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Efficacy of biopesticides against *Maruca vitrata* (Geyer) (Crambidae: Lepidoptera) under laboratory condition

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Abstract
Laboratory experiments were conducted to test the efficacy of biopesticides *viz.,* Emamectin benzoate, Spinosad and Azadirachtin against third, fourth and fifth instar larvae of *Maruca vitrata* on different pulses namely black gram, green gram, lablab, cowpea and pigeonpea. Among the three biopesticides tested, spinosad 45% SC was found to be highly effective against third, fourth and fifth instar larvae on all the pulses tested. The lowest LC_{50} values were recorded against third (24.20 ppm), fourth (30.69 ppm) and fifth instar (36.56 ppm) larvae on pigeonpea.

Keywords: *Maruca vitrata*, biopesticides, emamectin benzoate, spinosad

Introduction
India is the major pulse growing country in the world, sharing 35 to 36 per cent area with 27 to 28 per cent pulse production (Economic survey of India, 2012) [3]. It is producing 12 to 14 million tonnes of pulses from 22 to 24 million ha of land (Mahalakshmi *et al.,* 2016) [6]. The commonly grown major pulse crops in India are pigeonpea, mungbean, urdbean, chickpea, horsegram, cowpea and some of the minor pulse crops are drybean, mothbean, lathyrus, lentil and peas. Pulses are rich sources of protein to vegetarians with an inherent capacity to fix large amounts of atmospheric nitrogen. In India, pulses are grown under diverse climatic conditions such as Kharif / Rabi, rainfed / irrigated, mixed / monocrop, low / high input conditions, traditional / progressive farming etc., and hence, are highly vulnerable to wide spectrum of pest problems. The insect pest spectra that infest pulse crops includes more than 40 species on blackgram or greengram and 300 species on pigeonpea. The annual yield loss due the insect pests was estimated to be 30 per cent in urdbean and mungbean. On an average, 2.5 to 3.0 million tonnes of pulses are lost annually due to pest problems (Rabindra *et al.*, 2004) [8].
The spotted pod borer, commonly known as legume pod borer, *M. vitrata* (Lepidoptera: Pyralidae) is a serious pest of grain legumes in the tropics and subtropics due to its extensive host range, distribution and destructiveness. The larvae damage the flower buds, flowers and immature pods by webbing and contaminate with their excreta (Ranga Rao *et al.*, 2007) [9]. The grain yield loss due to legume pod borer was estimated to be 10.0 to 80.0 per cent in various crops (Rekha and Mallapur, 2007) [10]. Webbings of flowers and pods during feeding makes the pest hard to reach and hence makes the management difficult (Singh and Allen, 1980) [11]. However, the pest is still being managed by means of insecticides only (Jakhar *et al*., 2016) [5]. The increasing concern about pesticide hazards evoked worldwide interest on alternate pest management practices that are ecofriendly in nature.
Biologically derived insecticides or microbial insecticides, natural enemies and entomopathogenic fungi provide an alternative, more environmentally friendly option to control this insect pest. Sreelakshmi and Paul (2016) [13] reported the efficacy of spinosad and emamectin benzoate (insecticide based on microbial derivative) against *M. vitrata* infesting pulses. The use of synthetic insecticides and biological control has been investigated by many scientists for controlling this insect-pest. However there is no cost effective management practice so far. Hence, present investigation was carried out on testing the efficacy of biopesticides under laboratory condition.

Materials and Methods
Experiments were carried out to evaluate the efficacy of biopesticides / insecticides of

microbial origin that were recommended by the Central Insecticide Board and Registration Committee (CIB & RC) for pulse crops by following the procedure of Yule and Srinivasan (2014) [16]. Biopesticides used for the bioassay include emamectin benzoate 5% SG, spinosad 45% SC and azadirachtin 0.03%. Preliminary range finding test was carried out using four widely spaced concentrations of each biopesticide to arrive at the concentrations for the bioassay. From the results, five concentrations were fixed between the two widely spaced concentrations that caused 10 to 90 per cent mortality in the range finding tests. Concentrations *viz*., 20, 30, 40, 50 and 60 ppm for emamectin benzoate, 20, 25, 30, 35 and 40 ppm for spinosad and 450, 600, 750, 1000 and 1250 ppm for azadirachtin were used.

For the bioassay, ten prestarved third instar larvae were introduced into plastic containers (10 cm dia. and 3.5 cm ht.) containing treated pods of respective pulses *viz*., black gram, green gram, lablab, cowpea and pigeonpea separately. The containers were covered with muslin cloth to prevent the escape of the larvae. Each treatment on each host was replicated four times. The larval response and mortality were recorded after two to five days. At each assessment, larvae were classed as either alive or dead. The lethal concentrations causing 50 per cent mortality (LC_{50}), their fiducial limits (FL) and slope value of the probit line were assessed according to the probit analysis methodology (Finney, 1971) [4].

Results and Discussion

All the tested biopesticides were proved to be toxic to *M. vitrata* with significant differences in median lethal concentration. Larvae which were unable to make coordinated movement from gentle stimulus with a seeking pin or fine pointed forceps were considered as dead. Among the three biopesticides, spinosad 45% SC was found to be highly effective against third, fourth and fifth instar larvae on all the pulses tested. The LC_{50} values for spinosad 45% SC was the lowest against third (24.20 ppm), fourth (30.69 ppm) and fifth instar (36.56 ppm) larvae on pigeonpea followed by lablab, cowpea, black gram and green gram (Table 1, 2 and 3). These findings corroborates with Ranga Rao *et al*. (2007) [9] who reported the superior efficacy of spinosad against legume pod borer on pigeonpea. Sunitha *et al*. (2008) [15] reported that the spinosad was very effective against third instar larvae of *M. vitrata*. Srinivasan (2008) [14] reported that the spinosad @ 0.045 per cent and indoxacarb @ 0.015 per cent were very effective in managing *Maruca* population on short duration pigeonpea. According to Ankali *et al.* (2009) [2], spinosad provided effective control of *M. vitrata*. Ameta *et al.* (2011) concluded that the spinosad 48 SC recorded significantly high reduction in larval population of *Helicoverpa armigera* and *M. testulalis*. Similar results were also recorded by Moorthy *et al*. (2011) [7] on chick pea.

Table 1: Dose mortality response of biopesticides against third instar *M. vitrata* on different pulses

Pulses	Treatments	Heterogeneity ($\chi2$)	Regression equation	LC_{50} (ppm)	95% Fiducial Limits (ppm)
Lablab	Emamectin benzoate	1.18	y = 4.517x - 2.600	48.30	43.96 – 53.06
	Spinosad	2.09	y = 5.405x - 3.083	31.60	28.51 – 35.02
	Azadirachtin	1.51	y = 2.650x - 2.859	919.56	769.65 – 1098.66
Cowpea	Emamectin benzoate	1.56	y = 4.453x - 2.550	49.97	45.43 – 54.95
	Spinosad	2.02	y = 11.38x - 12.26	33.36	31.89 – 34.90
	Azadirachtin	1.72	y = 4.398x - 8.082	930.90	809.79- 1070.12
Green gram	Emamectin benzoate	1.82	y = 6.291x - 5.728	50.31	46.68 – 54.22
	Spinosad	1.94	y = 6.204x - 4.479	34.70	31.89 – 37.77
	Azadirachtin	1.24	y = 3.815x - 6.380	958.74	829.00 – 1108.79
Black gram	Emamectin benzoate	1.02	y = 7.067x - 7.097	50.66	47.11 – 54.47
	Spinosad	1.38	y = 6.184x - 4.389	32.95	30.04 – 36.14
	Azadirachtin	1.68	y = 3.117x - 4.255	925.26	789.86 – 1083.84
Pigeonpea	Emamectin benzoate	1.45	y = 2.072x + 1.789	35.57	29.04 - 43.43
	Spinosad	1.65	y = 2.459x + 1.604	24.20	18.97 – 30.87
	Azadirachtin	1.85	y = 6.145x - 12.96	906.68	819.57- 1003.05

Table 2: Dose mortality response of biopesticides against fourth instar *M. vitrata* on different pulses

Pulses	Treatments	Heterogeneity ($\chi2$)	Regression equation	LC_{50} (ppm)	95% Fiducial Limits (ppm)
Lablab	Emamectin benzoate	1.63	y = 6.400x - 6.006	52.79	49.26 – 56.58
	Spinosad	1.43	y = 5.625x - 3.453	32.07	29.03 – 35.44
	Azadirachtin	1.75	y = 4.337x - 7.967	925.34	863.49 – 1101.68
Cowpea	Emamectin benzoate	1.02	y = 7.102x - 7.364	55.36	52.08 – 58.85
	Spinosad	1.85	y = 5.881x - 4.003	35.15	32.16 – 38.42
	Azadirachtin	1.43	y = 4.423x - 8.263	965.19	882.69 – 1122.03
Green gram	Emamectin benzoate	1.77	y = 6.923x - 7.109	56.38	52.94 – 60.06
	Spinosad	1.28	y = 5.649x - 3.752	37.29	33.9 – 40.91
	Azadirachtin	1.37	y = 4.430x - 8.316	980.99	895.77 – 1141.04
Black gram	Emamectin benzoate	1.83	y = 7.137x - 7.392	54.81	51.56- 58.27
	Spinosad	1.63	y = 5.939x - 4.041	34.12	31.20 – 37.32
	Azadirachtin	1.10	y = 4.416x - 8.214	979.43	869.41 – 1103.37
Pigeonpea	Emamectin benzoate	1.56	y = 7.067x - 7.097	50.66	47.11- 54.47
	Spinosad	1.14	y = 5.026x - 2.449	30.69	27.40 – 34.37
	Azadirachtin	1.06	y = 3.805x - 6.310	930.29	805.60 – 1074.27

Table 3: Dose mortality response of biopesticides against fifth instar *M. vitrata* on different pulses

Pulses	Treatments	Heterogeneity (χ2)	Regression equation	LC_{50} (ppm)	95% Fiducial Limits (ppm)
Lablab	Emamectin benzoate	1.80	y = 7.335x - 7.676	53.36	49.96 – 56.99
	Spinosad	1.03	y = 10.82x - 12.12	38.49	36.49 – 39.86
	Azadirachtin	1.32	y = 3.87x - 6.512	936.68	814.31 – 1077.43
Cowpea	Emamectin benzoate	1.74	y = 7.501x - 8.180	57.22	53.95 – 60.70
	Spinosad	1.95	y = 9.384x - 10.16	41.21	39.01 – 43.53
	Azadirachtin	1.58	y = 3.940x - 6.761	961.87	836.24 – 1106.38
Green gram	Emamectin benzoate	1.97	y = 6.912x - 7.293	60.06	56.13 – 64.28
	Spinosad	1.42	y = 8.610x - 9.068	42.67	40.02 – 45.50
	Azadirachtin	1.37	y = 4.105x - 7.318	1001.48	875.18 – 1145.99
Black gram	Emamectin benzoate	1.53	y = 7.459x - 8.007	55.63	52.30 – 59.17
	Spinosad	1.09	y = 10.38x - 11.57	39.59	37.61 – 41.18
	Azadirachtin	1.55	y = 3.802x - 6.331	950.44	821.91 – 1099.06
Pigeonpea	Emamectin benzoate	1.08	y = 7.160x - 7.344	52.73	49.23 – 56.48
	Spinosad	1.50	y = 10.90x - 12.17	36.59	35.77 – 39.12
	Azadirachtin	1.68	y = 3.805x - 6.310	930.29	805.60 – 1074.27

In the present investigation, emamecting benzoate was next in the order of efficacy against *M. vitrata*. This is in line with the findings of Mahalakshmi *et al.* (2016) [6] who revealed the superior effectiveness of newer insecticides such as flubendiamide and emamectin benzoate followed by indoxacarb, spinosad and novaluron against *M. vitrata* on urdbean.

Conclusion
In conclusion, laboratory experiment findings are important, especially for controlling borer pests before field recommendation. Biopesticides proved to be a potential alternative for the control of insect pest such as *M. vitrata*. They provide safer and more acceptable alternatives than conventional pesticide control method due to low-risk pesticide and low cost. Also they tend to be secure to natural enemies.

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