts were corrected for control's mortality, if there was any mortality using Abbott's formula [7]

$$\text{Percent corrected mortality} = \frac{\text{Percent test mortality - Percent control mortality}}{\text{100 - Percent control mortality}} \times 100$$

Table 1. Details of test insecticides

Insecticide	Trade Name	Class	Manufacturers
Fipronil 80 WG	Jump	Phenyl pyrazole	M/s. Bayer Crop Science Limited
Cyantraniliprole 10.26 OD	Benevia	Diamide	M/s. FMC India Private Limited
Fluxametamide 10 EC	Gracia	Isoxazoline	M/s. Nissan chemical corporation
Phenthoate 50 EC	Phendal	Organophosphate	M/s. Coromandel International Limited
Thiamethoxam 25 WG	Actara	Neonicotinoid	M/s. Biostadt India Limited

The median lethal concentrations (LC_{50}) of insecticide used were determined by Finney's probit analysis [8] and confirmed in EPA probit analysis version 3.1.

3. RESULTS AND DISCUSSION

The acute toxicity of commonly used insecticides against pumpkin beetle, *A. foveicollis* at 24 hours after treatment is presented in Table 2. The LC_{50} values (ppm) obtained were 6.822, 14.793, 11.953, 29.465 and 14.732 for fipronil, cyantraniliprole, fluxametamide, thiamethoxam and phenthoate, respectively and the corresponding LC_{95} values were 65.396, 87.077, 42.090, 205.013 and 203.017 ppm, respectively.

At 48 HAT, the LC_{50} values obtained were 4.608, 10.128, 9.863, 20.353 and 10.033 ppm for fipronil, cyantraniliprole, fluxametamide, thiamethoxam and phenthoate, respectively (Table 3). Among the five different groups of insecticides, the phenyl pyrazole insecticide fipronil exhibited the highest level of toxicity to beetles followed by isoxazoline insecticide, fluxametamide against *A. foveicollis.* Conversely, Thiamethoxam was found to be the least effective among all the insecticides used with LC_{50} values of 29.465 and 20.353 ppm at 24 and 48 HAT.

Based on the obtained results (LC_{50}), the order of toxicity of different insecticides at 24 and 48 HAT was as follows: fipronil > fluxametamide > phenthoate > cyantraniliprole > thiamethoxam**.**

The present study revealed that fipronil was found to be effective against pumpkin beetle and this was in accordance with the findings [9], that stated tolfenpyrad 15% EC at 124.5 and 150 g a.i./ ha as well as fipronil 5% SC at 40 g a.i./ ha reduced the population of red pumpkin beetles, *A. foveicollis* during both *Kharif* and *Rabi* seasons. Fipronil 80 WG at 40 and 50 g a.i./ ha reduced the flea beetle, *Scelodonta strigicollis* (Coleoptera: Chrysomelidae) damage in grapes by 80.50, 80.80 and 83.20, 83.80 per cent and 86.70, 87.10 and 81.60, 82.10 per cent flea beetle reduction, respectively in the two-year field trials [10]. Carbaryl 85% (30 g), fipronil 5% SC (20 ml), tolfenpyrad 16% EC (20 ml), cyantraniliprole 10% OD (20 ml) and dinotefuran 10% SL (20 ml) were effective in controlling red cucumber leaf beetle, *Aulacophora indica* and it is in accordance with the present findings.

The second-best insecticide is fluxametamide which is a newer insecticide molecule registered for the management of insect pests belonging to Lepidoptera, Coleoptera and Thysanoptera [11] and its efficacy was already reported against diamondback moth, *Plutella xylostella*. The effect of phenthoate against pumpkin beetle was in line with the findings of an organophosphorous compound, malathion which at 0.5 per cent was effective in controlling *A. foveicollis* in sweet gourd, bitter gourd and bottle gourd both in field and laboratory conditions [12]. Cyantraniliprole 10 OD at 90 g a.i./ ha was found to be effective against *A. foveicollis* [13].

The least efficacy of thiamethoxam deviated from the findings of Gharde [14] who stated that thiamethoxam 25 WG at 4 g/l was found highly effective against *A. foveicollis* by reducing the beetle population up to 90 percent.

Table 2. Median lethal concentration of insecticides to *Aulachophora foveicollis* at 24 hours after treatment

Insecticides	LC_{50} (ppm)	95 % fiducial limits of LC_{50}		LC_{95} (ppm)	95 % fiducial limits of LC_{95}		Regression equation	X^2 value*
		Lower	Upper		Lower	Upper		
Fipronil	6.822	5.081	8.708	65.396	41.469	137.213	Y = 3.603+1.676±0.225x	8.955
Cyantraniliprole	14.793	11.791	17.918	87.077	61.443	151.237	Y = 2.500+2.137±0.274x	4.859
Fluxametamide	11.953	10.121	13.727	42.090	33.044	61.491	Y = 1.758+3.009±0.381x	5.340
Phenthoate	14.732	11.035	19.230	203.017	122.614	434.236	Y = 3.313+1.444±0.165x	7.634
Thiamethoxam	29.465	22.995	36.818	205.013	128.293	477.556	Y = 2.131+1.952±0.305x	2.468

**All lines are at best fit at P=0.05*

Table 3. Median lethal concentration of insecticides to *Aulachophora foveicollis* at 48 hours after treatment

Insecticides	LC_{50} (ppm)	95 % fiducial limits of LC_{50}		LC_{95} (ppm)	95 % fiducial limits of LC_{95}		Regression equation	X^2 value*
		Lower	Upper		Lower	Upper		
Fipronil	4.608	3.253	8.708	46.585	28.847	103.430	Y = 3.914+1.637±0.233x	7.426
Cyantraniliprole	10.128	7.762	17.918	54.242	38.643	94.892	Y = 2.731+2.257±0.319x	3.691
Fluxametamide	9.863	8.057	13.727	37.445	28.240	60.610	Y = 2.178+2.839±0.419x	3.113
Phenthoate	10.033	6.985	19.230	223.682	113.968	682.525	Y = 3.778+1.220±0.166x	1.222
Thiamethoxam	20.353	16.052	36.818	205.013	90.982	324.811	Y = 2.487+1.920±0.268x	0.733

**All lines are at best fit at P=0.05*

4. CONCLUSION

From the present study, it is concluded that among the five commonly used insecticides in cucurbit ecosystem belonging to five different insecticide groups, fipronil was found to be highly effective against pumpkin beetle, *A. foveicollis* followed by isoxazoline group of compound, fluxametamide and which can be recommended for the management of *A. foveicollis* in cucurbits.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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