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Efficacy of biopesticides against thrips (*Scirtothrips dorsalis* Hood) infesting chilli (*Capsicum annuum* L.)

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Abstract
The present investigation entitled "Efficacy of biopesticides against thrips (*Scirtothrips dorsalis* Hood) infesting chilli (*Capsicum annuum* L.)" was carried out on field during *rabi* season of 2018-2019 at Central Experiment Station, Wakawali. During this experiment total six biopesticides tested *viz*., *Metarrhizium anisopliae* 2×10^8 cfu/ml @ 2.5ml/lit, *Beauveria bassiana* 2×10^8 cfu/ml @ 5ml/lit, *Lecanicillium lecanii* 2×10^8 cfu/ml @ 4ml/lit, *Nomuraea rileyi* 2×10^8 cfu/g @ 1g/lit, *Bacillus thuringiensis* 3.5% ES @ 2ml/lit, Pongamia oil 2% EC @ 10ml/lit, respectively. The results regarding overall mean of three sprays against thrips revealed that the mean thrips population was reduced in the treatment *Beauveria bassiana* 2×10^8 cfu/ml @ 5ml/lit (1.87) and was significantly superior over rest of the treatments. The next effective treatment was *Lecanicillium lecanii* 2×10^8 cfu/ml @ 4ml/lit (2.14).

Keywords: Thrips, chilli, efficacy, biopesticides

Introduction

Chilli (*Capsicum annuum* L.), is emerging as most important economical and popular vegetable crop in India belonging to family Solanaceae. It is grown for its green fruits as vegetable and red form as spice. In India, it is cultivated in 309 thousand ha area with 3592 thousand MT production during year 2017-18. In Maharashtra, it is grown over an area 30.59 thousand ha, with a production of 342.48 thousand MT during year 2017-18 (Anonymous, 2018) [1].

India is the largest producer of chilli in the world which contributes about 25 per cent of the world's production. The crop is attacked by various pests in all the stages of its growth. The loss of yield is mainly due to the sucking pests like chilli thrips, *Scirtothrips dorsalis* (Hood), green peach aphid, *Myzus persicae* (Sulzer), chilli mite, *Polyphagotarsonemus latus* (Banks) and fruit borer, *Helicoverpa armigera* (Hubner). The damage is resulted not only by desapping leading to crinkling and curling of leaves and loss of plant vigour, but also by the transmission of serious diseases like leaf curl and mosaic viruses. The incidence of thrips starts from nursery and continues till harvest of the produce (Saivaraj *et al*., 1979) [9].

In case of thrips, both nymphs and adults suck the sap from tender crop canopy, resulting in shriveling of leaves and in extreme cases the shoots hardly develop and leafs fall-off. In addition to eruption of internal areas and puckering of leaves, upward curling of leaves is also noticed (Reddy and Puttaswamy, 1983) [8].

Use of chemical pesticides for management of these pests became a part of modern agricultural practices and their consumption has increased remarkably. Indiscriminate use of insecticides has led to insecticide resistance, pest resurgence and environmental pollution besides upsetting the natural ecosystem (Singh and Kumar, 1998) [10]. Biopesticides often considered to be important part of Integrated Pest Management (IPM) programmes for sustainable farming and have received much practical attention as substitutes to synthetic chemicals. Hence, it has been necessary to develop an alternative approach consisting of biopesticides for the thrips management as it is found safer management tool. Keeping in view the above facts, the present investigation was undertaken to find out suitable, effective, feasible and economical plant protection measures against thrips infesting chilli.

Materials and Methods

A field experiment was conducted during *rabi* season 2018-19 to evaluate the efficacy of biopesticides against thrips infesting chilli (genotype- Jwala). The details of experiment are given in below.

Cultural operations

The land was prepared as per the requirements of chilli crop and cleared by removing the residues of the previous crop. The experiment was laid out in Randomized Block Design (RBD). The half dose of urea fertilizer and full dose of phosphorous and potash was applied at the time of sowing and remaining half dose of urea was applied at 30 days after sowing. The experimental area was sown with good seed of chilli (genotype- Jwala) in each plot.

The transplanting of seedlings was done forty days after sowing. The other agronomic operations *viz.,* intercultural operations and weeding were done as per recommendation.

Table 1: Experimental details

Location	:	Central Experiment Station, Wakawali, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri
Period of study	:	November 2018 to April 2019
Genotype	:	Jwala
Spacing	:	60 cm × 60 cm
Size of treatment plot	:	6.6 m × 1.2m
Total plot size	:	166.32 m^2
Date of transplanting	:	22th November, 2018
Method of planting	:	On raised beds
Design	:	Randomized Block Design (RBD)
Number of replication	:	Three
Number of treatment	:	Seven

Table 2: Treatment details

Tr. no.	Treatments	Conc. (%)	Dose
T_1	*Metarrhizium anisopliae* 2×10^8 cfu/ml	0.25	2.5ml/lit
T_2	*Beauveria bassiana* 2×10^8 cfu/ml	0.5	5ml/lit
T_3	*Lecanicillium lecanii* 2×10^8 cfu/ml	0.4	4ml/lit
T_4	*Nomuraea rileyi* 2×10^8 cfu/g	0.1	1g/lit
T_5	*Bacillus thuringiensis* 3.5% ES	0.2	2ml/lit
T_6	Pongamia oil 2% EC	1	10ml/lit
T_7	Untreated control	-	-

Spraying

The quantity of spray suspension required for each treatment was calibrated by spraying water over three plots in the experiment prior to the application of biopesticides. Spray suspension of desired strength of each biopesticide was prepared against thrips in the field.

The biopesticides were sprayed thrice. First spray of each biopesticide was applied when incidence was noticed, while remaining two sprays were given at an interval of 7 days with manually operated knapsack sprayer. The observations were recorded in each treatment on randomly selected five plants.

Method of recording observations

Observations on the number of thrips were recorded on five randomly selected plants per plot. Number of thrips were recorded from the three leaves top, middle and bottom of the plant. The pre-treatment observations were recorded a day before application of biopesticides and subsequently post treatment observation were recorded at second, third and seventh day after each spray were recorded in the early morning hours.

Results and Discussion

Efficacy of biopesticides against thirps (*Scirtothrips dorsalis* Hood) infesting chilli

The data pertaining to the efficacy of different biopesticides against thrips infesting chilli at 2nd, 3rd and 7th days after spray are presented in Table 3.

First spray

The data on mean population of thrips prior to biopesticides application ranged from 3.90 to 4.05 per three leaves per plant. There is no significant difference among the different treatments since uniform distribution of thrips in different treatments.

The observations recorded on second day after first spraying of biopesticides ranges from 3.57 to 4.32 thrips per three leaves per plant. The treatment *Beauveria bassiana* 2×10^8 cfu/ml @ 5ml/lit was found to be most effective treatment which recorded 3.57 mean population of thrips per three leaves per plant and was at par with the treatments *Lecanicillium lecanii* 2×10^8 cfu/ml @ 4ml/lit (3.66) and *Metarrhizium anisopliae* 2×10^8 cfu/ml @ 2.5ml/lit (3.84). The treatment *Nomurea rileyi* 2×10^8 cfu/g @ 1g/lit recorded (3.91) mean population of thrips per three leaves per plant and was at par with Pongamia oil 2% EC @ 10ml/lit (3.95) and *Bacillus thuringiensis* 3.5% ES @ 2ml/lit (4.00). The maximum (4.32) thrips population was found in untreated control.

At the third day after first spraying of biopesticides population of thrips per three leaves per plant ranges from 3.40 to 4.37. The treatment *Beauveria bassiana* 2×10^8 cfu/ml @ 5ml/lit was found to be most effective treatment which recorded 3.40 mean population of thrips per three leaves per plant and was at par with the treatments *Lecanicillium lecanii* 2×10^8 cfu/ml @ 4ml/lit (3.51) and *Metarrhizium anisopliae* 2×10^8 cfu/ml @ 2.5ml/lit (3.65). The treatment *Nomurea rileyi* 2×10^8 cfu/g @ 1g/lit recorded (3.76) mean population of thrips per three leaves per plant and was at par with Pongamia oil 2% EC @ 10ml/lit (3.80) and *Bacillus thuringiensis* 3.5% ES @ 2ml/lit (3.84). The maximum (4.37) thrips population was found in untreated control.

The data recorded at seventh day after first spray revealed that the thrips population per three leaves per plant ranges from 2.68 to 4.54. The treatment *Beauveria bassiana* 2×10^8 cfu/ml @ 5ml/lit was found to be most effective treatment which recorded 2.68 mean population of thrips per three leaves per plant and was at par with the treatment *Lecanicillium lecanii* 2×10^8 cfu/ml @ 4ml/lit (2.89). The treatment *Metarrhizium anisopliae* 2×10^8 cfu/ml @ 2.5ml/lit recorded (3.08) mean population of thrips per three leaves per plant and was at par with the treatment *Nomurea rileyi* 2×10^8 cfu/g @ 1g/lit (3.22).

The treatment Pongamia oil 2% EC @ 10ml/lit recorded (3.56) mean population of thrips per three leaves per plant and was at par with *Bacillus thuringiensis* 3.5% ES @ 2ml/lit (3.69). The maximum (4.54) thrips population was found in untreated control.

Second spray

The results on effect of second spray are presented in Table 3. The observations recorded on second day after second spraying of biopesticides ranges from 1.94 to 4.23 thrips per three leaves per plant. The treatment *Beauveria bassiana* 2×10^8 cfu/ml @ 5ml/lit was found to be most effective treatment which recorded 1.94 mean population of thrips per three leaves per plant and was at par with the treatment *Lecanicillium lecanii* 2×10^8 cfu/ml @ 4ml/lit (2.13). The treatment *Metarrhizium anisopliae* 2×10^8 cfu/ml @ 2.5ml/lit recorded (2.48) mean population of thrips per three leaves per plant and was at par with the treatment *Nomurea rileyi* 2×10^8 cfu/g @ 1g/lit (2.62). The treatment Pongamia oil 2% EC @ 10ml/lit recorded (2.73) mean population of thrips per three leaves per plant and was at par with *Bacillus thuringiensis* 3.5% ES @ 2ml/lit (2.78). The maximum (4.23) thrips population was found in untreated control.

At the third day after second spraying of biopesticides population of thrips per three leaves per plant ranges from 1.84 to 4.16. The treatment *Beauveria bassiana* 2×10^8 cfu/ml @ 5ml/lit was found to be most effective treatment which recorded 1.84 mean population of thrips per three leaves per plant and was at par with the treatment *Lecanicillium lecanii* 2×10^8 cfu/ml @ 4ml/lit (2.04). The treatment *Metarrhizium anisopliae* 2×10^8 cfu/ml @ 2.5ml/lit recorded (2.34) mean population of thrips per three leaves per plant and was at par with the treatment *Nomurea rileyi* 2×10^8 cfu/g @ 1g/lit (2.51). The treatment Pongamia oil 2% EC @ 10ml/lit recorded (2.61) mean population of thrips per three leaves per plant and was at par with the treatment *Bacillus thuringiensis* 3.5% ES @ 2ml/lit (2.65). The maximum (4.16) thrips population was found in untreated control.

The data recorded at seventh day after second spray revealed that the thrips population per three leaves per plant ranges from 1.49 to 4.06. The treatment *Beauveria bassiana* 2×10^8 cfu/ml @ 5ml/lit was found to be most effective treatment which recorded 1.49 mean population of thrips per three leaves per plant. The next effective treatment was *Lecanicillium lecanii* 2×10^8 cfu/ml @ 4ml/lit which recorded (1.95) mean population of thrips per three leaves per plant and was at par with the treatment *Metarrhizium anisopliae* 2×10^8 cfu/ml @ 2.5ml/lit (2.15). The treatment *Nomurea rileyi* 2×10^8 cfu/g @ 1g/lit recorded (2.40) mean population of thrips per three leaves per plant and was at par with Pongamia oil 2% EC @10ml/lit (2.49) and *Bacillus thuringiensis* 3.5% ES @ 2ml/lit (2.55). The maximum (4.06) thrips population was found in untreated control.

Third spray

The results on effect of third spray are presented in Table 3. The observations recorded on second day after third spraying of biopesticides ranges from 0.99 to 3.97 thrips per three leaves per plant. The treatment *Beauveria bassiana* 2×10^8 cfu/ml @ 5ml/lit was found to be most effective treatment which recorded 0.99 mean population of thrips per three leaves per plant. The next effective treatment was *Lecanicillium lecanii* 2×10^8 cfu/ml @ 4ml/lit which recorded (1.40) mean population of thrips per three leaves per plant. The treatment *Metarrhizium anisopliae* 2×10^8 cfu/ml @ 2.5ml/lit recorded (1.81) mean population of thrips per three leaves per plant and was at par with the treatment *Nomurea rileyi* 2×10^8 cfu/g @ 1g/lit (2.01). The treatment Pongamia oil 2% EC @ 10ml/lit recorded (2.25) mean population of thrips per three leaves per plant and was at par with the treatment *Bacillus thuringiensis* 3.5% ES @ 2ml/lit (2.38). The maximum (3.97) thrips population was found in untreated control.

At the third day after third spraying of biopesticides population of thrips per three leaves per plant ranges from 0.65 to 3.15. The treatment *Beauveria bassiana* 2×10^8 cfu/ml @ 5ml/lit was found to be most effective treatment which recorded 0.65 mean population of thrips per three leaves per plant. The next effective treatment was *Lecanicillium lecanii* 2×10^8 cfu/ml @ 4ml/lit which recorded (1.00) mean population of thrips per three leaves per plant. The treatment *Metarrhizium anisopliae* 2×10^8 cfu/ml @ 2.5ml/lit recorded (1.64) mean population of thrips per three leaves per plant and was at par with the treatment *Nomurea rileyi* 2×10^8 cfu/g @ 1g/lit (1.72). The treatment Pongamia oil 2% EC @ 10ml/lit recorded (2.12) mean population of thrips per three leaves per plant and was at par with the treatment *Bacillus thuringiensis* 3.5% ES @ 2ml/lit (2.20). The maximum (3.15) thrips population was found in untreated control.

The data recorded at seventh day after third spray revealed that the thrips population per three leaves per plant ranges from 0.24 to 2.93. The treatment *Beauveria bassiana* 2×10^8 cfu/ml @ 5ml/lit was found to be most effective treatment which recorded 0.24 mean population of thrips per three leaves per plant. The next effective treatment was *Lecanicillium lecanii* 2×10^8 cfu/ml @ 4ml/lit which recorded (0.65) mean population of thrips per three leaves per plant. The treatment *Metarrhizium anisopliae* 2×10^8 cfu/ml @2.5ml/lit recorded (1.33) mean population of thrips per three leaves per plant and was at par with the treatment *Nomurea rileyi* 2×10^8 cfu/g @ 1g/lit (1.41). The treatment Pongamia oil 2% EC @ 10ml/lit recorded (1.79) mean population of thrips per three leaves per plant and was at par with the treatment *Bacillus thuringiensis* 3.5% ES @ 2ml/lit (1.84). The maximum (2.93) thrips population was found in untreated control.

The data pertaining to the overall efficacy of different biopesticides against thrips per three leaves per plant infesting chilli after three sprays revealed that the treatment *Beauveria bassiana* 2×10^8 cfu/ml @ 5ml/lit was the best treatment which was recorded minimum (1.87) mean population per three leaves per plant which was significantly superior over rest of the treatments. The next effective treatment was *Lecanicillium lecanii* 2×10^8 cfu/ml @ 4ml/lit which recorded (2.14) mean population of thrips per three leaves per plant. The treatment *Metarrhizium anisopliae* 2×10^8 cfu/ml @ 2.5ml/lit recorded (2.48) mean population of thrips per three leaves per plant and was at par with the treatment *Nomurea rileyi* 2×10^8 cfu/g @ 1g/lit (2.62). The treatment Pongamia oil 2% EC @ 10ml/lit recorded (2.81) mean population of thrips per three leaves per plant and was at par with the treatment *Bacillus thuringiensis* 3.5% ES @ 2ml/lit (2.88). All the above treatments were found to be significantly superior over untreated control which recorded highest pest population (3.97 per three leaves per plant).

The present findings are in conformity with the findings of Naik and Shekharappa (2009) [6]. They revealed that treatment *Beauveria bassiana* was highly effective for control of thrips population (2.58 thrips / 3 leaves) followed by *Verticillium lecanii* (3 thrips / 3 leaves). Result is also accordance with finding of Naga Bharani *et al.* (2015) [5], they evaluated the efficacy of biopesticides and novel insecticides against the thrips, *T. tabaci* in tomato and reported that lowest thrips population was recorded in *B. bassiana* + *V. lecanii* (2.01 / plant) followed by *B. bassiana* and *Verticillium lecanii* (2.12 and 2.33 nymphs / plant), respectively.

Chinniah *et al*. (2016) [2] reported that the seed treatment with *P. fluorescens* @ 10 g/kg of seed + foliar application of *B. bassiana* @ 1x10^8 cfu/ml, neem cake @ 600 kg/ha + *B. bassiana* @ 1x10^8 cfu/ml and farm yard manure @ 12.5 t/ha + *B. bassiana* @ 1x10^8 cfu/ml were found promising against sucking pest of chilli thrips, *S. dorsalis*, which are statistically on par. The next effective treatment was *P. fluorescens* @ 10 g/kg of seed + *L. lecanii* @ 1 x 10^8 CFU/ml in reducing population of thrips on chilli.

Hadiya *et al.* (2016) [3] studied the efficacy of different entomopathogenic fungus on chilli thrips and revealed that the treatment *B. bassiana* @ 0.4% was recorded (2.64/leaf) was found to be most effective and followed by *V. lecanii* @ 0.4% (3.14/leaf), *M. anisopliae* @ 0.25% (3.96/leaf) and *Nomuraea rileyi* @ 0.1% (4.19/leaf), respectively. Kumar (2016) [4] studied the field efficacy of certain bio-pesticides against Chilli Thrips *S. dorsalis* and reported that the thrips population per cent reduction over control among the treatments, *B. bassiana* (2×10^9 spores/ml) 68.93%, *M. anisopliae* (2x10^9 spores/ml) 68.43%, *V. lecanii* (2x10^9 spores/ml) 63.25%, *N. rileyi* (2x10^6 spores/ml) 47.10 and *V. lecanii* (2x10^6 spores/ml) 50.83%, respectively. Ravikumar *et al*. (2016) [7] studied the efficacy of biorationals against thrips, *S. dorsalis* infesting chilli and revealed that the treatment *B. bassiana* @ 1 x 10^8 spores/ml was recorded (1.01/leaf) and *Bt*. var. kurstaki @ 1 kg/ha (1.98/leaf).

Table 3: Efficacy of different biopesticides against thrips (*Scirtothrips dorsalis* Hood) infesting chilli

Treatment	Pre count	Mean population of thrips per 3 leaves per plant									
		Ist spray			IInd spray			IIIrd spray			Overall Mean
		2 DAS	3 DAS	7 DAS	2 DAS	3 DAS	7 DAS	2 DAS	3 DAS	7 DAS	
T_1	4.01 (2.24)	3.84 (2.20)	3.65 (2.16)	3.08 (2.02)	2.48 (1.86)	2.34 (1.83)	2.15 (1.78)	1.81 (1.68)	1.64 (1.62)	1.33 (1.53)	2.48 (1.86)
T_2	3.92 (2.22)	3.57 (2.14)	3.40 (2.10)	2.68 (1.92)	1.94 (1.71)	1.84 (1.69)	1.49 (1.58)	0.99 (1.41)	0.65 (1.29)	0.24 (1.11)	1.87 (1.66)
T_3	3.90 (2.21)	3.66 (2.16)	3.51 (2.12)	2.89 (1.97)	2.13 (1.77)	2.04 (1.74)	1.95 (1.72)	1.40 (1.55)	1.00 (1.42)	0.65 (1.28)	2.14 (1.75)
T_4	3.93 (2.22)	3.91 (2.21)	3.76 (2.18)	3.22 (2.05)	2.62 (1.90)	2.51 (1.87)	2.40 (1.84)	2.01 (1.74)	1.72 (1.65)	1.41 (1.55)	2.62 (1.89)
T_5	4.03 (2.24)	4.00 (2.24)	3.84 (2.20)	3.69 (2.16)	2.78 (1.94)	2.65 (1.91)	2.55 (1.88)	2.38 (1.84)	2.20 (1.79)	1.84 (1.69)	2.88 (1.96)
T_6	4.05 (2.25)	3.95 (2.23)	3.80 (2.19)	3.56 (2.14)	2.73 (1.93)	2.61 (1.90)	2.49 (1.87)	2.25 (1.80)	2.12 (1.77)	1.79 (1.67)	2.81 (1.94)
T_7	4.05 (2.25)	4.32 (2.31)	4.37 (2.32)	4.54 (2.35)	4.23 (2.29)	4.16 (2.27)	4.06 (2.25)	3.97 (2.23)	3.15 (2.04)	2.93 (1.98)	3.97 (2.23)
SE (m±)	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.03	0.02
CD at 05%	NS	0.06	0.06	0.06	0.06	0.06	0.07	0.09	0.06	0.09	0.07

*Figures in parenthesis are $\sqrt{X+1}$ values

DAS- Days after Spraying

Conclusion

From the present study, it can be concluded that the among different treatments, *Beauveria bassiana* 2×10^8 cfu/ml @ 5ml/lit was the best treatment for effective management of thrips infesting chilli followed by *Lecanicillium lecanii* 2×10^8 cfu/ml @ 4ml/lit.

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