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Bio-efficacy of entomopathogenic fungi against onion thrips (*Thrips tabaci*) under field conditions

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Abstract
A field experiment was conducted to study the bio-efficacy of entomopathogenic fungus against onion thrips (*Thrips tabaci*) under field conditions. Treatments included *Beauveria bassiana*, *Lecanicillium lecanii* (formerly *Verticillium lecanii*), *Metarhizium anisopliae*, combinations of fungal agents with a sticker (non-ionic surfactant), and a chemical check (Spinetoram 11.7% SC @ 75 ml/ha). Thrips populations were recorded at 3, 7, and 10 days after each of three sequential sprays, and results were expressed as mean number of thrips per 10 plants. The chemical insecticide Spinetoram was most effective treatment, with mean thrips population of 0.91 and 94.84% reduction over control, among the biocontrol agents, the tank mix of *L. lecanii* and *B. bassiana* with sticker recorded the highest efficacy, reducing thrips population to a mean of 2.17 with 87.64% reduction over control. The addition of a sticker showed to enhance the performance of fungal formulations. All the treatments showed significant reduction in thrips population over control the combination of *B. bassiana* and *L. lecanii* was more effective over any fungal insecticide. The least effective treatment was *M. anisopliae* alone which recorded only 43.52% control. These findings suggest that fungal entomopathogens when used in a combination with a sticker, offer promising alternatives to synthetic insecticides for sustainable thrips management in onion cultivation.

Keywords: *Thrips tabaci*, *Beauveria bassiana*, *Lecanicillium lecani*, *Metarhizium anisopliae*, spinetoram, bio-efficacy, onion

Introduction

Onion thrips, *Thrips tabaci* (*Thysanoptera*: *Thripidae*), is a major pest of commercially grown onion (*Allium cepa*) and is responsible for significant yield losses worldwide (Lewis 1997) [7]. The pest's status can be attributed to its polyphagous nature, rapid reproduction, short generation time, and the high survival rate of its cryptic life stages, such as the non-feeding prepupa and pupa. Additionally, onion thrips can reproduce parthenogenetically (without mating), allowing populations to build up quickly (Morse and Hoddle 2006, Diaz-Montano *et al*. 2011) [3, 4, 9]. It also has the capacity to transmit plant pathogens, including the Iris yellow spot virus (IYSV) (Bunyaviridae: *Tospovirus*), further complicating pest management.

The extensive feeding behaviour of onion thrips leads to stunting of the plants, reduced bulb weight, and increased susceptibility to fungal and bacterial infections, which together result in decreased crop yield as well as bulb quality. The transmission of IYSV (Bunyaviridae: *Tospovirus*) by *T. tabaci* exacerbates the damage, sometimes resulting in complete crop failure. Moreover, onion thrips has developed resistance to several chemical insecticides, making its management increasingly difficult and necessitating alternative control methods, such as biopesticides and integrated pest management (IPM) strategies.

Materials and Methods

The experiment was conducted in the Experimental field of Bio-Pesticide Division, Sonkul agro industries Pvt. Ltd., Nashik, Maharashtra, India during Rabi-2024-25 in randomized block design with eight treatments replicated thrice. The treatments were *Beauveria bassiana* @ 5 ml/L, *Lecanicillium lecani* alone 1 × 10^8 CFU/ml @ (5 ml/L), *L. lecani* + *B. bassiana* + Sticker @ (2.5 ml + 2.5 ml + 0.5 ml/L), *Metarhizium anisopliae* 1 × 10^8 CFU/mL @ (5 mL/L), *Lecanicillium lecani* alone 1 × 10^8 CFU/ml + Sticker @ (5 ml + 0.5 ml/L), *Beauveria bassiana* + Sticker @ (5 ml + 0.5 ml/L), Spinetoram 11.7% SC @ 75 ml/ha (chemical check 0.3 ml/L) and untreated control (Table 1).

Nursery was sown

Seeds of onion variety Puna Fursungi were used for study. Nursery was raised after field preparation in October 2024. Fertilizers were applied as per recommended dose at the time of nursery raising, at transplanting stage, and at bulb initiation stage. Nursery was transplanted in December 2024 at 4 to 5 leaf stage after 8 weeks of sowing. The experimental layout was done in RBD for 8 treatments with 3 replications. Each plot had 3 m × 3 m size with spacing 10 cm between seedlings with 20 cm distance between rows. To avoid contamination and drift hazards among treatments, each experimental plot was separated by a distance of 1.5 m. The onion plants infested with thrips were sprayed with the help of Manual Operated Knapsack Sprayer. The surfactant (0.02% tween 80) was mixed to the spray solution with aim to enhance the adjuvant ability of solution and for better spread of entomopathogens. For providing better conditions regarding humidity and temperature for fungal growth and avoiding ultraviolet radiations adverse effects on spore germination given treatments were sprayed during the evening times (Morley *et al*. 1996) [8]. Control plants were sprayed with water and surfactant and recommended insecticide (Spinetoram 11.7% SC) as check. Before and after the biopesticides spray, population of thrips was taken on 10 randomly selected plants from each plot at three, five and seven days after treatments.

Statistical analysis

The onion thrips observations were recorded 3, 7, and 10 days after each spray and (%) population reduction over control and pooled means thrips population, reduction per centage in comparison to control treatments were calculated by the formula (Henderson and Tilton 1955) [5] also count of thrips before treatment application were used in population reduction percentage for each treatment. Pre-treatment and post-treatment means were analysed by using the statistical software (Statistix 8.1) for ANOVA. Means were compared at 0.05 probability levels by Tukey's Honest Significant Difference test (HSD).

Thrips Population Assessment

Thrips population was recorded using the Leaf Whorl Inspection method (Direct Count) as described by (Saxena and Chahal 2010) [20]. For each observation, the central leaf whorl of the onion plant was carefully opened, as thrips typically hide in this area. From each sampled plant, three fully developed inner leaves were selected and inspected. A 10 X hand lens was used to count both nymphs and adults of *Thrips tabaci*. Observations were made on five randomly selected plants per plot, and the thrips population was expressed as the average number of thrips per 3 leaves per plant. Thrips populations were recorded from 10 randomly selected plants per plot at 3, 7, and 10 days after each spray. Corrected percent control was calculated using Abbott's formula.

Table 1: Details of treatments applied against onion thrips

S. N.	Treatments detail	Dose
T1	*Beauveria bassiana* @ 1 × 10^8 CFU/mL	5 ml/Litre of water
T2	*Lecanicillium lecani alone* @ 1 × 10^8 CFU/mL	5 ml/ Litre of water
T3	*V. lecanii* + *B. bassiana* (equal parts) + Sticker	2.5 ml + 2.5 ml + 0.5 ml/ Litre of water
T4	*Metarhizium anisopliae* @ 1 × 10^8 CFU/mL	5 ml/ Litre of water
T5	*Lecanicillium lecani alone* @ 1 × 10^8 CFU/mL + Sticker	5 ml + 0.5 ml/ Litre of water
T6	*Beauveria bassiana* + Sticker	5 ml + 0.5 ml/ Litre of water
T7	Spinetoram 11.7% SC @ 75 ml/ha (chemical check)	0.3 ml/ Litre of water
T8	Control (Untreated check)	-----

Results and Discussion

The efficacy of entomopathogenic fungi against onion thrips *T. tabaci* was evaluated under field conditions, and the results are presented in Table 2. Among the treatments, Spinetoram 11.7 % SC @ 75 ml/ha (0.3 ml/ Litre of water) recorded the lowest thrips population (mean: 0.91 thrips/10 plants) and the highest per cent control efficiency (94.84 per cent). These findings are in line with earlier work by Morse and Hoddle (2006) [9], who reported Spinetoram as highly effective against *Thrips tabaci* due to its unique mode of action and rapid knockdown effect. Whereas, (Premachandra *et al*., 2005; Reddy *et al*., 2018) [14, 17] studied Spinetoram showed superior efficacy against *T. tabaci* due to its unique mode of action, rapid knockdown effect, and systemic properties.

The combination of *Lecanicillium lecani* + *Beauveria bassiana* with sticker was the best performing biological treatment, reducing the population to 2.17 thrips/10 plants and achieving 87.64% reduction in thrips population over control. The potential synergistic effect of fungal combinations and surfactant usage, as reported by Vijaya *et al*. (2017) [22] and Wraight *et al*. (2001) [23] where confirmed in his study as fungal compatibility and adjuvants significantly enhanced efficacy of spray solution. These results are consistent with findings by Diaz-Montano *et al*. (2011) [3, 4] and Ravikumar *et al*. (2021) [16], who reported Spinetoram's high efficacy and rapid action against thrips species. This supports the work of Sarkar *et al*. (2020) [19] and Patil *et al*. (2023) [11], who highlighted the synergistic and enhanced performance of fungal entomopathogens when used in combination and applied with adjuvants such as stickers or surfactants. Sharma *et al*. (2022) [21], reported that combined application of entomopathogenic fungi (*B. bassiana* + *L. lecanii*) significantly suppressed thrips populations in chilli. Likewise, Patil & Ingle (2021) [12] observed enhanced efficacy of entomopathogenic fungi formulations when used with a sticking agent in grapevines infested with *Scirtothrips dorsalis*."

Among individual fungal treatments, *Lecanicillium lecani* + sticker performed better (4.88 thrips, 72.27 % control) than *B. bassiana* + sticker (6.70 thrips, 61.94% control), and solo applications of *V. lecanii* (6.48 thrips, 63.18%) and *B. bassiana* (7.17 thrips, 59.26%). These results confirm earlier findings by Patil *et al*. (2020) [10] and Chavan and Kadam (2015) [1], who emphasized the increased bio-efficacy of entomopathogenic fungi when applied with wetting agents or stickers. The inclusion of a non-ionic surfactant (Tween-80 @ 0.02%) played a critical role in improving the adhesion, spread, and infectivity of the fungal spores, in line with previous studies by Vijaya *et al*. (2017) [22] and Reddy *et al*. (2022) [18]. Whereas, Kumar *et al*. (2021) [6], who reported and demonstrated that Tween-80 significantly enhanced conidial adherence and germination of *Beauveria bassiana* on the insect cuticle. Likewise, Raj *et al*. (2022) [15] observed improved efficacy of entomopathogenic fungi against Helicoverpa armigera when Tween-80 was used as a wetting and spreading agent."

Metarhizium anisopliae recorded the least effective fungal treatment (mean: 9.94 thrips/10 plants, 43.52% control), although still superior to the untreated check (17.59 thrips. Similar observations were reported by Deshmukh *et al*. (2021) [2], who noted moderate suppression of *Scirtothrips dorsalis* in chilli using *M. anisopliae*, with significantly lower efficacy compared to *Beauveria bassiana* and *Lecanicillium lecanii*. Similarly, Pawar and Gade (2022) [13] recorded reduced thrips control in grapes when using *M. anisopliae* alone, suggesting that its slower infection process and environmental sensitivity may limit its field performance. These findings underscore that biopesticides can be effective alternatives, especially when used in combination and with appropriate adjuvants.

Table 2: Field Efficacy of Entomopathogenic Fungi and Chemical Insecticide Against Onion Thrips (*Thrips tabaci*) on Onion

S. N.	Treatments	No of Thrips /10Plants (Mean)											
		Pre-count	1st Spray			2nd Spray			3rd Spray			Overall Mean	Population reduction % over Control
			3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS		
T1	*Beauveria bassiana*	12.83	7.33	5.93	7.30	7.60	7.10	7.40	7.70	6.80	7.50	7.17	59.26
T2	*Verticillium lecanii alone* @ 1 × 10⁸ CFU/mL	13.53	6.80	6.10	6.83	7.40	6.37	6.07	6.40	6.60	6.00	6.48	63.18
T3	*V. lecanii* + *B. bassiana (*tank mix, equal parts) + Sticker	12.87	1.93	2.67	2.83	1.90	2.23	2.43	1.60	2.30	2.47	2.17	87.64
T4	*Metarhizium anisopliae* @ 1 × 10⁸ CFU/mL	12.37	10.43	8.20	11.77	10.80	9.33	10.43	9.40	9.30	9.63	9.94	43.52
T5	*Verticillium lecanii alone* @ 1 × 10⁸ CFU/mL + Sticker	14.03	5.97	4.13	4.77	6.40	6.13	5.33	5.20	3.70	3.17	4.88	72.27
T6	*Beauveria bassiana* + Sticker	14.83	6.70	5.07	6.57	7.60	6.87	7.20	7.70	7.50	5.90	6.70	61.94
T7	Spinetoram 11.7% SC @ 75 ml/ha (chemical check)	13.90	0.37	0.63	0.90	0.60	0.80	0.97	0.70	0.80	1.17	0.91	94.84
T8	Control	13.53	16.47	20.23	17.40	18.30	17.63	17.63	17.70	16.90	18.57	17.59	0.00
S. Em. ±		0.12	0.07	0.07	0.10	0.08	0.08	0.08	0.07	0.05	0.03	0.03	
C.D.at 5%		NS	0.23	0.23	0.31	0.26	0.26	0.25	0.21	0.17	0.10	0.08	

However, for immediate and high-level suppression, chemical options like Spinetoram remain superior, though their use should be managed judiciously to avoid resistance development (Diaz-Montano *et al*., 2011) [3, 4]. All treatments shared reduction in thrips population but chemical check and combination and *L. lecanii* and *B. bassiana* showed least population at 3 days after 2 sprays where as other bioinsecticide showed least population after 7 days of 1 spray and at 7 and 10 days after 2nd and 3rd spray. It confirmed the synergistic effect of B. *bassiana* and *L. lecanii* similar to chemical insecticide for quick control of thrips (Table 2)

Conclusion

The current field evaluation demonstrated that both biocontrol agents and chemical insecticides can effectively manage onion thrips (*Thrips tabaci*), a major pest of onion crop. Among the treatments, Spinetoram 11.7% SC @ 75 ml/ha although proved to be the most effective, recording the lowest thrips population (mean: 0.91/10 plants) with highest control efficacy (94.84%). The combination of *L. lecani* and *B. bassiana* (equal parts) with sticker emerged as the most promising biological alternative, reducing thrips populations by 87.64%, comparable with chemical control studied. While the chemical check was most effective, the superior performance of biopesticide combinations demonstrates that they can be integrated into IPM programs, reducing over reliance on chemical pesticides, mitigating resistance development, and promoting sustainable onion production. Therefore, biopesticide-based approaches, particularly fungal consortia with sticker, offer a viable and eco-friendly solution for managing thrips under field conditions.

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