Mysore J. Agric. Sci., 55 (4) : 100-103 (2021)

Relative Toxicity of Insecticides Against Legume Pod Borer, *Maruca vitrata* F. (Lepidoptera : Crambidae)

B. R. Chethan[1], T. Venkatesan[2], M. Mohan[3] and B. Shivanna[4]
[1,3&4]Department of Agricultural Entomology, College of Agriculture, UAS, GKVK, Bengaluru - 560 065
[2]Division of Genomic Resources, ICAR - NBAIR, Bengaluru - 560 024
e-Mail : tvenkat12@gmail.com

Abstract

Legume pod borer, *Maruca vitrata* F. is the most devastating insect pest of food legumes worldwide. The larvae cause damage to flowers, flower buds, pods and developing grains. In the absence of any viable biocontrol agents and resistant plant varieties, various groups of insecticides with different mode of action are routinely used to protect the crop. Hence, the study was undertaken to evaluate the relative toxicity of the commonly used insecticides *viz*., indoxacarb 14.5 SC, chlorpyriphos 20 EC, spinosad 45 SC, emamectin benzoate 5 SG and lambda cyhalothrin 5 EC against second and third instar larvae of *M. vitrata* under laboratory conditions. The results revealed that emamectin benzoate 5 SG was the most toxic followed by indoxacarb 14.5 SC, spinosad 45 SC and lambda cyhalothrin 5 EC and chlorpyriphos 20 EC. The knowledge can help in integration of effective insecticides in IPM systems for the management of the pod borer.

Keywords : Insecticides, *Maruca vitrata,* Relative toxicity, Emamectin benzoate, Indoxacarb

Legume pod borer, *Maruca vitrata* F. (Lepidoptera: Crambidae) also known as spotted pod borer, is the highly destructive pest on grain legumes in tropical Asia and sub-Saharan Africa. As a major pest, *M. vitrata* was found to cause up to 72 per cent yield loss in *Vigna unguiculata*, *V. unguiculata* sub sp. *sesquipedalis*, *Vigna radiata*, *Vigna mungo*, *Lablab purpureus*, *Dolichos lablab*, *Phaseolus vulgaris*, *Cajanus cajan* and *Glycine max* (Srinivasan *et al.,* 2021) and has total 73 host plants (Ba *et al.,* 2019 and Dannon *et al.,* 2012). Larvae feed on flowers, flower buds, developing pods by making webs with adjacent leaves, flowers and pods from inside. Early instar larvae prefer to feed on flowers over pods. This behaviour protects larvae from the natural enemies and insecticides. In the absence of any effective natural enemies and resistant cultivars, use of insecticides is the paramount strategy in controlling pod borer by the legume growers (Srinivasan *et al.,* 2021). The knowledge on the most effective insecticides is essential to incorporate them in the IPM programmes. Hence, the present study was conducted to know the relative toxicity of various groups of insecticides against the larvae of *M. vitrata.*

Material and Methods

Insects

A colony of *M. vitrata* was brought from Chikkaballapur during September 2020 and the iso-female colony was developed (NBAIR-IS-CRA-02) and being maintained at Division of Genomic Resources, ICAR-NBAIR, Bengaluru. The larvae were maintained at 25 ± 1 °C and 70 ± 5 per cent relative humidity, 12:12 (L:D) photoperiod on a specially designed semi synthetic diet as per Rachappa *et al.* (2016). The adults were maintained in plastic containers with 10 per cent honey solution for mating and pigeonpea twigs were provided for egg laying. After hatching of eggs, neonates were transferred to the diet.

Bioassay

To study the relative toxicity of insecticide molecules, preliminary range finding bioassay were conducted with five widely spaced concentrations by using diet overlaying method. The details of insecticides and concentrations used are presented in Table 1. In diet overlaying method, approximately 1 ml of diet was

TABLE 1

Details of insecticides used for bioassay against *Maruca vitrata*

Chemical	Trade Name	Concentrations tested (ppm)	Source of availability
Indoxacarb 14.5 SC	Avaunt®	80, 40, 20, 10, 5	Dupont India Pvt. Ltd, Gujarat
Chlorpyriphos 20 EC	Lethal®	1100, 550, 275, 137.50, 68.75	Insecticides (India) Ltd., Delhi
Spinosad 45 SC	Tracer®	270, 135, 67.5, 33.75, 16.875	Dow AgroSciences India Pvt. Ltd., Mumbai
Emamectin benzoate 5 SG	Proclaim®	16, 8, 4, 2, 1	Syngenta India Ltd., Mumbai
Lambda cyhalothrin 5 EC	Karate®	200, 100, 50, 25, 12.5	Syngenta India Ltd., Mumbai

poured into each well and allowed for dry and 50 µl of insecticidal solution was applied on the diet to each well of bioassay tray (C-D International, USA). After setting of the diet, a single larva of 2nd and 3rd instar was transferred to each well separately. The bioassay trays were covered with self-adhesive pull-n-peel tab (BIO-CV-16, Pitman N.J. USA-609-582-2392). The experiment was replicated three times. The bioassay trays were incubated at 25 ± 1 °C, and 70 ± 5 per cent relative humidity, 12:12 (L:D) photo period. The larval mortality was recorded at 24 and 48 h after treatment. The data was subjected to probit analysis according to Finney (1971) using Polo Plus 2.0 software and assessed LC_{50} (lethal concentrations causing 50 per cent mortality), 95 per cent fiducial limits and slope value of probit line.

RESULTS AND DISCUSSION

The toxicity of insecticides against second instar larvae of *M. vitrata* is presented in Table 2 and 3. All the tested insecticides differed significantly on the basis of non-overlapping of fiducial limits for LC_{50}. The insecticide emamectin benzoate 5 SG was found to be highly toxic with LC_{50} of 2.666 and 1.988 ppm at 24 and 48 h after exposure of insecticides to second instar, respectively. This was followed by indoxacarb 14.5 SC (11.607 and 7.946 ppm), spinosad 45 SC (34.359 and 24.299 ppm) and lambda cyhalothrin 5 EC (51.426 and 35.885 ppm), where chlorpyriphos 20 EC was least toxic with the LC_{50} value of 114.195 and 78.267 ppm at 24 and 48 h after treatment, respectively.

The toxicity of insecticides against third instar larvae of *M. vitrata* is presented in Table 4 and 5. Similar trend was observed with respect to toxicity of insecticides to third instar larva and differed significantly on the basis of non-overlapping of fiducial limits for LC_{50}, where emamectin benzoate 5 SG was more toxic both at 24 and 48 h after treatment with LC_{50} values of 3.669 and 2.413 ppm, respectively. This was followed by indoxacarb 14.5 SC (15.981 and 10.246 ppm), spinosad 45 SC (41.982

TABLE 2

Dosage response of 2nd instar *Maruca vitrata* larvae to insecticides after 24 hours

Insecticides	Slope ± SE	χ^2	LC_{50} (ppm)	95% Fiducial limits (ppm)	Heterogeneity
Indoxacarb14.5 SC	1.814 ± 0.303	1.452	11.607 b	8.060 - 15.485	0.484
Chlorpyriphos 20 EC	1.789 ± 0.323	2.843	114.195 e	71.578 -156.027	0.948
Spinosad 45 SC	1.892 ± 0.319	2.882	34.359 c	23.537 - 45.643	0.961
Emamectin benzoate 5 SG	2.389 ± 0.347	1.589	2.666 a	2.055 - 3.365	0.530
Lambda cyhalothrin 5 EC	1.818 ± 0.290	0.440	51.426 d	38.303 - 69.290	0.147

TABLE 3

Dosage response of 2nd instar *Maruca vitrata* larvae to insecticides after 48 hours

Insecticides	Slope ± SE	χ^2	LC_{50} (ppm)	95% Fiducial limits (ppm)	Heterogeneity
Indoxacarb 14.5 SC	2.168 ± 0.373	2.965	7.946 b	5.411 - 10.413	0.988
Chlorpyriphos 20 EC	1.851 ± 0.366	1.082	78.267 e	41.925 - 111.344	0.361
Spinosad 45 SC	1.965 ± 0.356	1.842	24.299 c	15.191 - 32.915	0.614
Emamectin benzoate 5 SG	2.576 ± 0.394	0.398	1.988 a	1.508 - 2.495	0.133
Lambda cyhalothrin 5 EC	1.906 ± 0.302	1.768	35.885 d	26.217 - 47.228	0.589

TABLE 4

Dosage response of 3rd instar *Maruca vitrata* larvae to insecticides after 24 hours

Insecticides	Slope ± SE	χ^2	LC_{50} (ppm)	95% Fiducial limits (ppm)	Heterogeneity
Indoxacarb 14.5 SC	1.840 ± 0.292	0.514	15.981 b	11.701 - 21.230	0.171
Chlorpyriphos 20 EC	1.624 ± 0.298	2.310	132.210 e	82.519 - 183.035	0.770
Spinosad 45 SC	1.666 ± 0.290	0.907	41.982 c	28.477 - 57.068	0.302
Emamectin benzoate 5 SG	2.561 ± 0.349	1.395	3.669 a	2.913 - 4.587	0.465
Lambda cyhalothrin 5 EC	2.297 ± 0.341	2.805	77.786 d	61.200 - 102.115	0.935

TABLE 5

Dosage response of 3rd instar *Maruca vitrata* larvae to insecticides after 48 hours

Insecticides	Slope ± SE	χ^2	LC_{50} (ppm)	95% Fiducial limits (ppm)	Heterogeneity
Indoxacarb 14.5 SC	2.112 ± 0.334	1.354	10.246 b	7.354 - 13.304	0.451
Chlorpyriphos 20 EC	1.820 ± 0.350	1.202	86.067 e	48.150 - 121.224	0.401
Spinosad 45 SC	2.004 ± 0.332	2.025	33.072 c	22.995 - 43.482	0.675
Emamectin benzoate 5 SG	2.792 ± 0.398	0.743	2.413 a	1.905 - 2.982	0.248
Lambda cyhalothrin 5 EC	2.124 ± 0.314	1.042	64.781 d	50.280 - 85.470	0.347

and 33.072 ppm) and lambda cyhalothrin 5 EC (77.786 and 64.781 ppm). Chlorpyriphos 20 EC was least toxic with the LC_{50} value of 132.210 and 86.067 ppm at 24 and 48 h after treatment, respectively. The toxicity level for selected insecticides is in the range of emamectin benzoate 5 SG > indoxacarb 14.5 SC > spinosad 45 SC > lambda cyhalothrin 5 EC > chlorpyrifos 20 EC. The results are in accordance with findings of Sreelakshmi and Paul (2016) who reported emamectin benzoate, spinosad and indoxa carb + acetamiprid caused 100 per cent mortality in laboratory. The emamectin benzoate 5 SG was very effective in suppressing the *M. vitrata* on yard long bean (Ahmed *et al.,* 2020) and black gram (Yadav

et al., 2015) under field conditions. The present study found that insecticides with broad spectrum in mode of action are best suitable in management of targeted insect pests.

From the present investigation, it is evident that emamectin benzoate 5 SG is very effective in controlling the legume pod borer, *M. vitrata* followed by indoxacarb 14.5 SC and spinosad 45 SC. These insecticides can be effectively incorporated in the IPM programmes for the management of pod borer of *M. vitrata*.

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(*Received :* August 2021 *Accepted :* October 2021)