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B.B Gaikwad

Department of Agricultural
Entomology, College of
Agriculture, Parbhani,
(Vasantrao Naik Marathwada
Krishi Vidyapeeth, Parbhani)
Maharashtra, India.

B.B Bhosle

Department of Agricultural
Entomology, College of
Agriculture, Parbhani,
(Vasantrao Naik Marathwada
Krishi Vidyapeeth, Parbhani)
Maharashtra, India.

B.V Bhede

Department of Agricultural
Entomology, College of
Agriculture, Parbhani,
(Vasantrao Naik Marathwada
Krishi Vidyapeeth, Parbhani)
Maharashtra, India.

Corresponding Author:**B.B Gaikwad**

Department of Agricultural
Entomology, College of
Agriculture, Parbhani,
(Vasantrao Naik Marathwada
Krishi Vidyapeeth, Parbhani)
Maharashtra, India.

Efficacy of different biopesticides against Green lacewing on okra

B.B Gaikwad, B.B Bhosle and B.V Bhede

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Abstract

The untreated control recorded maximum larval population. Among the biopesticides LAMIT 0.6% and eucalyptus oil 0.2%, recorded maximum population. These were followed by karanj oil 0.5%, biomix 0.3%, beauveria bassiana 0.4% neem oil 0.2%, NSKE 5%, verticilium lecanii 0.4%, metarhizium+ beauveria bassiana 0.4% and dashparni ark 0.6%. The most toxic insecticides were emamectin benzoate 5% SG and Thiamethoxam 25% WG.

Keywords: Emamectin benzoate, LAMIT, Metarhizium+Beauveria and biomix

Introduction

In India, vegetables have occupied the prime position in human diet, as these are the cheaper source of carbohydrate, minerals, vitamins, proteins, dietary fibers besides having medicinal value and provide nutritional security to a predominately vegetarian population. Among different vegetables, okra, *Abelmoschus esculentus* (L.) Moench belonging to the family Malvaceae is an important annual vegetable, grown for its immature green non fibrous edible fruits in the tropical and sub-tropical regions of the world.

Okra has its own importance, taste, flavour and nutritional values as human food. It has good nutritional value particularly high content of calcium and vitamin C (Anitha and Nandihalli, 2008). It is grown extensively in the tropical, subtropical and warm temperature regions of the world especially in India, U.S.A., Africa, Asia, Nigeria, Sudan, Iraq, Pakistan, Turkey, Australia, U.K. and other neighboring countries. India ranks first in area and production in the world. It is a major commercial vegetable cultivated all over India particularly in the states of Andhra Pradesh, West Bengal, Jharkhand, Orissa, Uttar Pradesh, Madhya Pradesh, Karnataka, Gujarat and Maharashtra. India occupies an area of 532.66 thousand hectares with a production of 6346.37 thousand tones and productivity of 11.9 MT/ha. (Anonymous, 2014) [1]. Highest productivity is reported from Egypt (12.5 tons/ha) followed by Saudi Arabia (13.3 tons/ha). Botanical pesticides are well suited for use in organic food production and may play a great role in the production and protection of food in developing countries. The current trends of modern society towards 'green consumerism' desiring fewer synthetic ingredients in food may favour plant-based products which are generally recognized as safe in eco-friendly management of plant pests as botanical pesticides (Isman *et al.*, 2006) [2]. *Part of approved Ph. D. (Agri.) Dissertation submitted by B.B. Gaikwad to Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani.*

Material and methods

The field experiment on evaluation of different bio-pesticides against major pests of okra using Parbhani OK-1 variety was conducted in a randomized block design with thirteen treatments including untreated control replicated thrice at the farm of Department of Agricultural Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *Kharif* season 2017-18 and 2018-19. The number green lace wing (grubs) population was counted on five randomly selected plants in each plot. The pre-treatment count was made a day before each spray, while the post treatment counts were made on 1, 3, 7 and 15 days after each spray. The data were subjected to square root ($\sqrt{x+0.5}$) and angular transformation as per data and then statistically analyzed to obtain critical difference for comparison of treatments as per Panse &

Sukhatme (1967) [3].

Results and Discussion

First spray

The data on green lacewing on one day before, 1, 3, 7 and 15 DAS of first spraying are given in Table 1.

Precount

The precount of green lacewing was non-significant in 2017-18 and 2018-19. The population ranged from 0.62 to 0.80 and 0.43 to 0.59 /plant during 2017-18 and 2018-19, respectively.

One day after spray

During 2017-18, minimum number of larvae was recorded in emamectin benzoate 5% SG (0.24/plant) and thiamethoxam 25% WG (0.31/plant) treated plots. Eucalyptus oil 0.2% (0.74/plant) noted highest population among the all bio-pesticides. The maximum number of larvae (0.77/plant) was recorded in untreated check among all treatments

During 2018-19, the maximum population was observed in untreated control (0.53/plant). It was followed by LAMIT 0.6%, eucalyptus oil 0.2%, karanj oil 0.5%, NSKE 5%, neem oil 0.2%, dashparni ark 0.6%, *Beauveria bassiana* 0.4%, biomix 0.3%, *Metarhizium + Beauveria* 0.4% and *Verticilium lecanii* 0.4%. The minimum population was recorded in emamectin benzoate 5% SG followed by thiamethoxam 25% WG.

Three days after spray

During 2017-18, the untreated control recorded maximum larval population. Among the bio pesticides, LAMIT 0.6% (0.82/plant), eucalyptus oil 0.2%, karanj oil 0.5%, neem oil 0.2%, biomix 0.3%, neem oil 0.2%, *Beauveria bassiana* 0.4% and NSKE 5% recorded maximum population.

These were followed by *Metarhizium+Beauveria* 0.4%, *Verticilium lecanii* 0.4% and dashparni ark 0.6%. The plots treated with emamectin benzoate 5 SG (0.28/plant) and thiamethoxam 25% WG (0.37/plant) observed lowest population among all treatments.

During 2018-19 the untreated control noted highest population. It was followed by LAMIT 0.6%, eucalyptus oil 0.2% and karanj oil 0.5%. Next safer bio pesticides were NSKE 5%, neem oil 0.2%, *Beauveria bassiana* 0.4%, biomix 0.3%, dashparni ark 0.6%, *Metarhizium+Beauveria* 0.4% and *Verticilium lecanii* 0.4%. Minimum larval population were recorded in emamectin benzoate 5 SG (0.17/plant) and thiamethoxam 25% WG.

Seven days after spray

During 2017-18, the untreated control recorded highest population.

The less toxic biopesticides were LAMIT 0.6%, eucalyptus oil 0.2%, karanj oil 0.5%, neem oil 0.2%, *Beauveria bassiana* 0.4%, biomix 0.3%, NSKE 5% and *Verticilium lecanii* 0.4%. The lowest population was noticed in emamectin benzoate 5 SG. It was followed by thiamethoxam 25 WG and dashparni ark 0.6%.

Table 1: Effect of different bio-pesticides against green lace wing on okra after first spraying during the years 2017& 2018

Tr No	Treatment	Dose g or ml/ha	No. of larvae/plant											
			2017						2018					
			Precount	1 DAS	3 DAS	7 DAS	15 DAS	Mean	Precount	1 DAS	3 DAS	7 DAS	15 DAS	Mean
T ₁	NSKE	25 kg	0.74 (1.32)	0.67 (1.29)	0.75 (1.32)	0.83 (1.35)	0.91 (1.38)	0.79 (1.33)	0.50 (1.22)	0.46 (1.20)	0.52 (1.23)	0.60 (1.26)	0.69 (1.29)	0.56 (1.24)
T ₂	LAMIT	3 lit	0.80 (1.34)	0.74 (1.31)	0.82 (1.35)	0.89 (1.37)	0.95 (1.40)	0.85 (1.35)	0.59 (1.26)	0.54 (1.23)	0.60 (1.26)	0.67 (1.29)	0.77 (1.30)	0.64 (1.27)
T ₃	Eucalyptus oil	1 lit	0.76 (1.32)	0.71 (1.30)	0.80 (1.34)	0.87 (1.36)	0.93 (1.39)	0.82 (1.34)	0.57 (1.25)	0.52 (1.23)	0.58 (1.25)	0.67 (1.29)	0.76 (1.32)	0.63 (1.27)
T ₄	Karanj oil	2.5 lit	0.75 (1.32)	0.66 (1.29)	0.78 (1.33)	0.86 (1.36)	0.92 (1.38)	0.80 (1.34)	0.56 (1.24)	0.50 (1.22)	0.57 (1.25)	0.66 (1.28)	0.76 (1.32)	0.62 (1.26)
T ₅	Neem oil	1 lit	0.75 (1.32)	0.66 (1.29)	0.77 (1.33)	0.85 (1.35)	0.88 (1.37)	0.79 (1.33)	0.49 (1.22)	0.45 (1.21)	0.52 (1.23)	0.64 (1.27)	0.73 (1.31)	0.58 (1.25)
T ₆	<i>Metarhizium + Beauveria</i>	2 kg	0.76 (1.33)	0.65 (1.28)	0.74 (1.32)	0.82 (1.34)	0.90 (1.37)	0.77 (1.32)	0.49 (1.21)	0.41 (1.18)	0.47 (1.21)	0.58 (1.25)	0.68 (1.29)	0.53 (1.23)
T ₇	<i>Beauveria bassiana</i>	2 kg	0.73 (1.31)	0.67 (1.29)	0.76 (1.33)	0.85 (1.35)	0.92 (1.38)	0.80 (1.33)	0.49 (1.21)	0.43 (1.19)	0.51 (1.22)	0.59 (1.26)	0.68 (1.29)	0.55 (1.24)
T ₈	<i>Verticilium lecanii</i>	2 kg	0.70 (1.30)	0.65 (1.28)	0.73 (1.32)	0.83 (1.35)	0.92 (1.38)	0.78 (1.33)	0.51 (1.22)	0.40 (1.18)	0.46 (1.20)	0.56 (1.24)	0.66 (1.28)	0.52 (1.22)
T ₉	Dashparni ark	3 lit	0.72 (1.31)	0.61 (1.26)	0.67 (1.29)	0.77 (1.33)	0.85 (1.36)	0.72 (1.31)	0.50 (1.22)	0.44 (1.20)	0.50 (1.21)	0.54 (1.23)	0.63 (1.27)	0.52 (1.22)
T ₁₀	Biomix	1.5 kg	0.79 (1.33)	0.68 (1.29)	0.78 (1.33)	0.85 (1.36)	0.93 (1.39)	0.81 (1.34)	0.48 (1.21)	0.42 (1.19)	0.51 (1.22)	0.62 (1.27)	0.71 (1.30)	0.56 (1.24)
T ₁₁	Thiamthoxam 25 WG	225 g	0.71 (1.31)	0.31 (1.14)	0.37 (1.16)	0.41 (1.19)	0.43 (1.19)	0.38 (1.17)	0.45 (1.20)	0.24 (1.11)	0.28 (1.13)	0.31 (1.14)	0.37 (1.16)	0.30 (1.13)
T ₁₂	Emamectin benzoate 5 SG	100 g	0.69 (1.30)	0.24 (1.11)	0.28 (1.13)	0.30 (1.14)	0.33 (1.15)	0.29 (1.13)	0.43 (1.19)	0.14 (1.06)	0.17 (1.07)	0.19 (1.08)	0.24 (1.11)	0.18 (1.08)
T ₁₃	Control (water spray)		0.62 (1.27)	0.77 (1.33)	0.85 (1.35)	0.93 (1.39)	1.00 (1.41)	0.88 (1.37)	0.67 (1.28)	0.56 (1.24)	0.63 (1.27)	0.72 (1.31)	0.81 (1.34)	0.68 (1.29)
	SE±		0.08	0.10	0.10	0.09	0.09	0.09	0.07	0.09	0.07	0.12	0.08	0.09
	C.D. at 5 %		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	C.V. %		7.88	9.11	11.17	8.14	9.74	9.54	6.47	9.33	5.89	10.55	8.65	8.60

*Figures in parentheses are square root transformed values

DAS: Days after Spray

NS: Non Significant

During 2018-19, the untreated check (0.63/plant) noted highest larval population followed by LAMIT 0.6% (0.60/plant), eucalyptus oil 0.2% (0.58/plant) and karanj oil 0.5% (0.57/plant). Emamectin benzoate 5 SG (0.17/plant) and thiamethoxam 25 WG (0.28/plant) were proved to be most harmful insecticides against larval population of green lace on okra.

Fifteen days after spray

During 2017-18, the maximum population was observed in untreated control and it was followed by LAMIT 0.6%, eucalyptus oil 0.2%, biomix 0.3%, karanj oil 0.5%, *Verticilium lecanii* 0.4%, *Beauveria bassiana* 0.4%, NSKE 5% and *Metarhizium + Beauveria* 0.4%. These were followed by neem oil 0.2% and dashparni ark 0.6%. Minimum population was observed in emamectin benzoate 5 SG followed by thiamethoxam 25 WG.

The data on larval population of green lacewing during 2018-19 revealed that the untreated control (0.81/plant) recorded maximum population which were at par with LAMIT 0.6%, eucalyptus oil 0.2% and karanj oil 0.5%. Followed by neem oil 0.2%, biomix 0.3%, NSKE 5%, *Metarhizium+Beauveria* 0.4%, *Beauveria bassiana* 0.4%, *Verticilium lecanii* 0.4% and dashparni ark 0.6%. The lowest population was observed in emamectin benzoate 5SG (0.24/plant) and thiamethoxam 25WG (0.37/plant).

Second spray

The data recorded on effect of different bio-pesticides against larvae of green lacewing after second spray on okra one day before spraying (precount), 1 DAS, 3 DAS, 7DAS and 15DAS are given in Table 54 and depicted in Fig. 48.

Precount

The Precount was non-significant in 2017-18 and 2018-19. The population varied from 0.61 to 0.78 and 0.70 to 0.92/plant, respectively.

One day after spray

During 2017-18, the highest population was observed in untreated control (0.75/plant) which was followed by LAMIT 0.6% (0.72/plant) and eucalyptus oil 0.2% (0.69/plant). These were followed by, biomix 0.3%, *Beauveria bassiana* 0.4%, NSKE 5%, karanj oil 0.5%, neem oil 0.2%,

Metarhizium+Beauveria 0.4%, *Verticilium lecanii* 0.4% and dashparni ark 0.6%. The most toxic insecticides were Emamectin benzoate 5% SG and thiamethoxam 25% WG.

During 2018-19, the maximum larval population was noticed in untreated plots (0.85/plant). Plots sprayed with LAMIT 0.6 (0.78/plant) were safer bio pesticides among the all treatments and followed by eucalyptus oil 0.2%, karanj oil 0.5% and biomix 0.3%. These were followed by *Beauveria bassiana* 0.4%, neem oil 0.2%, NSKE 5%, *Verticilium lecanii* 0.4%, and *Metarhizium+Beauveria* 0.4%. The lowest population was registered in emamectin benzoate 5 SG (0.16/plant) followed by thiamethoxam 25% WG and dashparni ark 0.6%.

Three days after spray

During 2017-18, there were no significant differences among treatments. The population varied from 0.27 to 0.84/plant in different treatments. The highest population was noticed in untreated control and followed by LAMIT 0.6%, eucalyptus oil 0.2%, karanj oil 0.5%, biomix 0.3%, neem oil 0.2%, *Metarhizium+Beauveria* 0.4%, *Beauveria bassiana* 0.4%, NSKE 5% and *Verticilium lecanii* 0.4%. Emamectin benzoate 5 SG, thiameth-oxam 25% WG and dashparni ark 0.6% were registered lowest population among the all treatments.

Table 2: Effect of different bio-pesticides against green lacewing on okra after second spraying during the years 2017 and 2018

Tr No	Treatment	Dose g or ml/ha	No. of larvae/plant											
			2017						2018					
			Precount	1 DAS	3 DAS	7 DAS	15 DAS	Mean	Precount	1 DAS	3 DAS	7 DAS	15 DAS	Mean
T ₁	NSKE	25 kg	0.72 (1.31)	0.65 (1.28)	0.73 (1.31)	0.82 (1.34)	0.89 (1.37)	0.77 (1.32)	0.82 (1.34)	0.59 (1.26)	0.68 (1.29)	0.77 (1.33)	0.85 (1.36)	0.72 (1.31)
T ₂	LAMIT	3 lit	0.78 (1.33)	0.72 (1.31)	0.80 (1.34)	0.87 (1.36)	0.94 (1.39)	0.83 (1.35)	0.85 (1.36)	0.78 (1.33)	0.88 (1.37)	0.98 (1.40)	1.00 (1.41)	0.91 (1.37)
T ₃	Eucalyptus oil	1 lit	0.74 (1.31)	0.69 (1.30)	0.78 (1.33)	0.85 (1.36)	0.91 (1.38)	0.80 (1.34)	0.82 (1.35)	0.76 (1.32)	0.86 (1.36)	0.95 (1.39)	0.98 (1.40)	0.88 (1.36)
T ₄	Karanj oil	2.5 lit	0.73 (1.31)	0.64 (1.28)	0.76 (1.32)	0.84 (1.35)	0.91 (1.38)	0.78 (1.33)	0.80 (1.34)	0.73 (1.31)	0.83 (1.35)	0.93 (1.38)	0.96 (1.40)	0.86 (1.36)
T ₅	Neem oil	1 lit	0.73 (1.31)	0.64 (1.28)	0.75 (1.32)	0.83 (1.35)	0.87 (1.36)	0.77 (1.32)	0.84 (1.35)	0.63 (1.27)	0.72 (1.31)	0.82 (1.34)	0.88 (1.37)	0.76 (1.32)
T ₆	<i>Metarhizium + Beauveria</i>	2 kg	0.74 (1.32)	0.63 (1.27)	0.74 (1.31)	0.80 (1.33)	0.88 (1.37)	0.76 (1.32)	0.74 (1.32)	0.46 (1.20)	0.54 (1.24)	0.65 (1.28)	0.72 (1.31)	0.59 (1.25)
T ₇	<i>Beauveria bassiana</i>	2 kg	0.71 (1.31)	0.65 (1.28)	0.74 (1.31)	0.83 (1.35)	0.90 (1.38)	0.78 (1.33)	0.84 (1.35)	0.68 (1.29)	0.77 (1.33)	0.86 (1.36)	0.90 (1.38)	0.80 (1.34)
T ₈	<i>Verticilium lecanii</i>	2 kg	0.68 (1.29)	0.62 (1.27)	0.71 (1.30)	0.81 (1.34)	0.89 (1.37)	0.75 (1.32)	0.70 (1.30)	0.52 (1.23)	0.61 (1.26)	0.72 (1.31)	0.80 (1.34)	0.66 (1.28)
T ₉	Dashparni ark	3 lit	0.70 (1.30)	0.60 (1.26)	0.65 (1.28)	0.75 (1.32)	0.83 (1.35)	0.70 (1.30)	0.70 (1.30)	0.39 (1.18)	0.47 (1.21)	0.57 (1.25)	0.67 (1.29)	0.52 (1.23)
T ₁₀	Biomix	1.5 kg	0.77 (1.33)	0.67 (1.29)	0.76 (1.32)	0.83 (1.35)	0.91 (1.38)	0.79 (1.33)	0.87 (1.36)	0.71 (1.30)	0.81 (1.34)	0.90 (1.37)	0.94 (1.39)	0.84 (1.35)
T ₁₁	Thiamthoxam 25 WG	225 g	0.69 (1.30)	0.30 (1.14)	0.38 (1.17)	0.40 (1.18)	0.43 (1.19)	0.37 (1.17)	0.89 (1.37)	0.23 (1.10)	0.26 (1.12)	0.28 (1.14)	0.31 (1.15)	0.27 (1.12)
T ₁₂	Emamectin benzoate 5 SG	100 g	0.67 (1.29)	0.21 (1.09)	0.27 (1.12)	0.31 (1.14)	0.35 (1.16)	0.28 (1.12)	0.92 (1.38)	0.16 (1.07)	0.19 (1.08)	0.21 (1.09)	0.24 (1.11)	0.20 (1.08)
T ₁₃	Control (water spray)		0.61 (1.26)	0.75 (1.32)	0.84 (1.35)	0.92 (1.38)	0.98 (1.40)	0.83 (1.36)	0.79 (1.34)	0.85 (1.36)	0.92 (1.38)	0.99 (1.41)	1.01 (1.42)	0.94 (1.39)
	SE±		0.09	0.13	0.08	0.07	0.09	0.09	0.08	0.07	0.10	0.12	0.11	0.10
	C.D. at 5%		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	C.V. %		9.21	12.16	8.63	6.58	8.43	8.95	8.80	7.43	9.74	10.23	11.11	9.62

*Figures in parentheses are square root transformed values

DAS: Days after Spray

NS: Non Significant

During 2018-19, the control plots noted maximum population. The most safer bio pesticides were LAMIT 0.6%, eucalyptus oil 0.2%, karanj oil 0.5% and biomix 0.3%. These were followed by *Beauveria bassiana* 0.4%, neem oil 0.2%, NSKE 5%, *Verticilium lecanii* 0.4%, *Metarhizium+Beauveria* 0.4% and dashparni ark 0.6%. Emamectin benzoate 5% SG and thiamethoxam 25% WG were proved to be most harmful insecticides against green lacewing on okra.

Seven days after spray

During 2017-18, the untreated plots (0.92/plant) recorded highest population among all treatments.

LAMIT 0.6% (0.97/plant) recorded high population among bio pesticides. The next best treatments were eucalyptus oil 0.2%, karanj oil 0.5%, neem oil 0.2%, *Beauveria bassiana* 0.4% and biomix 0.3%. These were followed by NSKE 5%, *Verticilium lecanii* 0.4%, *Metarhizium+Beauveria* 0.4% and dashparni ark 0.6%. The lowest population was noticed in emamectin benzoate 5 SG (0.31/plant) followed by thiamethoxam 25 WG (0.40/plant).

During 2018-19, the lowest population was recorded in emamectin benzoate 5 SG (0.21/plant) and thiamethoxam 25 WG (0.28/plant). The highest population was observed in untreated control (0.99/plant) which was followed by LAMIT 0.6% (0.98/plant), eucalyptus oil 0.2% (0.95/plant), karanj oil 0.5% (0.93/plant) and biomix 0.3% (0.90/plant). The next treatments were *Beauveria bassiana* 0.4%, neem oil 0.2%, NSKE 5%, *Verticilium lecanii* 0.4%, *Metarhizium+Beauveria* 0.4% and dashparni ark 0.6%.

Fifteen days after spray

During 2017-18, the plots treated with LAMIT 0.6% (0.94/plant) recorded maximum population among all bio-pesticides. It was followed by eucalyptus oil 0.2%, karanj oil 0.5% and biomix 0.3% (0.91/plant). The next treatments were *Beauveria bassiana* 0.4% *Verticilium lecanii* 0.4%, NSKE 5%, *Metarhizium+Beauveria* 0.4%, neem oil 0.2% and dashparni ark 0.6%. The minimum population was noted in the plots sprayed with emamectin benzoate 5 SG (0.35/plant) followed by thiamethoxam 25 WG. The highest population was recorded in untreated control (0.98/plant) among all treatments.

During 2018-19, among all bio-pesticides, the maximum population was noted in the plots treated with LAMIT 0.6% (1.00/plant). The next safer bio pesticides were eucalyptus oil (0.98/plant), karanj oil 0.5% (0.96/plant) and biomix 0.3% (0.94/plant). These were followed by *Beauveria bassiana* 0.4 %, neem oil 0.2%, NSKE 5%, *Verticilium lecanii* 0.4%, *Metarhizium+Beauveria* 0.4%, and dashparni ark 0.6%. The lowest population was observed in emamectin benzoate 5 SG (0.24/plant) and thiamethoxam 25% WG (0.31/plant). The untreated control (1.01/plant) recorded significantly highest population among all treatments.

Third spray

There were non-significant differences among treatments on one day before spraying after third spray on okra during 2017-18 and 2018-19.

Precount

The data on one day before spraying (Precount), 1 DAS, 3 DAS, 7DAS and 15DAS are presented in Table 55 and depicted in Fig. 49. The larval population ranged from 0.72 to 0.94 and 0.45 to 0.62/plant during 2017-18 and 2018-19, respectively.

One day after spray

During 2017-18, there were no significant differences among treatments and untreated control (0.87/plant) recorded highest population.

It was followed by LAMIT 0.6% (0.80/plant), eucalyptus oil 0.2% (0.78/plant), karanj oil 0.5 % (0.75/plant), biomix 0.3% (0.73/plant), *Beauveria bassiana* 0.4% (0.70/plant), neem oil 0.2 % (0.65/ plant), NSKE 5% (0.61/plant), *Verticilium lecanii* 0.4 % (0.55/plant), *Metarhizium+Beauveria* 0.4% (0.54/plant) and dashparni ark 0.6%. The minimum population was registered in emamectin benzoate 5 SG% (0.21/plant).

During 2018-19, the untreated control (0.61/plant) recorded highest population than any other treatment. Among the biopesticides treatments, the maximum population were noticed in eucalyptus oil 0.2% (0.53/plant) treated plots which was followed by karanj oil 0.5% (0.52/plant), neem oil 0.2% (0.47/plant) and NSKE 5% (0.48/plant). These were followed by dashparni ark 0.6%, *Beauveria bassiana* 0.4% biomix 0.3%, *Metarhizium+Beauveria* 0.4 % and *Verticilium lecanii* 0.4%. The minimum population was found in the plots sprayed with emamectin benzoate 5 SG% (0.12/plant) and thiamethoxam 25 WG (0.21/ plant).

Three days after spray

The data on larval population of green lacewing on okra after seven DAS during 2017-18, indicated that LAMIT 0.6% (0.90/plant), eucalyptus oil 0.2% (0.88/plant), karanj oil (0.85/plant) and biomix 0.3% (0.83/plant). Recorded significantly higher population among all the biopesticides treatments. These were followed by *Beauveria bassiana* 0.4%, neem oil 0.2%, NSKE 5%, *Verticilium lecanii* 0.4%, *Metarhizium+Beauveria* 0.4% and dashparni ark 0.6%. The lowest population was observed in emamectin benzoate 5SG (0.24/plant) which was at par with thiamethoxam 25 WG (0.30/plant). However, the significantly highest population was noticed in untreated control (0.94/plant).

During 2018-19, the population varied from 0.15 to 0.68/plant in various treatments in emamectin benzoate 5 SG (0.15/plant) was more toxic to green lacewing as it recorded lowest population and followed by thiamethoxam 25 WG (0.24/plant). The untreated control (0.68/plant) recorded significantly highest population than all treatments. However, among the biopesticides treatments the maximum population was noticed in LAMIT 0.6% (0.60/plant) treated plots. The next best treatments were eucalyptus oil 0.2%, karanj oil 0.5%, neem oil 0.2%, NSKE 5%, *Beauveria bassiana* 0.4%, biomix 0.3%, dashparni ark 0.6 %, *Verticilium lecanii* 0.4% and *Metarhizium+Beauveria bassiana* 0.4%.

Table 3: Effect of different bio-pesticides against green lacewing on okra after third spraying during the years 2017 and 2018

Tr No	Treatment	Dose g or ml/ha	No. of larvae/plant											
			2017						2018					
			Precount	1 DAS	3 DAS	7 DAS	15 DAS	Mean	Precount	1 DAS	3 DAS	7 DAS	15 DAS	Mean
T ₁	NSKE	25 kg	0.84 (1.35)	0.61 (1.27)	0.70 (1.30)	0.79 (1.34)	0.87 (1.36)	0.74 (1.31)	0.52 (1.22)	0.48 (1.21)	0.54 (1.24)	0.62 (1.27)	0.71 (1.30)	0.58 (1.25)
T ₂	LAMIT	3 lit	0.87 (1.36)	0.80 (1.34)	0.90 (1.37)	0.99 (1.41)	1.02 (1.42)	0.92 (1.38)	0.61 (1.26)	0.42 (1.24)	0.63 (1.27)	0.69 (1.30)	0.74 (1.31)	0.63 (1.28)
T ₃	Eucalyptus oil	1 lit	0.84 (1.35)	0.78 (1.33)	0.88 (1.37)	0.97 (1.40)	1.00 (1.41)	0.90 (1.37)	0.59 (1.26)	0.53 (1.23)	0.60 (1.26)	0.69 (1.30)	0.78 (1.33)	0.65 (1.29)
T ₄	Karanj oil	2.5 lit	0.82 (1.35)	0.75 (1.32)	0.85 (1.36)	0.94 (1.39)	0.98 (1.40)	0.88 (1.36)	0.58 (1.25)	0.52 (1.23)	0.59 (1.26)	0.68 (1.29)	0.80 (1.34)	0.64 (1.28)
T ₅	Neem oil	1 lit	0.86 (1.36)	0.65 (1.28)	0.74 (1.31)	0.84 (1.35)	0.90 (1.38)	0.78 (1.33)	0.51 (1.23)	0.47 (1.21)	0.54 (1.23)	0.66 (1.28)	0.75 (1.32)	0.60 (1.26)
T ₆	<i>Metarhizium + Beauveria</i>	2 kg	0.76 (1.32)	0.54 (1.23)	0.56 (1.25)	0.67 (1.29)	0.74 (1.32)	0.61 (1.26)	0.62 (1.27)	0.43 (1.19)	0.48 (1.21)	0.60 (1.26)	0.70 (1.30)	0.55 (1.24)
T ₇	<i>Beauveria bassiana</i>	2 kg	0.86 (1.36)	0.70 (1.30)	0.79 (1.33)	0.88 (1.37)	0.92 (1.38)	0.82 (1.34)	0.51 (1.22)	0.45 (1.20)	0.52 (1.23)	0.61 (1.26)	0.67 (1.29)	0.57 (1.24)
T ₈	<i>Verticillium lecanii</i>	2 kg	0.72 (1.31)	0.55 (1.24)	0.63 (1.27)	0.74 (1.31)	0.82 (1.34)	0.68 (1.29)	0.53 (1.23)	0.42 (1.19)	0.48 (1.21)	0.58 (1.25)	0.68 (1.29)	0.54 (1.23)
T ₉	Dashparni ark	3 lit	0.72 (1.31)	0.51 (1.22)	0.53 (1.23)	0.59 (1.26)	0.69 (1.30)	0.54 (1.24)	0.58 (1.25)	0.45 (1.19)	0.52 (1.22)	0.56 (1.24)	0.65 (1.28)	0.53 (1.23)
T ₁₀	Biomix	1.5 kg	0.89 (1.37)	0.73 (1.31)	0.83 (1.35)	0.92 (1.38)	0.96 (1.40)	0.86 (1.36)	0.50 (1.21)	0.45 (1.20)	0.53 (1.23)	0.64 (1.27)	0.73 (1.31)	0.58 (1.25)
T ₁₁	Thiamthoxam 25 WG	225 g	0.91 (1.38)	0.28 (1.14)	0.30 (1.14)	0.33 (1.15)	0.35 (1.16)	0.31 (1.14)	0.47 (1.21)	0.21 (1.08)	0.24 (1.11)	0.27 (1.12)	0.29 (1.13)	0.26 (1.11)
T ₁₂	Emamectin benzoate 5 SG	100 g	0.94 (1.39)	0.21 (1.09)	0.24 (1.11)	0.26 (1.12)	0.29 (1.14)	0.25 (1.11)	0.45 (1.20)	0.12 (1.04)	0.15 (1.06)	0.18 (1.08)	0.20 (1.09)	0.16 (1.06)
T ₁₃	Control (water spray)		0.81 (1.34)	0.87 (1.37)	0.94 (1.39)	1.00 (1.41)	1.03 (1.42)	0.96 (1.39)	0.54 (1.24)	0.61 (1.26)	0.68 (1.29)	0.75 (1.32)	0.83 (1.35)	0.71 (1.30)
	SE±		0.08	0.09	0.10	0.13	0.09	0.10	0.06	0.08	0.10	0.07	0.10	0.08
	C.D. at 5 %		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	C.V. %		7.47	8.17	10.09	11.26	9.33	9.71	6.90	7.61	8.90	6.83	9.41	8.18

*Figures in parentheses are square root transformed values

DAS: Days after Spray

NS: Non Significant

Seven days after spray

During 2017-18, there were no significant differences among the treatments. The highest population was noted in untreated control (1.00/plant). However, among the biopesticides treatments, LAMIT 0.6% (0.99/plant), eucalyptus oil 0.2% (0.97/plant), karanj oil 0.5% (0.94/plant) and biomax 0.3% (0.92/plant) registered maximum population. The next best treatments were *Beauveria bassiana* 0.4%, neem oil 0.2%, NSKE 5%, *Verticillium lecanii* 0.4%, *Metarhizium+Beauveria* 0.4%, and dashparni ark 0.6%. The lowest population was observed in emamectin benzoate 5 SG (0.26/plant) and thiamethoxam 25% WG.

The larval population ranged from 0.18 to 0.75/plant in various treatments during 2018-19. The plots treated with emamectin benzoate 5 SG (0.18/plant) and thiamethoxam 25 WG (0.27/plant) noted lowest population. The untreated control (0.75/plant) recorded highest population among all treatments. Among the biopesticides, the maximum population was observed in LAMIT 0.6% followed by eucalyptus oil 0.2%, karanj oil 0.5%, neem oil 0.2%, biomix 0.3% and NSKE 5%. It was followed by *Beauveria bassiana* 0.4%, *Metarhizium+ Beauveria* 0.4 % and dashparni ark 0.6%.

Fifteen days after spray

During 2017-18, LAMIT 0.6 % (1.02/plant) treated plots registered maximum population among biopesticides treatments. It was followed by eucalyptus oil 0.2% (1.02/plant), karanj oil 0.5% (1.02/plant), biomix 0.3% (1.02/plant), *Beauveria bassiana* 0.4%, neem oil 0.2%, NSKE 5 %, *Verticillium lecanii* 0.4 %, *Metarhizium+ Beauveria* 0.4 % and dashparni ark 0.6 %. The lowest population was

found in emamectin benzoate 5 SG (0.29/plant) treated plots which was followed by thiamethoxam 25 WG. The highest population was noticed in untreated plot (1.03/plant) among the all treatments

During 2018-19, the larval population varied from 0.20 to 0.83/plant in different treatments. The untreated control (0.83/plant) recorded higher population. However, among biopesticides karanj oil 0.5 % (0.80/plant) noted maximum population. It was followed by eucalyptus oil 0.2%. Neem oil 0.2%, LAMIT 0.6%, biomix 0.3%, NSKE 5%, *Metarhizium+ Beauveria* 0.4%, *Verticillium lecanii* 0.4 %, *Beauveria bassiana* 0.4% and dashparni ark 0.6%. Emamectin benzoate 5 SG (0.20/plant) and thiamethoxam 25% WG (0.29/plant) treated plots registered lowest larval population.

Pooled data 2017-18 and 2018-19

The data on larval population one day before spraying after each spraying are presented in given in Table 56 and depicted in Fig.50.

Precount

The Precount of larvae was showing non-significant of population in all plots during both years 2017-18 and 2018-19. Before first, second and third spray, it ranged from 0.57 to 0.69, 0.69 to 0.81 and 0.57 to 0.74/plant, respectively. The pooled data were also non-significant.

After spray

The pooled data of two years observed after first spray indicated that the untreated control (0.76/plant) recorded maximum population.

Among biopesticides lowest population in LAMIT 0.6% (0.74/plant) followed by eucalyptus oil 0.2% (0.72/plant), karanj oil 0.5% (0.71/plant), neem oil 0.2%, biomix 0.3%, NSKE 5%, *Beauveria bassiana* 0.4%, *Verticilium lecanii*

0.4%, *Metarhizium + Beauveria bassiana* 0.4% and dashparni ark 0.6%. Minimum larval population recorded in emamectin benzoate 5 SG and thiamethoxam 25 WG.

Table 4: Effect of different bio-pesticides against green lacewing on okra after different spraying (Pooled data of 2017 & 2018)

Tr No	Treatment	Dose g or ml/ha	No. of larvae/plant					
			Precount	After first spray	Precount	After second spray	Precount	After third spray
T ₁	NSKE	25 kg	0.62 (1.27)	0.67 (1.28)	0.77 (1.32)	0.74 (1.31)	0.68 (1.28)	0.66 (1.28)
T ₂	LAMIT	3 lit	0.69 (1.30)	0.74 (1.31)	0.81 (1.34)	0.87 (1.36)	0.74 (1.31)	0.77 (1.33)
T ₃	Eucalyptus oil	1 lit	0.66 (1.28)	0.72 (1.30)	0.78 (1.33)	0.84 (1.35)	0.71 (1.30)	0.77 (1.33)
T ₄	Karanj oil	2.5 lit	0.65 (1.28)	0.71 (1.30)	0.76 (1.32)	0.82 (1.34)	0.70 (1.30)	0.76 (1.32)
T ₅	Neem oil	1 lit	0.62 (1.27)	0.68 (1.29)	0.78 (1.33)	0.76 (1.32)	0.68 (1.29)	0.69 (1.29)
T ₆	<i>Metarhizium + Beauveria</i>	2 kg	0.62 (1.27)	0.65 (1.27)	0.74 (1.32)	0.67 (1.28)	0.62 (1.27)	0.58 (1.29)
T ₇	<i>Beauveria bassiana</i>	2 kg	0.61 (1.26)	0.67 (1.28)	0.77 (1.33)	0.79 (1.33)	0.68 (1.29)	0.69 (1.29)
T ₈	<i>Verticilium lecanii</i>	2 kg	0.60 (1.25)	0.65 (1.27)	0.69 (1.29)	0.70 (1.30)	0.62 (1.27)	0.61 (1.26)
T ₉	Dashparni ark	3 lit	0.61 (1.26)	0.62 (1.26)	0.70 (1.30)	0.61 (1.26)	0.62 (1.26)	0.54 (1.23)
T ₁₀	Biomix	1.5 kg	0.63 (1.27)	0.68 (1.29)	0.81 (1.34)	0.82 (1.34)	0.68 (1.29)	0.72 (1.30)
T ₁₁	Thiamthoxam 25 WG	225 g	0.59 (1.25)	0.34 (1.15)	0.79 (1.33)	0.32 (1.14)	0.69 (1.29)	0.28 (1.12)
T ₁₂	Emamectin benzoate 5 SG	100 g	0.57 (1.24)	0.23 (1.10)	0.79 (1.33)	0.24 (1.10)	0.67 (1.28)	0.20 (1.08)
T ₁₃	Control (water spray)		0.64 (1.27)	0.76 (1.32)	0.70 (1.30)	0.88 (1.37)	0.57 (1.24)	0.83 (1.34)
	SE±		0.07	0.09	0.08	0.09	0.07	0.09
	C.D. at 5 %		NS	NS	NS	NS	NS	NS
	C.V. %		7.17	9.07	9.00	10.28	7.18	8.94

*Figures in parentheses are square root transformed values

DAS: Days after spray

NS: Non significant

The pooled data of two years indicated that after second spray maximum population was observed in control plots (0.88/plant). The most safer biopesticides were LAMIT 0.6%, eucalyptus oil 0.2%, karanj oil 0.5% and biomix 0.3%. These were followed by *Beauveria bassiana* 0.4%, neem oil 0.2%, NSKE 5%, *Verticilium lecanii* 0.4%, *Metarhizium+Beauveria bassiana* 0.4% and dashparni ark 0.6%. The minimum population was recorded in emamectin benzoate 5SG (0.24/plant) and thiamethoxam 25WG (0.32/plant). The pooled data of two years recorded that after third spray population ranged between 0.20 to 0.83/plant in various treatments. The untreated control recorded maximum larval population. Among the biopesticides LAMIT 0.6% and eucalyptus oil 0.2%, recorded maximum population. These were followed by karanj oil 0.5%, biomix 0.3%, *Beauveria bassiana* 0.4%, neem oil 0.2%, NSKE 5%, *Verticilium lecanii* 0.4%, *Metarhizium + Beauveria* 0.4% and dashparni ark 0.6%. The most toxic insecticides were emamectin benzoate 5% SG and thiamethoxam 25% WG.

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