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., Metarhizium anisopliae 2×10⁸ cfu/ml @ 2.5ml/lit, Beauveria bassiana 2×10⁸ cfu/ml @ 5ml/lit, Lecanicillium lecanii 2×10⁸ cfu/ml @ 4ml/lit, Nomuraea rileyi 2×10⁸ cfu/ml @ 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 2×10⁸ cfu/ml @ 5ml/lit (1.87) and was significantly superior over rest of the treatments. The next effective treatment was Lecanicillium lecanii 2×10⁸ 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 leaves 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 transplanting of seedlings was done forty days after sowing. The other agronomic operations viz., intercultural operations and weeding were done as per recommendation.

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 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 thrips (*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* 2×10⁸ 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* 2×10⁸ cfu/ml @ 2ml/lit (3.84), *Metarrhizium anisopliae* 2×10⁸ cfu/ml @ 2.5ml/lit (3.84), *Nomurea rileyi* 2×10⁸ 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* 2×10⁸ 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* 2×10⁸ cfu/ml @ 4ml/lit (3.66) and *Metarrhizium anisopliae* 2×10⁸ cfu/ml @ 2.5ml/lit (3.84). The treatment *Nomurea rileyi* 2×10⁸ 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 (4.37) 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* 2×10⁸ 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* 2×10⁸ cfu/ml @ 4ml/lit (2.89). The treatment *Metarrhizium anisopliae* 2×10⁸ 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* 2×10⁸ cfu/g @ 1g/lit (3.22).

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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 m²                                                                                       |
| Date of transplanting | 22nd 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  |
|---------|---------------------------------|-----------|-------|
| T₁      | *Metarrhizium anisopliae* 2×10⁸ cfu/ml | 0.25      | 2.5ml/lit |
| T₂      | *Beauveria bassiana* 2×10⁸ cfu/ml    | 0.5       | 5ml/lit |
| T₃      | *Lecanicillium lecanii* 2×10⁸ cfu/ml | 0.4       | 4ml/lit |
| T₄      | *Nomurea rileyi* 2×10⁸ cfu/g        | 0.1       | 1g/lit |
| T₅      | *Bacillus thuringiensis* 3.5% ES     | 0.2       | 2ml/lit |
| T₆      | *Pongamia oil 2% EC*               | 1         | 10ml/lit |
| T₇      | Untreated control                 | -         | -     |
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 2×10⁸ 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 2×10⁶ cfu/ml @ 4ml/lit (2.13). The treatment Metarrhizium anisopliae 2×10⁹ 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 2×10⁸ 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 2×10⁹ 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 2×10⁹ cfu/ml @ 4ml/lit (2.04). The treatment Metarrhizium anisopliae 2×10⁹ 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 2×10⁸ 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 2×10⁹ 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 2×10⁹ 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 2×10⁸ cfu/ml @ 2.5ml/lit (2.15). The treatment Nomurea rileyi 2×10⁸ 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 2×10⁸ 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 2×10⁹ cfu/ml @ 4ml/lit which recorded (1.40) mean population of thrips per three leaves per plant. The treatment Metarrhizium anisopliae 2×10⁸ 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 2×10⁸ 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 2×10⁹ 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 2×10⁹ cfu/ml @ 4ml/lit which recorded (1.00) mean population of thrips per three leaves per plant. The treatment Metarrhizium anisopliae 2×10⁸ 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 2×10⁸ 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 2×10⁸ 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 2×10⁹ cfu/ml @ 4ml/lit which recorded (0.65) mean population of thrips per three leaves per plant. The treatment Metarrhizium anisopliae 2×10⁸ 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 2×10⁸ 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 2×10⁸ 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 2×10⁹ cfu/ml @ 4ml/lit which recorded (2.14) mean population of thrips per three leaves per plant. The treatment Metarrhizium anisopliae 2×10⁸ 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 2×10⁸ 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 Shekarappa (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) [3], 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 kg of seed + foliar application of *B. bassiana* @ 1x10⁸ cfu/ml, neem cake @ 600 kg/ha + *B. bassiana* @ 1x10⁷ cfu/ml and farm yard manure @ 12.5 t/ha + *B. bassiana* @ 1x10⁶ 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 kg of seed + *L. lecanii* @ 1 x 10⁶ CFU/ml in reducing population of thrips on chilli.

### 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 |
|-----------|-----------|--------------------------------------------------|
|           | 2 DAS | 3 DAS | 7 DAS | 2 DAS | 3 DAS | 7 DAS | 2 DAS | 3 DAS | 7 DAS | Overall Mean |
| T₁ | 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) |
| T₂ | 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) |
| T₃ | 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) |
| T₄ | 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) |
| T₅ | 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) |
| T₆ | 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) |
| T₇ | 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 (±)*

| SE (±) | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| CD at 05% | NS | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.07 | 0.09 | 0.06 | 0.09 | 0.07 |

*Figures in parenthesis are *x*² + 1 values

DAS- Days after Spraying

### Conclusion

From the present study, it can be concluded that the among different treatments, *Beauveria bassiana* 2×10⁸ cfu/ml @ 5ml/lit was the best treatment for effective management of thrips infesting chilli followed by *Lecanicillium lecanii* 2×10⁷ cfu/ml @ 4ml/lit.

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