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

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

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

Corresponding Author:
BB Gaikwad
Department of Agricultural Entomology, College of Agriculture, Parbhani, (Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani) Maharashtra, India.

Efficacy of different biopesticides against spider on okra

BB Gaikwad, BB Bhosle and AB Mudgalkar

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Abstract
Among all biopesticides, the maximum spider population was noted in the plots treated with biomix 0.3% which was at par with LAMIT 0.6%, eucalyptus oil 0.2%, and karanj oil 0.5%. These were followed by verticilium lecanii 0.4%, beauveria bassiana 0.4%, NSKE 5%, neem oil 0.2%, dashparni ark 0.6% and metarhizium + beauveria bassiana 0.4%. The lowest population was observed in emamectin benzoate 5 SG and thiamethoxam 25 WG. The untreated control recorded significantly highest spider population among all treatments.

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 favours 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 BB 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 spider 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 spider on one day before spraying (Precount), 1 DAS, 3 DAS, 7DAS and 15DAS are given in Table 1.

Precount

There were non-significant differences among treatments on one day before spraying after first spray on okra during 2017-18 and 2018-19. The spider population ranged from 0.50 to 0.69 and 0.30 to 0.48/plant during 2017-18 and 2018-19, respectively.

Table 1: Effect of different bio-pesticides against spiders on okra after first spraying during the years 2017 and 2018

Tr No	Treatment	Dose g or ml/ha	No. of spiders/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	0.64 (1.28)	0.49 (1.22)	0.61 (1.27)	0.66 (1.29)	0.76 (1.32)	0.63 (1.27)	0.37 (1.16)	0.35 (1.15)	0.39 (1.17)	0.52 (1.23)	0.57 (1.25)	0.45 (1.20)
T_2	LAMIT	3 lit	0.63 (1.27)	0.55 (1.24)	0.62 (1.27)	0.63 (1.27)	0.82 (1.35)	0.65 (1.28)	0.48 (1.21)	0.42 (1.19)	0.52 (1.23)	0.63 (1.27)	0.77 (1.33)	0.57 (1.25)
T_3	Eucalyptus oil	1 lit	0.60 (1.26)	0.53 (1.23)	0.57 (1.25)	0.63 (1.27)	0.79 (1.33)	0.63 (1.27)	0.47 (1.21)	0.40 (1.17)	0.47 (1.21)	0.63 (1.27)	0.75 (1.32)	0.56 (1.24)
T_4	Karanj oil	2.5 lit	0.56 (1.25)	0.55 (1.24)	0.67 (1.29)	0.69 (1.30)	0.79 (1.33)	0.65 (1.29)	0.37 (1.17)	0.32 (1.15)	0.43 (1.19)	0.57 (1.25)	0.70 (1.30)	0.51 (1.22)
T_5	Neem oil	1 lit	0.50 (1.22)	0.44 (1.19)	0.50 (1.22)	0.55 (1.24)	0.76 (1.32)	0.56 (1.24)	0.41 (1.18)	0.37 (1.17)	0.42 (1.19)	0.55 (1.24)	0.68 (1.29)	0.50 (1.22)
T_6	*Metarhizium +Beauveria*	2 kg	0.60 (1.26)	0.49 (1.22)	0.56 (1.25)	0.64 (1.28)	0.74 (1.31)	0.60 (1.26)	0.36 (1.16)	0.32 (1.14)	0.36 (1.16)	0.45 (1.20)	0.51 (1.22)	0.41 (1.18)
T_7	*Beauveria bassiana*	2 kg	0.59 (1.26)	0.44 (1.19)	0.55 (1.24)	0.60 (1.26)	0.77 (1.33)	0.59 (1.25)	0.45 (1.20)	0.38 (1.17)	0.42 (1.19)	0.55 (1.24)	0.61 (1.26)	0.49 (1.21)
T_8	*Verticilium lecanii*	2 kg	0.63 (1.27)	0.55 (1.24)	0.63 (1.27)	0.66 (1.29)	0.81 (1.34)	0.66 (1.28)	0.40 (1.17)	0.37 (1.16)	0.40 (1.17)	0.52 (1.23)	0.56 (1.24)	0.46 (1.20)
T_9	Dashparni ark	3 lit	0.63 (1.27)	0.47 (1.21)	0.65 (1.29)	0.68 (1.29)	0.81 (1.34)	0.64 (1.28)	0.40 (1.17)	0.34 (1.15)	0.39 (1.17)	0.45 (1.20)	0.52 (1.22)	0.42 (1.18)
T_{10}	Biomix	1.5 kg	0.69 (1.30)	0.61 (1.26)	0.69 (1.30)	0.74 (1.31)	0.83 (1.35)	0.71 (1.30)	0.43 (1.19)	0.42 (1.19)	0.47 (1.20)	0.60 (1.26)	0.68 (1.29)	0.54 (1.23)
T_{11}	Thiamethoxam 25 WG	225 g	0.63 (1.27)	0.21 (1.09)	0.25 (1.11)	0.28 (1.12)	0.30 (1.14)	0.26 (1.11)	0.32 (1.14)	0.18 (1.08)	0.21 (1.09)	0.23 (1.10)	0.27 (1.12)	0.22 (1.09)
T_{12}	Emamectin benzoate 5 SG	100 g	0.61 (1.27)	0.14 (1.06)	0.15 (1.07)	0.17 (1.07)	0.20 (1.09)	0.16 (1.07)	0.30 (1.15)	0.12 (1.04)	0.14 (1.06)	0.16 (1.07)	0.18 (1.08)	0.15 (1.06)
T_{13}	Control (water spray)		0.68 (1.29)	0.70 (1.30)	0.84 (1.35)	0.88 (1.34)	1.00 (1.41)	0.85 (1.35)	0.45 (1.20)	0.50 (1.22)	0.55 (1.24)	0.70 (1.30)	0.82 (1.37)	0.64 (1.28)
	SE±		0.03	0.04	0.03	0.06	0.05	0.04	0.07	0.07	0.04	0.08	0.09	0.07
	C.D. at 5 %		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	C.V. %		4.57	5.31	6.89	8.27	7.33	6.95	5.04	8.51	6.52	7.08	9.81	7.98

*Figures in parentheses are square root transformed value
DAS: Days after Spray, NS: Non Significant

One day after spray

During 2017-18, the safest biopesticides to spider was biomix 0.3 % (0.61/plant) which recorded highest population among all bio-pesticides. The next less harmful biopesticides were LAMIT 0.6%, karanj oil 0.5%, *Verticilium lecanii* 0.4% and eucalyptus oil 0.2%. These were followed by NSKE 5%, *Metarhizium+Beauveria* 0.4%, dashparni ark 0.6% *Beauveria bassiana* 0.4% and neem oil 0.2%. The most toxic insecticides were emamectin benzoate 5 SG (0.14/plant) and thiamethoxam (0.21/plant). The untreated control (0.70/plant) noted highest population over all treatments.

During 2018-19, there were uniform population of spider among treatments. The untreated control (0.50/plant) recorded higher spiders. Among the biopesticides, biomix 0.3% (0.42/plant) and LAMIT 0.6% (0.42/plant) was safer to spider than other biopesticides. The lowest population was observed in the plots treated with emamectin benzoate 5 SG (0.12plant) and thiamethoxam 25% WG (0.18/plant).

Three days after spray

During 2017-18, it was found that the most toxic insecticides were emamectin benzoate 5 SG (0.15/plant) and thiamethoxam WG (0.25/ plant). The most safer biopesticides were biomix 0.3%, (0.69/plant), karanj oil 0.5% (0.67/plant), dashparni ark 0.6% (0.65/plant) and *Verticilium lecanii* 0.4% (0.63/plant) which recorded maximum population among all biopesticides. The next treatments were LAMIT 0.6%, NSKE 5%, eucalyptus oil 0.2%, neem oil 0.2 %, *Metarhizium+ Beauveria* 0.4% and neem oil 0.2%. The highest spider was observed in untreated control (0.84/plant) among all treatments.

During 2018-19, the spider population ranged from 0.14 to 0.55/plant. The population was high in untreated control (0.55/plant). Among the bio-pesticides treatments, the plots sprayed with LAMIT 0.6% (0.52/plant) registered maximum population. The next less harmful biopesticides were eucalyptus oil 0.2%, biomix 0.3%, karanj oil 0.5% neem oil 0.2%, *Beauveria bassiana* 0.4%, *Verticilium lecanii* 0.4%, NSKE 5%, dashparni ark 0.6% and *Metarhizium+Beauveria* 0.4 %. The most deleterious effects were of emamectin benzoate 5 SG followed by thiamethoxam 25 WG.

Seven days after spray

The data on effect of various biopesticides on spider during 2017-18 revealed that the plots treated with emamectin benzoate 5 SG (0.17/plant) recorded lowest population

followed by thiamethoxam 25 WG (0.28/plant). The plots sprayed with biomix 0.3% (0.74/plant) noted maximum population and safer to spider among all biopesticides. It was followed by karanj oil 0.5% and dashparni ark 0.6%. The highest population was noticed in untreated control (0.88/plant) among all treatments.

During 2018-19, the spider population was significantly highest in untreated control (0.70/plant). Among all biopesticides the maximum population was observed in LAMIT 0.6% (0.63/plant) and eucalyptus oil 0.2 % (0.63/plant) which were followed by biomix 0.3 % and karanj oil 0.5%. Next biopesticides were neem oil 0.2%, *Beauveria bassiana* 0.4%, NSKE 5%, *Verticilium lecanii* 0.4%, *Metarhizium+Beauveria* 0.4% and dashparni ark 0.6%. The lowest population was recorded in emamectin benzoate 5 SG (0.16/plant) and thiamethoxam 25 WG (0.23/plant).

Fifteen days after spray

During 2017-18, biomix 0.3 % (0.83/plant) recorded maximum population and safer to spider and followed by LAMIT 0.6 %, *Verticilium lecanii* 0.4%, dashparni ark 0.6%, eucalyptus oil 0.2% and karanj oil 0.5%, *Beauveria bassiana* 0.4%, neem oil 0.2%, NSKE 5% and *Metarhizium+Beauveria* 0.4 %. The most harmful insecticide was emamectin benzoate 5 SG (0.20/plant) followed by thiamethoxam 25 WG. The highest population was noted in untreated control (1.00/plant) among all treatments.

During 2018-19, the untreated control recorded highest population (0.82/plant). LAMIT 0.6% (0.77/plant) was registered maximum population as compared to other biopesticides and it was followed by eucalyptus oil 0.2%, karanj oil 0.5%, neem oil 0.2%, biomix 0.3%, *Beauveria bassiana* 0.4%, NSKE 5%, *Verticilium lecanii* 0.4%, *Metarhizium+Beauveria* 0.4% & dashparni ark 0.6%. The lowest population was noticed in emamectin benzoate 5 SG (0.18/plant) and thiamethoxam 25 WG (0.27/plant).

Second spray

The data on one day before spraying (Precount), 1 DAS, 3 DAS, 7DAS and 15 DAS are presented in Table 2.

Precount

The Precount of spider was non-significant after second spray on okra during 2017-18 and 2018-19. It varied from 0.58 to 0.82, and 0.49 to 0.66/plant during 2017-18, 2018-19, respectively.

One day after spray

During 2017-18, the population of spider varied from 0.18 to 0.72/plant in various treatments. The untreated control (0.72/plant) recorded highest population. The less harmful treatments were LAMIT 0.6%, eucalyptus oil 0.2% and dashparni ark 0.6%. These were followed by karanj oil 0.5%, biomix 0.3%, *Verticilium lecanii* 0.4 %, *Beauveria bassiana* 0.4%, NSKE 5%, neem oil 0.2%, and *Metarhizium+ Beauveria* 0.4%. Emamectin benzoate 5 SG and thiamethoxam 25 WG was the most toxic among all insecticides.

During 2018-19, there were no significant differences of the effect of various biopesticides on spider. The lowest population was observed in the plots treated with emamectin benzoate 5 SG (0.10/plant) and thiamethoxam 25 WG (0.19/plant). The untreated control (0.75/plant) recorded maximum population and remaining all treatments were statistically at par with each other.

Three days after spray

During 2017-18, on 3 DAS the highest spider population was noticed in untreated control (0.80/plant). LAMIT 0.6% (0.75/plant) and eucalyptus oil.

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

Tr No	Treatment	Dose g or ml/ha	No. of spiders/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	0.60 (1.26)	0.52 (1.23)	0.56 (1.24)	0.65 (1.28)	0.72 (1.31)	0.60 (1.26)	0.52 (1.23)	0.49 (1.22)	0.58 (1.25)	0.62 (1.27)	0.72 (1.30)	0.60 (1.26)
T_2	LAMIT	3 lit	0.73 (1.31)	0.64 (1.28)	0.75 (1.32)	0.85 (1.36)	0.92 (1.38)	0.79 (1.33)	0.59 (1.26)	0.40 (1.18)	0.61 (1.26)	0.59 (1.25)	0.74 (1.32)	0.58 (1.25)
T_3	Eucalyptus oil	1 lit	0.71 (1.30)	0.62 (1.27)	0.71 (1.31)	0.81 (1.34)	0.88 (1.37)	0.75 (1.32)	0.56 (1.24)	0.43 (1.19)	0.55 (1.24)	0.59 (1.26)	0.73 (1.31)	0.57 (1.24)
T_4	Karanj oil	2.5 lit	0.68 (1.29)	0.58 (1.26)	0.68 (1.29)	0.77 (1.33)	0.85 (1.36)	0.72 (1.31)	0.60 (1.26)	0.40 (1.18)	0.53 (1.23)	0.62 (1.27)	0.75 (1.32)	0.57 (1.24)
T_5	Neem oil	1 lit	0.62 (1.27)	0.51 (1.22)	0.59 (1.26)	0.69 (1.30)	0.75 (1.32)	0.63 (1.27)	0.59 (1.26)	0.54 (1.24)	0.59 (1.26)	0.64 (1.28)	0.77 (1.33)	0.63 (1.27)
T_6	*Metarhizium +Beauveria*	2 kg	0.58 (1.25)	0.50 (1.22)	0.58 (1.25)	0.60 (1.26)	0.63 (1.27)	0.58 (1.25)	0.57 (1.25)	0.40 (1.18)	0.49 (1.22)	0.60 (1.26)	0.70 (1.30)	0.57 (1.24)
T_7	*Beauveria bassiana*	2 kg	0.68 (1.29)	0.54 (1.24)	0.64 (1.28)	0.72 (1.31)	0.79 (1.34)	0.67 (1.29)	0.56 (1.24)	0.46 (1.20)	0.52 (1.23)	0.56 (1.24)	0.67 (1.29)	0.58 (1.25)
T_8	*Verticilium lecanii*	2 kg	0.60 (1.26)	0.54 (1.24)	0.60 (1.26)	0.63 (1.27)	0.70 (1.30)	0.61 (1.26)	0.59 (1.26)	0.51 (1.23)	0.60 (1.26)	0.63 (1.27)	0.79 (1.34)	0.62 (1.27)
T_9	Dashparni ark	3 lit	0.68 (1.29)	0.60 (1.26)	0.62 (1.27)	0.64 (1.28)	0.67 (1.29)	0.63 (1.27)	0.49 (1.22)	0.46 (1.21)	0.58 (1.25)	0.67 (1.29)	0.72 (1.31)	0.60 (1.26)
T_{10}	Biomix	1.5 kg	0.71 (1.30)	0.56 (1.25)	0.67 (1.29)	0.75 (1.32)	0.83 (1.35)	0.70 (1.30)	0.66 (1.28)	0.57 (1.25)	0.66 (1.28)	0.70 (1.30)	0.79 (1.34)	0.68 (1.29)
T_{11}	Thiamthoxam 25 WG	225 g	0.82 (1.34)	0.24 (1.11)	0.32 (1.14)	0.34 (1.15)	0.39 (1.17)	0.32 (1.14)	0.60 (1.26)	0.19 (1.08)	0.22 (1.10)	0.27 (1.12)	0.30 (1.13)	0.24 (1.10)
T_{12}	Emamectin benzoate 5 SG	100 g	0.75 (1.32)	0.18 (1.08)	0.26 (1.12)	0.28 (1.12)	0.30 (1.13)	0.25 (1.11)	0.58 (1.25)	0.10 (1.02)	0.12 (1.04)	0.13 (1.04)	0.17 (1.07)	0.13 (1.04)
T_{13}	Control (water spray)		0.64 (1.28)	0.72 (1.31)	0.80 (1.34)	0.89 (1.37)	0.96 (1.40)	0.84 (1.35)	0.65 (1.28)	0.75 (1.32)	0.77 (1.33)	0.84 (1.35)	0.95 (1.40)	0.83 (1.35)
	SE±		0.11	0.07	0.9	0.10	0.08	0.08	0.05	0.07	0.06	0.09	0.08	0.07

	C.D. at 5 %		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	C.V. %		10.08	8.76	9.09	11.44	6.27	8.89	4.89	6.63	5.05	8.35	7.77	6.95

*Figures in parentheses are square root transformed values
DAS: Days after Spray, NS: Non Significant

0.2% (0.71/plant) were safest among all biopesticides. The next less toxic biopesticides were karanj oil 0.5%, biomix 0.3%, *Beauveria bassiana* 0.4%, dashparni ark 0.6% *Verticilium lecanii* 0.4%, neem oil 0.2%, *Metarhizium+ Beauveria* 0.4% and NSKE 5%. The most harmful biopesticides to spider were emamectin benzoate 5 SG (0.26/plant) and thiamethoxam 25 WG (0.32/plant).

During 2018-19, the spider population was significantly highest in control plots (0.77/plant) than other treatments. Among the biopesticides, biomix 0.3% (0.66/plant) recorded maximum spider population and followed by LAMIT 0.6% (0.61/plant), *Verticilium lecanii* 0.4% (0.60/plant) and neem oil 0.2% (0.59/plant), dashparni ark 0.6%, NSKE 5%, eucalyptus oil 0.2%, karanj oil 0.5%, *Beauveria bassiana* 0.4% and *Metarhizium+Beauveria* 0.4%. The most toxic insecticide was emamectin benzoate 5 SG (0.12/plant) followed by thiamethoxam 25 WG (0.22/plant).

Seven days after spray

The observations on spider during 2017-18 revealed that the population varied from 0.28 to 0.89/plant in different treatments. The untreated control recorded maximum population. Among the biopesticides, the safest biopesticides to spider was LAMIT 0.6% (0.85/plant) followed by eucalyptus oil 0.2%, karanj oil 0.5%, biomix 0.3%, *Beauveria bassiana* 0.4%, neem oil 0.2%, NSKE 5%, dashparni ark 0.6% *Verticilium lecanii* 0.4% and *Metarhizium+Beauveria* 0.4%. The most deleterious effect on spider was observed due to spraying of emamectin benzoate 5 SG (0.28/plant) and thiamethoxam.

During 2018-19, biomix 0.3 % (0.70/plant), dashparni ark 0.6% (0.67/plant), neem oil 0.2% (0.64/plant) and V*erticilium lecanii* 0.4% (0.63/plant) were safer biopesticides than other biopesticides. These were followed by karanj oil 0.5%, *Metarhizium+Beauveria* 0.4%, LAMIT 0.6%, eucalyptus oil 0.2% and *Beauveria bassiana* 0.4%.

The plots treated with emamection benzoate 5 SG (0.13/plant) and thiamethoxam 25 WG (0.27/plant) recorded lowest population. The untreated control recorded highest population than other treatments.

Fifteen days after spray

During 2017-18, it was found that emamectin benzoate 5 SG (0.30/plant) treated plots recorded minimum spider population and followed by thiamethoxam 25 WG (0.39/plant). The population was highest in untreated control (0.96/plant). Among the biopesticides LAMIT 0.6% (0.92/plant) registered maximum population which was followed by eucalyptus oil 0.2%, karanj oil 0.5%, biomix 0.3%, *Beauveria bassiana* 0.4%, neem oil 0.2%, NSKE 5% *Verticilium lecanii* 0.4%, dashparni ark 0.6% and *Metarhizium+Beauveria* 0.4%.

During 2018-19, there were no statistically significant differences among different treatments. The untreated control (0.95/plant) noted maximum population. It was followed by biomix 0.3%, *Verticilium lecanii* 0.4%, neem oil 0.2%, karanj oil 0.5%, LAMIT 0.6%, eucalyptus oil 0.2%, dashparni ark 0.6%, NSKE 5%, *Metarhizium+Beauveria* 0.4% and *Beauveria bassiana* 0.4%. Emamectin benzoate 5 SG (0.17/plant) recorded lowest population followed by thiamethoxam 25 WG and.

Third spray

The data recorded on effect of different bio-pesticides against spider after third spray on okra one day before spraying (Precount), 1 DAS, 3 DAS, 7DAS and 15DAS are presented in Table 3.

Precount

The Precount was non-significant in 2017-18 and 2018-19. The population varied from 0.76 to 0.94 and 0.52 to 0.67, respectively.

One day after spray

During 2017-18, the maximum spider population was observed in untreated control (0.87/plant). However, among biopesticides LAMIT 0.6% recorded more spider (0.80/plant). It was followed by eucalyptus oil 0.2%

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

Tr No	Treatment	Dose g or ml/ha	No. of spiders/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 (1.34)	0.61 (1.26)	0.70 (1.30)	0.79 (1.33)	0.87 (1.36)	0.74 (1.31)	0.62 (1.27)	0.57 (1.25)	0.59 (1.26)	0.63 (1.27)	0.74 (1.31)	0.63 (1.27)
T_2	LAMIT	3 lit	0.87 (1.36)	0.80 (1.33)	0.90 (1.37)	0.99 (1.41)	1.02 (1.42)	0.92 (1.38)	0.56 (1.24)	0.53 (1.23)	0.64 (1.28)	0.67 (1.29)	0.76 (1.32)	0.65 (1.28)
T_3	Eucalyptus oil	1 lit	0.85 (1.35)	0.78 (1.33)	0.88 (1.36)	0.97 (1.39)	1.00 (1.41)	0.90 (1.37)	0.58 (1.25)	0.51 (1.22)	0.55 (1.24)	0.61 (1.26)	0.75 (1.32)	0.60 (1.26)
T_4	Karanj oil	2.5 lit	0.82 (1.33)	0.75 (1.32)	0.85 (1.35)	0.94 (1.39)	0.98 (1.40)	0.88 (1.36)	0.54 (1.24)	0.52 (1.23)	0.56 (1.24)	0.64 (1.28)	0.77 (1.33)	0.62 (1.26)
T_5	Neem oil	1 lit	0.86 (1.36)	0.65 (1.21)	0.74 (1.31)	0.84 (1.35)	0.90 (1.37)	0.78 (1.31)	0.61 (1.26)	0.59 (1.25)	0.60 (1.26)	0.66 (1.28)	0.79 (1.34)	0.66 (1.28)
T_6	*Metarhizium +Beauveria*	2 kg	0.76 (1.32)	0.71 (1.30)	0.73 (1.31)	0.75 (1.32)	0.85 (1.36)	0.76 (1.32)	0.63 (1.27)	0.55 (1.24)	0.57 (1.25)	0.62 (1.27)	0.72 (1.31)	0.61 (1.26)
T_7	*Beauveria bassiana*	2 kg	0.81 (1.33)	0.70 (1.30)	0.79 (1.33)	0.88 (1.37)	0.92 (1.38)	0.82 (1.34)	0.67 (1.29)	0.63 (1.27)	0.66 (1.29)	0.69 (1.30)	0.71 (1.30)	0.67 (1.28)
T_8	*Verticilium lecanii*	2 kg	0.77 (1.33)	0.60 (1.26)	0.63 (1.27)	0.74 (1.31)	0.82 (1.34)	0.69 (1.29)	0.61 (1.26)	0.58 (1.24)	0.61 (1.26)	0.67 (1.29)	0.83 (1.35)	0.68 (1.29)
T_9	Dashparni ark	3 lit	0.78 (1.32)	0.62 (1.27)	0.64 (1.28)	0.68 (1.29)	0.77 (1.33)	0.67 (1.29)	0.64 (1.28)	0.60 (1.26)	0.63 (1.27)	0.68 (1.29)	0.80 (1.33)	0.58 (1.24)
T_{10}	Biomix	1.5 kg	0.89	0.73	0.83	0.92	0.96	0.86	0.67	0.59	0.59	0.71	0.81	0.66

			(1.37)	(1.31)	(1.35)	(1.38)	(1.39)	(1.35)	(1.29)	(1.25)	(1.26)	(1.31)	(1.34)	(1.29)
T_{11}	Thiamthoxam 25 WG	225 g	0.91 (1.38)	0.26 (1.12)	0.30 (1.13)	0.35 (1.16)	0.37 (1.17)	0.32 (1.14)	0.61 (1.26)	0.20 (1.09)	0.22 (1.10)	0.23 (1.11)	0.27 (1.12)	0.23 (1.10)
T_{12}	Emamectin benzoate 5 SG	100 g	0.94 (1.39)	0.18 (1.08)	0.20 (1.09)	0.25 (1.12)	0.30 (1.13)	0.23 (1.10)	0.52 (1.23)	0.13 (1.04)	0.15 (1.06)	0.17 (1.07)	0.19 (1.08)	0.16 (1.06)
T_{13}	Control (water spray)		0.83 (1.35)	0.87 (1.36)	0.94 (1.39)	1.00 (1.41)	1.03 (1.42)	0.96 (1.39)	0.57 (1.25)	0.64 (1.28)	0.71 (1.30)	0.84 (1.35)	0.93 (1.38)	0.77 (1.32)
	SE±		0.04	0.06	0.05	0.08	0.10	0.07	0.05	0.03	0.06	0.10	0.08	0.06
	C.D. at 5 %		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	C.V. %		5.34	6.61	4.69	7.12	8.16	6.64	6.74	4.61	7.90	9.66	5.41	6.89

*Figures in parentheses are square root transformed values
DAS: Days after Spray, NS: Non Significant

(0.78/plant), karanj oil 0.5 % (0.75/plant), biomax 0.3% (0.73/plant), *Metarhizium+Beauveria* 0.4% (0.71/plant), *Beauveria bassiana* 0.4% (0.70/plant), neem oil 0.2% (0.65/plant), dashparni ark 0.6% (0.62/plant), NSKE 5% (0.61/plant) and *Verticilium lecanii* 0.4% (0.60/plant). The treatment emamectin benzoate 5 SG (0.18/plant) recorded minimum population followed by thiamethoxam 25WG and (0.26/plant).

The data of spider during 2018-19, revealed that the untreated control (0.64/plant) registered highest population. It was followed by *Beauveria bassiana* 0.4% (0.63/plant), dashparni ark 0.6% (0.60/plant), neem oil 0.2% (0.59/plant), biomix 0.3% (0.59/plant), *Verticilium lecanii* 0.4%, NSKE 5%, *Metarhizium+Beauveria* 0.4%, LAMIT 0.6%, karanj oil 0.5% and eucalyptus oil 0.2%. Emamection benzoate 5 SG (0.13/plant) recorded lowest population.

Three days after spray

During 2017-18, the maximum population of spider was observed in untreated control (0.94/plant). It was followed LAMIT 0.6 % (0.90/plant) and eucalyptus oil 0.2% (0.88/plant). Next safer biopesticides were karanj oil 0.5% (0.85/plant), biomix 0.3% (0.83/plant), *Beauveria bassiana* 0.4%, neem oil 0.2%, *Metarhizium+Beauveria* 0.4%. NSKE 5%, dashparni ark 0.6% and *Verticilium lecanii* 0.4%. The minimum population was noted emamection benzoate 5SG (0.20/plant) followed by thiamethoxam 25 WG (0.30/plant).

During 2018-19, the highest spider population was observed in untreated control (0.71/plant) However, most safer biopesticides *Beauveria bassiana* 0.4% (0.66/plant). Followed by LAMIT 0.6%, dashparni ark 0.6%, *Verticilium lecanii* 0.4%, neem oil 0.2%, NSKE 5%, biomix 0.3%, *Metarhizium+Beauveria* 0.4%, karanj oil 0.5% and eucalyptus oil 0.2%. The plots treated emamectin benzoate 5SG (0.15/plant) and thiamethoxam 25WG (0.22/plant) recorded lowest population among the all treatments.

Seven days after spray

During 2017-18, the highest population was observed in control plots (1.00/plant). The most safer biopesticides were LAMIT 0.6% (0.99/plant), eucalyptus oil 0.2% (0.97/plant), karanj oil 0.5% (0.94/plant), and biomix 0.3% (0.92/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 most toxic insecticides were emamectin benzoate 5 SG and thiamethoxam 25 WG.

During 2018-19, the untreated plots (0.84/plant) recorded highest population among all treatments. Biomix 0.3% (0.71 plant), B*eauveria bassiana* 0.4% (0.69/plant) dashparni ark 0.6% (0.68/plant), LAMIT 0.6% (0.67/plant) and *Verticilium lecanii* 0.4% (0.67/plant) were more safer. The next treatments were neem oil 0.2%, karanj oil 0.5%, NSKE 5%, *Metarhizium+ Beauveria* 0.4% and eucalyptus oil 0.2%. The lowest population was noticed in emamectin benzoate 5 SG (0.17/plant) treated plots and thiamethoxam 25 WG.

Fifteen days after spray

During 2017-18, the lowest spider population was noticed in the plots sprayed with emamection benzoate 5 SG (0.30/plant) followed by thiamethoxam 25 WG. The highest population was observed in untreated control (1.03/plant). Among biopesticides LAMIT 0.6 % (1.02/plant), eucalyptus oil 0.2% (1.00/plant) and karanj oil 0.5% (0.98/plant) were more safer. The next treatments were biomix 0.3%, *Beauveria bassiana* 0.4%, neem oil 0.2%, NSKE 5%, *Metarhizium+Beauveria* 0.4%, *Verticilium lecanii* 0.4% and dashparni ark 0.6%.

During 2018-19, it was observed that the plots treated with *Verticilium lecanii* 0.4% (0.83/plant) recorded maximum spider among all biopesticides. It was followed by biomix 0.3%, dashparni ark 0.6%, neem oil 0.2%, karaj oil 0.5%, LAMIT 0.6%, eucalyptus oil 0.2%, NSKE 5%, *Metarhizium+Beauveria* 0.4 %. The minimum population was noted in the plots sprayed with emamectin benzoate 5% SG (0.60/plant) and thiamethoxam 25% WG (0.62/plant). The highest population was recorded in untreated control (0.81/plant) among all treatments.

Pooled data 2017-18 and 2018-19

The observations recorded on number spider before one day before spraying and after each spraying were given in Table 4.

Precount

The Precount of spider was non-significant showing uniform distribution of population in all plots during both years 2017-18 and 2018-19. Before first, second and third spray, they ranged from 0.44 to 0.56, 0.57 to 0.71 and 0.65 to 0.78/plant, respectively. The pooled data were also non-significant.

After spray

The pooled data of two years recorded that after first spray among all biopesticides, the maximum spider population was noted in the plots treated with biomix 0.3% (0.62/plant). It was followed by LAMIT 0.6%, eucalyptus oil 0.2%, karanj oil 0.5%, *Verticilium lecanii* 0.4%, *Beauveria bassiana* 0.4%, NSKE 5%, neem oil 0.2%, dashparni ark 0.6% and *Metarhizium + Beauveria* 0.4%. The lowest population was observed in emamectin benzoate 5 SG (0.15/plant) and thiamethoxam 25WG (0.24/plant). The untreated control (0.74/plant) recorded highest spider population among all treatments.

The pooled data of two years indicated that after second spray the untreated control (0.83/plant) recorded highest spider than any other treatment. Among the biopesticides treatments, the maximum population were noticed in biomix 0.3%

(0.69/plant) treated plots which was followed by LAMIT 0.6% (0.68/plant), eucalyptus oil 0.2% (0.66/plant) and karanj oil 0.5 % (0.64/plant).

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

Tr No	Treatment	Dose g or ml/ha	No. of spiders/plant					
			Precount	After first spray	Precount	After second spray	Precount	After third spray
T_1	NSKE	25 kg	0.50 (1.22)	0.54 (1.23)	0.56 (1.24)	0.60 (1.26)	0.73 (1.30)	0.68 (1.29)
T_2	LAMIT	3 lit	0.55 (1.24)	0.61 (1.26)	0.66 (1.28)	0.68 (1.29)	0.74 1.31)	0.78 (1.33)
T_3	Eucalyptus oil	1 lit	0.53 (1.23)	0.59 (1.26)	0.63 (1.27)	0.66 (1.28)	0.71 (1.29)	0.75 (1.31)
T_4	Karanj oil	2.5 lit	0.44 (1.21)	0.58 (1.25)	0.64 (1.27)	0.64 (1.27)	0.68 (1.28)	0.77 (1.32)
T_5	Neem oil	1 lit	0.45 (1.20)	0.53 (1.23)	0.60 (1.260	0.63 (1.27)	0.73 (1.31)	0.72 (1.31)
T_6	*Metarhizium +Beauveria*	2 kg	0.48 (1.21)	0.50 (1.22)	0.57 (1.250	0.57 (1.24)	0.67 (1.29)	0.68 (1.29)
T_7	*Beauveria bassiana*	2 kg	0.52 (1.23)	0.54 (1.23)	0.62 (1.26)	0.61 (1.27)	0.69 (1.28)	0.74 (1.31)
T_8	*Verticilium lecanii*	2 kg	0.51 (1.22)	0.56 (1.24)	0.59 (1.25)	0.61 (1.26)	0.66 (1.28)	0.69 (1.29)
T_9	Dashparni ark	3 lit	0.51 (1.22)	0.53 (1.23)	0.58 (1.24)	0.62 (1.27)	0.65 (1.29)	0.62 (1.26)
T_{10}	Biomix	1.5 kg	0.56 (1.24)	0.62 (1.26)	0.68 (1.29)	0.69 (1.29)	0.78 (1.33)	0.76 (1.32)
T_{11}	Thiamthoxam 25 WG	225 g	0.47 (1.20)	0.24 (1.10)	0.71 (1.30)	0.28 (1.12)	0.76 (1.32)	0.27 (1.12)
T_{12}	Emamectin benzoate 5 SG	100 g	0.45 (1.21)	0.15 (1.06)	0.66 (1.28)	0.19 (1.07)	0.76 (1.31)	0.19 (1.08)
T_{13}	Control (water spray)		0.56 (1.24)	0.74 (1.31)	0.64 (1.28)	0.83 (1.35)	0.70 (1.29)	0.86 (1.35)
	SE±		0.05	0.05	0.08	0.07	0.04	0.06
	C.D. at 5 %		NS	NS	NS	NS	NS	NS
	C.V. %		4.80	7.46	7.48	8.30	5.89	6.76

*Figures in parentheses are square root transformed values
DAS: Days after Spray, NS: Non Significant

These were followed by neem oil 0.2%, dashparni ark 0.6% *Beauveria bassiana* 0.4%, *Verticilium lecanii* 0.4%, NSKE 5% & *Metarhizium+Beauveria* 0.4%. The population was minimum in the plots sprayed with emamectin benzoate 5 SG (0.19/plant) followed by thiamethoxam 25 WG (0.28/plant).

The pooled data of two years revealed that after third spray population of spider varied from 0.19 to 0.86/plant in various treatments. Emamectin benzoate 5 SG (0.19/plant) was more toxic to spider as it recorded lowest population and followed by thiamethoxam 25 WG (0.27/plant). The untreated control (0.86/plant) recorded highest population than all treatments. However, among the biopesticides treatments, the maximum spider was noticed in LAMIT 0.6% (0.78/plant) treated plots. The next best treatments were karanj oil 0.5% biomix 0.3%, eucalyptus oil 0.2% *Beauveria bassiana* 0.4%, neem oil 0.2%, *Verticilium lecanii* 0.4%, NSKE 5%, *Metarhizium+Beauveria* 0.4% and dashparni ark 0.6%.

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