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Eco-Friendly Management of Major insect Pests of Mustard (*Brassica juncea* L.)

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ABSTRACT: The field trial was conducted to evaluate the effect of different biopesticides against major insect pests of mustard at research farm of Department of Agricultural Entomology, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India. The results revealed that Azadirachtin 10000 ppm, *Beauveria bassiana, Lecanicillium lecanii* and NSKE could be the best combination of treatments in management of major insect pests of mustard as Azadirachtin 10000 ppm and *Beauveria bassiana* had a superior control over aphids and larval populations, respectively and both were aptly assisted by *Lecanicillium lecanii* and NSKE. Considering the economics of treatments, Azadirachtin 10000 ppm (1:16.97) and *Beauveria bassiana* (1:13.50) were found more economical than other treatments.

Keywords: Biopesticides, Azadirachtin 10000 ppm, *Beauveria bassiana*, mustard etc.

INTRODUCION

Mustard has taken on a significant role in the national economy, ranking second in terms of acreage behind groundnut. With a volume of 68.87 million tonnes, it is the world's second largest oilseed (Anon., 2021). India contributed 13.14 percent to global production with a total area of 6.23 mha, an output of 9.34 mt and a productivity of 14.99 q ha^{-1}. Rajasthan contributes 38.07% area and 43.69% production to the nation. In India, major mustard and rapeseed producing States are Rajasthan, Haryana, Uttar Pradesh, Madhya Pradesh, Gujarat, Assam, West Bengal, Punjab and Maharashtra (Anon., 2019). Mustard is an important oilseed crop which is grown in subtropical as well as tropical countries in the world. India is the second largest producer of this crop in the World (Dwivedi *et al.*, 2019).

During the crop period, mustard is attacked by many pests and diseases. Mustard aphid, *Lipaphis erysimi*; sawfly, *Athalia lugens proxima*; painted bug *Bagrada cruciferum*; leaf minor, *Chromatomyia herticola*; and Bihar hairy caterpillar, *Spilarctia oblique* are among the insect pests (Sachan and Purwar 2007).

Among the insect pests, mustard aphid is the most damaging insect, causing 24.5 to 68.00 percent yield loss (Parmar *et al*., 200. Kular and Kumar, 2011; Sharma *et al*., 2019 ; Kumar 2017) and 3.38 to 8.14 percent oil loss (Sharma *et al*., 2019) with Patel *et al*. (2004) reported a 97.40 percent yield loss. *Crocidolomi abinonalis* reduces yield by 13.2 to 81.3 percent (Pawar *et al*., 2009) whereas the losses caused by the mustard sawfly have been measured to 15.50 percent (Divakaran and Babu 2016).

Several techniques have been modified to handle insect pests on mustard crop; among these pest control methods, chemical control has been widely used for insect pest control. Pesticides have certain drawbacks, such as adverse effects on natural enemies and pollution of the environment. Many undesirable side effects of older insecticides include residue issues, environmental risks, destruction of non-targeted insects such as parasites and predators as bio-control agents and honeybees as pollinators, and the growth of insecticide resistance. There is a need to adapt eco-friendly management to combat mustard pests.

Entomo pathogenic fungi are often host-specific and pose little danger to mammals or the ecosystem. White muscardine is caused by *Beauveria bassiana*. In an integrated pest management (IPM) programme against aphids, the use of *Lecanicillium lecanii* is suggested as a complementary biological control technique. The key pesticidal component of neem extracts are azadirachtin, which has aphid-feeding-deterrent, repellent, toxic, and growth-disrupting properties (Khanal *et al*., 2020). Botanicals, in addition to biopesticides, are more environmentally friendly. To effectively control this insect pest, modern biological methods must be used, which are readily available and equal the potency of chemical insecticides.

MATERIALS AND METHODS

An experiment was conducted at research of field Department of Agricultural Entomology, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra during *Rabi* season 2020-21 to evaluate the effect of different treatment materials against major insect pests of mustard. Eight treatments including untreated control plot were evaluated in Randomized block design with three replications. The treatments were T_1-Lamit Ark @ 25 L/ha, T_2- Dashparni Ark @ 25 L/ha, T_3- *Beauveria bassiana*@ 2 kg/ha,T_4- Azadirachtin 10000 ppm @ 500ml/ha, T_5- NSKE @ 25 kg/ha, T_6- *Lecanicillium lecanii*@ 2 kg/ha, T_7- Cow urine@ 25 L/ha and T_8- Control (untreated). Ten plants from each plot were selected and tagged for observation. Populations of aphid was counted by number aphids / 10 cm terminal leaf, meanwhile leaf webber and saw flies were observed by number of larvae / plant. A pre-count of pests was taken one day before treatment application, and post-counts were taken based on pest survival population on the 3rd, 7th and 10th days after treatment applications. Crop yield was calculated separately for each treatment in each replication. Obtained data were compiled and analyzed statistically. Incremental cost benefit ratio (ICBR) for each treatment was worked out.

RESULTS AND DISCUSSION

A. Effect of different treatment materials on mustard aphid Lipaphis erysimi

The results as shown in Table 1, average aphid population after treatment application revealed that the plots applied with Azadirachtin 10000 ppm recorded the lowest (17.28 aphids / 10 cm terminal shoot). It was followed by *Lecanicillium lecanii* (20.28aphids / 10 cm terminal shoot) and *Beauveria bassiana* (22.08 aphids / 10 cm terminal shoot), NSKE (22.53 aphids / 10 cm terminal shoot), Cow urine (23.96 aphids / 10 cm terminal shoot) and Lamit Ark (27.71 aphids / 10 cm terminal shoot). The highest count among the treatments was found in Dashparni Ark (28.59 aphids / 10 cm terminal shoot). The untreated control recorded 31.96 aphids / 10 cm terminal shoot.

Sharma *et al.* (2017) reported that dimethoate was observed as being the most successful in lowering the aphid population (95.33%), led by *V. lecanii* @ 108 CS/ml + NSKE @ 5% (88.52 percent), NSKE @ 5% + Clipping of infested twigs (87.77 percent), and *B. bassiana* @ 108 CS/ml + NSKE @ 5% (86.91 percent). Adhikari *et al.* (2019) reported that altineem was more successful than *Bacillus thuringiensis* in controlling the mustard aphid. Khanal *et al.* (2020) revealed that Neemraj Super (Azadirachtin 0.3 Percent w/w) was shown as being the most successful at 48, 72, and 96 HAT with the leaf spray process. Rahul *et al*. (2020) found that *Verticillium lecanii* was a better option in bio-insecticides application against aphids. Singh *et al*. (2020) showed that Dimethoate was reported to have the highest IBCR as related to the other drugs, and the next most appropriate cure was Azadirachtin supported by *Verticillium leccani* after 15 days. Present study results are in line with the above research scientists' reports. Similar result found *Bacillus thuringiensis* (57.02%) was found to be the next best treatment which is in line with the similar findings of Kumar and Kumar. Neem oil 5% (52.93%) was found to be the next best treatment which is in line with the similar findings of Kumar and Kumar (2016). Neem seed kernel extract (NSKE) and garlic extract (5 and 10 %) effective control of thrips were the superior and persistent treatments followed by Fenvalerate.

B. Effect of different treatment materials on leaf webber Crocidolomia binotalis

The data is presented in Table 1. Mean larval population revealed that *Beauveria bassiana* had better control (0.83 larvae / plant), followed by *Lecanicillium lecanii* (0.98 larvae / plant). Other treatments in order of their merit were Azadirachtin and NSKE had equal level of control (1.13 larvae / plant), followed by Cow urine (1.52 larvae / plant), Lamit Ark (1.58 larvae / plant) and Dashparni Ark (1.75 larvae / plant). The untreated control recorded highest larval population (1.91 larvae / plant). There is very negligible count of research work was done on these aspects by earlier research scientists.

C. Effect of different treatment materials on sawfly Athalia lugens proxima

Table 1 gives the data on effect of different materials on sawfly. Average larval population depicted that *Beauveria bassiana* had the better control (0.44 larvae / plant), followed by *Lecanicillium lecanii* (0.59 larvae / plant), Azadirachtin 10000 ppm (0.61 larvae / plant). All the other treatments showed their performance in the order of NSKE (0.67 larvae / plant), Cow urine (0.69 larvae / plant), Lamit Ark (0.74 larvae / plant) and Dashparni Ark (0.75 larvae / plant). Untreated control plot had 1.23 larvae / plant.

As the earlier research workers were mainly concentrated on mustard aphid management, references are hardly available on these areas. There is a need to have some more experiments regarding eco-friendly management of major insect pests of mustard.

Table 1: Effect of different treatment materials on major insect pests of mustard.

Tr. No.	Treatments	No. of aphids / 10 cm terminal shoot					No. of leaf webber larvae / plant					No. of sawfly larvae / plant				
		PTC	3DAS	7DAS	10DAS	Mean	PTC	3DAS	7DAS	10DAS	Mean	PTC	3DAS	7DAS	10DAS	Mean
T_1	Lamit Ark	32.27 (5.72*)	26.60 (5.21)	27.80 (5.32)	24.17 (4.97)	27.71 (5.31)	1.33 (1.35)	1.23 (1.32)	1.43 (1.39)	2.33 (1.68)	1.58 (1.44)	0.90 (1.18)	0.77 (1.13)	0.73 (1.11)	0.57 (1.03)	0.74 (1.11)
T_2	Dashparni Ark	31.20 (5.63)	28.33 (5.37)	29.40 (5.47)	25.43 (5.09)	28.59 (5.39)	1.47 (1.40)	1.33 (1.35)	1.63 (1.46)	2.57 (1.75)	1.75 (1.50)	0.83 (1.15)	0.80 (1.14)	0.77 (1.13)	0.60 (1.05)	0.75 (1.12)
T_3	*Beauveria bassiana*	31.53 (5.66)	21.57 (4.70)	18.47 (4.36)	16.73 (4.15)	22.08 (4.75)	1.53 (1.43)	0.73 (1.11)	0.37 (0.93)	0.67 (1.08)	0.83 (1.15)	0.87 (1.17)	0.40 (0.95)	0.37 (0.93)	0.13 (0.80)	0.44 (0.97)
T_4	Azadirachtin 10000 ppm	30.53 (5.57)	16.13 (4.08)	12.53 (3.61)	9.90 (3.22)	17.28 (4.22)	1.50 (1.41)	1.10 (1.26)	0.73 (1.11)	1.17 (1.29)	1.13 (1.27)	0.90 (1.18)	0.77 (1.13)	0.47 (0.98)	0.30 (0.89)	0.61 (1.05)
T_5	NSKE	30.40 (5.56)	22.23 (4.77)	19.87 (4.51)	17.63 (4.26)	22.53 (4.80)	1.37 (1.37)	1.07 (1.25)	0.80 (1.14)	1.30 (1.34)	1.13 (1.27)	0.97 (1.21)	0.73 (1.11)	0.60 (1.05)	0.37 (0.93)	0.67 (1.08)
T_6	*Lecanicillium lecanii*	32.13 (5.71)	19.37 (4.46)	16.57 (4.13)	13.07 (3.68)	20.28 (4.56)	1.30 (1.34)	0.97 (1.21)	0.63 (1.06)	1.03 (1.24)	0.98 (1.22)	1.07 (1.25)	0.63 (1.06)	0.43 (0.97)	0.23 (0.86)	0.59 (1.04)
T_7	Cow urine	30.67 (5.58)	23.23 (4.87)	21.37 (4.68)	20.57 (4.59)	23.96 (4.95)	1.47 (1.40)	1.30 (1.34)	1.57 (1.44)	1.73 (1.49)	1.52 (1.42)	0.83 (1.15)	0.73 (1.11)	0.67 (1.08)	0.53 (1.02)	0.69 (1.09)
T_8	Control (Untreated)	30.53 (5.57)	33.40 (5.82)	35.50 (6.00)	28.40 (5.38)	31.96 (5.70)	1.50 (1.41)	1.40 (1.38)	1.87 (1.54)	2.87 (1.83)	1.91 (1.55)	1.03 (1.24)	1.60 (1.45)	1.33 (1.35)	0.93 (1.20)	1.23 (1.31)
	SE±	0.32	0.31	0.38	0.41		0.12	0.06	0.09	0.13		0.08	0.07	0.07	0.06	
	CD at 5%	NS	0.94	1.13	1.24		NS	0.18	0.27	0.40		NS	0.21	0.22	0.19	
	CV	9.81	11.15	13.78	16.36		14.85	7.99	12.29	16.02		11.99	11.03	11.04	11.79	

*Figures in parenthesis are square root transformed values

Table 2: Economics of different treatment materials in management of major insect pests of mustard.

Tr. No.	Treatments	Yield (q/ha)	Increase in yield over control (q/ha)	Value of additional yield (Rs/ha)	Total cost of treatment application	Net profit (Rs/ha)	ICBR	Rank
T_1	Lamit Ark	13.24	2.50	12750	2110	10640	1:5.04	**VI**
T_2	Dashparni Ark	11.48	0.74	3774	1610	2164	1:1.34	**VII**
T_3	*Beauveria bassiana*	15.46	4.72	24072	1660	22412	1:13.50	**II**
T_4	Azadirachtin 10000 ppm	16.94	6.20	31620	1760	29860	1:16.97	**I**
T_5	NSKE	15.55	4.81	24531	2110	22421	1:10.63	**IV**
T_6	*Lecanicillium lecanii*	13.52	2.78	14178	1660	12518	1:7.54	**V**
T_7	Cow urine	13.05	2.31	11781	860	10921	1:12.70	**III**
T_8	Control (Untreated)	10.74	-	-	-	-	-	-

Rates:
i) Lamit Ark – Rs. 50/L
ii) Dashparni Ark – Rs. 30/L
iii) *Beauveria bassiana* – Rs. 400/kg
iv) Azadirachtin 10000 ppm – Rs. 450/250 ml
v) NSKE – Rs. 50/kg
vi) *Lecanicillium lecanii*– Rs. 400/kg
vii) Labour charge – Rs. 330/day/labour
viii) Sprayer charge – Rs. 200/day
ix) Marketable price mustard – Rs. 5100/q

D. Economics of different treatment materials in management of major insect pests of mustard

The data is represented in Table 2. The data revealed that applications with Azadirachtin 10000 ppm and *Beauveria bassiana* were recorded highest cost benefit ratio of 1:16.97 and 1:13.50, respectively. All other treatments were in the order of Cow urine (1:12.70), NSKE (1:10.63), *Lecanicillium lecanii* (1:7.54), Lamit Ark(1:5.04) and Dashparni Ark (1:1.34).

Similar findings were observed by Sharma *et al.* (2017), who reported that treatment dimethoate 30EC produced the largest seed yield (1702 kg/ha), led by *V. lecanii* @ 108 CS/ml +NSKE @ 5% (1635 kg/ha), NSKE @ 5% + Clipping of infested twigs (1626 kg/ha), and *B. bassiana* @ 108 CS/ml + NSKE @ 5% (1617 kg/ha). The most cost-effective treatment was dimethoate, which had the best cost-benefit ratio, led by NSKE @ 5% + clipping of infested twigs and NSKE @ 5%. Singh *et al.* (2020) showed thatdimethoate was reported to have the highest IBCR since it had the greatest benefit (1:37.6) as related to the other drugs, and the next most appropriate cure was Azadirachtin supported by *Lecanicillium leccani* (1:12.5). Yadav *et al*. (2021) came up with the result that treatment diamethoate 30 EC @ 625 ml/ha yielded the highest seed yield (16.80 q/ha), followed by Neem oil @ 5% after clipping infested twigs (15.45 q/ha) in accordance with control (8.31 q/ha). Narayan *et al*. (2022), reported that *Beauveria bassiana* 10 % WP (1 × 109CFU/gm) @ 10 g/lit. was recorded with 3.83 larvae/plant, 67.59 cent reduction in population while other treatments viz *Metarhizium anisopliae* 10% WP (1 × 109 CFU/gm) @ 10g/lit. Yadav *et al.* (2021), reported that maximum seed yield was found in treatment Diamethoate 30 EC @ 625 ml/ha (16.80 q/ha) followed by Neem oil @ 5% after clipping of infested twigs (15.45 q/ha).

CONCLUSIONS

The results shown that Azadirachtin 10000 ppm assisted by *Lecanicillium lecanii* had better control over aphids whereas *Beauveria bassiana* followed by *Lecanicillium lecanii* had superiority in controlling the leaf webber and sawfly population. Both these materials are supported by NSKE. One can here clearly sees the best combination of treatments in managing the major insect pests by eco-friendly method. When it comes to the economics of treatments, Azadirachtin 10000 ppm (1:16.97) and *Beauveria bassiana* (1:13.50) were found more economical. As the world is concerned about climate change, global warming and environment pollution, we as an agriculture scientists need to look for alternative methods to conventional chemical applications. More of experiments are needed to evaluate these treatment materials in oil seed crops.

FUTURE SCOPE

1 Studies may provide information on eco-friendly or use of bio-pesticides for management of major insect pests of mustard

2. More studies should be conducted at different region to find out the suitable bio-pesticides and eco-friendly management of major pests of mustard in Marathwada region.

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Conflict of Interest. None.

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