

BIOEFFICACY OF *Lecanicillium lecanii* AGAINST APHID (*Aphis craccivora*) OF FRENCH BEAN AND WHITE FLY OF GREEN GRAM

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ABSTRACT

Bio-efficacy of most effective isolates of *Lecanicillium clecanii* entomopathogenic fungi and their combination with different biocontrol agents and insecticides was studied at section of plant pathology, BTC, Collage Agriculture and Research Station, IGKV, Bilaspur, (Chhattisgarh) during 2022-2023 under field condition against Aphid (*Aphis craccivora*) in French bean (variety falguni) and white fly of green gram. *L. lecanii* and their combination with other biocontrol agent i.e. *M. anisopliae*, *Paceliomyces spp.* and *B. bassiana* were also used. Insecticides were sprayed with the standard check insecticide. Standard checks Imidachlorpid 17.8% SL and Thiomethoxam 75% WG were found most effective among all the treatments. These two insecticides reduced infestation by 92.08 and 89.58% respectively. The highest reduction in infestation among all the biopesticide and insecticides combinations was observed in treatment *L. lecanii* (25%) + *Beauveria bassiana* (25%) + Imidachlorpid 17.8% SL 50% (82.08%), followed by *L. lecanii* (25%) + *Beauveria bassiana* (25%) + Thiomethoxm 75% WG (50%) (81.25%) and *L. lecanii* (50%) + Imidachlorpid 17.8% SL (50%) (79.16%). In case of green gram whitefly the maximum % reduction was recorded in Imidachlorpid 17.8% SL + *L. lecanii* (85.66%) and Thiamenthoxam 75% WG + *L. lecanii* (81.45%). Among the biopesticide the highest % reduction was recorded in treatment T5 - (*Beauveria*50% + *L. lecanii* 950%) -10% (76.18%) followed by treatments T₆ - (*L. lecanii* 50% + BT 50%) -10% (73.10%) and T₄ - (*L. lecanii* 50% + *Metarhizium anisopliae* 50%) -10% (71.42%).

(Key words: French bean, green gram, *Lecanicillium lecanii*, aphid, white fly and biopesticides)

INTRODUCTION

A deuteromycetes, *L. lecanii* (Zimmermann) Viegas, formerly known as *Cephalosporium lecanii*, was first described in 1991 and is a cosmopolitan fungus found on insects. *L. lecanii* and *Verticillium chlamydosporium* are the two most important species of this genus. Fungus *L. lecanii* is widely distributed, which can cause large epizootic events in tropical and subtropical regions, as well as in warm and humid environments. *L. lecanii* is an entomopathogenic fungus composed primarily of aphids and whiteflies. Many isolates of this fungus demonstrate high pathogenicity to several species of aphids, such as *Aphis gossypii*, *Macrosiphum euphorbiae*, *Brevicoryne brassicae*(L.), and *Myzus persicae*. (Askary *et al.*, 1998; Derakhshan *et al.*, 2007; Kim and Goettal, 2007, Verma, 2022).

The Faba bean (*Vicia faba*) is one of the most important leguminous crops as a source of plant protein, and the crop is highly susceptible to *Aphis craccivora* (Aphid) (Defrawi *et al.*, 1998). Aphids are important piercing-sucking insects that cause significant loss of a plant's phloem sap, which is essential for plant growth (Dixon, 1998). Indirectly, the faba bean aphid disrupts photosynthesis by

the presence of fungus on the leaves carried out by the aphid, resulting in honeydew excretion (Klinger *et al.*, 2001). Plant damage increases because of the aphid role as a vector for numerous plant viruses (Smith and Boyko, 2007). *L. lecanii* is a hyphomycetes parasite of aphids that can target a wide range of insects in both tropical and temperate environments.

Green gram (*Vigna radiate*) is one of the most cultivated pulse crops in the country and grown about 3.44 m. ha with annual production of 1.44 mt along with the productivity of 406.98 kg ha⁻¹ various insect pest damage to green gram but white fly is of the most important insect and highly susceptible to green gram. Whiteflies are small insects distinguished by their wax-covered wings. (Hodges and Evans, 2005). Since the early 1980s, it has caused severe problem to agriculture crops and ornamental plants. The chemical pesticides belong to synthetic pyrethroids and organophosphate were applied at initial stage of infection with increased dose and frequency over the year in vegetables crops. The sharp increase in the use of pesticides resulted in development of resistance key pest species in soil and pollution also. Therefore, there is a need to find alternative of chemicals such as microbial and plant products.

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MATERIALS AND METHODS

Pot experiment was set up at Barrister Thakur Chhedilal, College of Agriculture and Research Station, Bilaspur (Attitude 22.1032601 and Longitude 82.1389713) during *kharif* and *rabi* season of 2022-23 in random block design to evaluate the field-bioefficacy of *L. lecanii* under *in-vivo* condition. Falguni French bean seeds were sown in the second week of November. Agronomic practices were followed throughout the trial. Thiamethoxam 75% WG and Imidachloprid 17.8% SL insecticides were applied as a standard check and water was sprayed in the control. Green gram seeds were sown in the second week of August-September. Imidachloprid + *L. lecanii* and Thiamethoxam 75% WG + *L. lecanii* were applied as a standard check and water was sprayed in the control plot. Infestation was recorded prior to spraying and three, five and seven DAS. For the observation, the upper, middle and lower leaves were recorded.

Aphid damage assessment

Based on the number of infected leaves the % damage was calculated using the following formula and the data was analysed in simple RBD and transformed into angular data transformation (Diehl *et al.*, 1995).

$$\% \text{ damage} = \frac{\text{Total no. of infected leaf plant-1}}{\text{Total no. of observed leaf}} \times 100$$

$$\text{Reduction \%} = \frac{\text{Control} - \text{treatment}}{\text{control}} \times 100$$

White fly damage assessment

Based on the overall number of infected leaves, the efficacy of treatments against green gram whiteflies was evaluated. The percentage of damage was calculated by following formula (Diehl *et al.*, 1995).

$$\% \text{ damage} = \frac{\text{Total no. of infected leaf plant-1}}{\text{Total no. of observed leaf}} \times 100$$

$$\text{Reduction \%} = \frac{\text{Control} - \text{treatment}}{\text{control} - \text{trea}} \times 100$$

RESULTS AND DISCUSSION

Aphid infestation in French bean

Data disclosed from Table 1 that the mean per cent reduction of leaf infestation over control was recorded maximum 70.65% at standard check treatment – Imidachloprid 17.8% SL followed by Thiamethoxam 75% WG (68.54%) and *Lecanicillium lecanii* (25%) + *Beauveria bassiana* 25% + Imidachloprid 17.8% SL 50% (63.35%). Least per cent reduction of leaf infestation was recorded by 46.83% by the application of *L. lecanii* 10%. Among the entomopathogen the mean per cent reduction of leaf infestation was found maximum by the application of *L. lecanii* (25%) + *Beauveria bassiana* (25%) + Imidachloprid 17.8% SL (50%) (63.35%) followed by the application of *Lecanicillium. lecanii*+ *Beauveria bassiana*+ Thiamethoxam 75%WG (60.80%)

and *L. lecanii* SL (50%) + imidachloprid 17.8% SL (50%) (57.99%).

Reduction at 3rd DAS

Maximum per cent reduction of aphid infestation was recorded at standard check insecticide Imidachloprid 17.8% SL (51.11%) and Thiamethoxam 75%WG (49.16%), followed by *L. lecanii* (25%) + *Beauveria bassiana*(25%) + Imidachloprid 17.8% SL (50%) (46.38%) and *L. lecanii* (25%)+*Beauveria bassiana* (25%) + Thiomethoxam 75% WG (50%) (41.66%) standard check showed significant difference with all other treatments and performed superior for minimizing aphid infestation at 3rd DAS while least per cent reduction of Aphid infestation was recorded in *L. lecanii*- 10% (25.66) when we use entomopathogen with combination of insecticides i.e. combination of *L. lecanii*(50%) + Thiamethoxam 75% WG (50%), *L. lecanii*(25%) + Imidachloprid 17.8% SL (50%), *L. lecanii*(25%) + *Paecilomyces lilacinus*(25%) + Thiomethoxam 75% WG (50%) the entomopathogen showed statistically equally effective against Aphid of French bean.

Reduction at 5th DAS

Maximum per cent reduction of aphid infestation was recorded at standard check insecticide Imidachloprid 17.8% SL (68.76%) and Thiamethoxam 75% WG (66.90%) followed by *L. Lecanii* (25%) + *Beauveria bassiana* (25%) + Imidachloprid 17.8% SL (50%) (61.59%) and *L. lecanii* (25%) + *Beauveria bassiana* (25%) + Thiomethoxam 75% WG (50%) (59.51%). Standard check showed significant difference with all other treatments and performed superior for minimizing aphid infestation at 5th DAS. While least per cent reduction of Aphid infestation was recorded by the application of *L. lecanii*-10% (44.84%). When we use entomopathogen with combination of insecticides i.e. combination of *L. lecanii*(50%) + Thiamethoxam 75% WG (50%), *L. lecanii* (25%) + Imidachloprid 17.8% SL (50%), *L. lecanii*(25%) + *Paecilomyces lilacinus*(25%) + Thiomethoxam 75% WG (50%), the entomopathogen showed statistically equally effective against aphid of French bean.

Reduction at 7th DAS

Maximum per cent reduction of aphid infestation was recorded at standard check insecticide Imidachloprid 17.8% SL (92.08%) and Thiomethoxam 75% WG (89.58%) followed by the application of *L. Lecanii* (25%) + *Beauveria bassiana* (25%) + Imidachloprid 17.8% SL (50%) (82.08%) and *L. lecanii* (25%) + *Beauveria bassiana* (25%) + Thiomethoxam 75% WG (50%) (81.25%). Standard check showed significant difference with all other treatments and performed superior for minimizing aphid infestation at 7th DAS. Least per cent reduction of aphid infestation was recorded by the application of fungus *L.lecanii*-10% (70.00). When we use entomopathogen with combination of insecticides i.e. combination of *L. lecanii* (50%) + Thiomethoxam 75% WG (50%), *L. lecanii* (50%) + imidachloprid 17.8% SL (50%), *L. lecanii* (25%) + *Paecilomyces lilacinus* (25%) + Thiomethoxam 75% WG, the entomopathogen showed statistically equally effective

against aphid of french bean. Many researchers Aqeel and Leather (2019) and Trinh *et al.* (2020) also found similar trend of results and showed 85.30 % of mortality by the application of *B. bassiana*.

Whitefly infestation in green gram

Data revealed from Table 1 that the mean per cent reduction of leaf infestation over control was recorded maximum 62.88% at standard check treatment T₀-Imidachloprid 17.8% SL + *L. lecanii* 0.33 ml + 10 ml⁻¹ water followed by Thiamethoxam 75% WG + *L. lecanii* (59.59%) and *Beauveria bassiana* 50% + *L. lecanii* 50% (54.89%). Least per cent reduction of leaf infestation was recorded by 32.02% by the application of *L. lecanii* 1.5%. Among the entomopathogen the mean per cent reduction of leaf infestation was found maximum by the application of *Beauveria bassiana* 50% + *L. lecanii* 50%-10% (54.89%) followed by *L. lecanii* 50% + BT 50%-10% (53.07%) and *L. lecanii* 50% + *Metarhizium anisopliae* 50% -10% (51.42%). Per cent reduction of leaf infestation was gradually increased from 28.51% to 43.63% and 62.42% over control from third, fifth and seventh DAS, respectively. Among the entomopathogen the per cent reduction of leaf infestation was higher 47.69%, 49.73% and 53.07% when conidial concentration was higher (1×10⁹) and when load of conidia declined then per cent reduction of leaf infestation was gradually decreased *i.e.* 37.12 %,32.00 % at (1×10⁸) and (1×10⁷) conidial load of *L. lecanii* respectively.

Mortality at 3rd DAS

The maximum per cent reduction of white fly infestation was recorded at standard check Imidachloprid 17.8% SL + *L. lecanii* 50% (41.33%) and Thiamethoxam 75% WG + *L. lecanii*50% (39.00%) followed by *Beauveria bassiana*50% + *L. lecanii*50% (34.50%) and *L. lecanii*50% + BT 50% (33.47%). Application of *L. lecanii* -10%, *L. lecanii*50% + *Paecilomyces lilacinus*50% and *L. lecanii*50% +*Metarhizium anisopliae*50% showed non-significant difference between each other that mean all treatments were equal effective against white fly of green gram. While least per cent reduction of white fly infestation was recorded at treatment *L. lecanii*-1.5% (20.00%). When we use higher spore load formulation of *L. lecanii* or combination of *L. lecanii* and *Metarhizium anisopliae* and combination of *L. lecanii* and BT the entomopathogen showed statistically and equally effective against white fly of green gram.

Mortality at 5th DAS

The maximum per cent reduction of white fly infestation was recorded at standard check Imidachloprid 17.8% SL + *L. lecanii* 50% (61.66%) and Thiamethoxam 75% WG + *L. lecanii* 50% (58.33%) followed by *Beauveria bassiana* 50% + *L. lecanii* 50% (54.00%) and *L. lecanii* 50% + BT 50% (52.66%). Treatments *L. lecanii* 10%, *L. lecanii* 50% + *Paecilomyces lilacinus* 50% and *L. lecanii* 50% + *Metarhizium anisopliae* 50% showed non-significant difference between each other that means these treatments were equal effective against white fly of green gram. While

least per cent reduction of white fly infestation was recorded in treatment *L. lecanii*-1.5% (30.00%). When we use higher spore load formulation of *L. lecanii* or combination of *L. lecanii* and *P. lilacinus* or combination of *L. lecanii* and *Metarhizium anisopliae*, the entomopathogen showed statistically equally effective against white fly of green gram.

Mortality at 7th DAS

The maximum per cent reduction of white fly infestation was recorded at treatments T₀ standard check Imidachloprid 17.8% SL + *L. lecanii*50%(85.66%) and T₈Thiamethoxam 75% WG + *L. lecanii* 50% (81.45%) followed by *Beauveria bassiana* 50% + *L. lecanii* 50% (76.18%) and *L. lecanii* 50% + BT 50% (73.10%). Treatments *L. lecanii* - 10%, *L. lecanii* 50% + *Paecilomyces lilacinus* 50% and *L. lecanii* 50% + *Metarhizium anisopliae* 50% showed non-significant difference between each other that mean these treatments were equally effective against white fly of green gram. While least per cent reduction of white fly infestation was recorded at treatment *L. lecanii*- 1.5% (46.02%). When we use higher spore load formulation of *L. lecanii* or combination of *L. lecanii* and BT or combination of *L. lecanii* and *L. lecanii* and *Metarhizium anisopliae* the entomopathogen showed statistically equally effective against white fly of green gram. Similar trends was also found by Javed *et al.* (2019). They reported 41.47% mortality of white fly by the application of *L. lecanii* but lesser compared to application of *B. bassiana* (46.33%). Trinh *et al.* (2020); Wawdhane *et al.* (2020) and Verma *et al.* (2023) also found similar trends and showed 64.07% of mortality by the application of *B. bassiana*.

Aphid infestation of French bean

In aphid mean per cent reduction of leaf infestation over control was recorded maximum 92.08% at standard check treatment Imidachloroid 17.8% SL 0.33 ml l⁻¹ water followed by Thiomethxam 75% WG (89.58%) and *Lecanicillium lecanii* + *Beauveria bassiana* 25% + Imidachlorpid 17.8% SL 50% (82.07%) and least per cent reduction of leaf infestation was recorded 70.00 % by the application of *L. lecanii* 10%. Per cent reduction of leaf infestation was gradually increased from 36.82% to 51.79% and 72.29% over control from 5th and 7th respectively. Mortality at 7th DAS was recorded at treatment T9 standard check insecticide Imidachloroid 17.8% SL (92.08%) and standard check Thiomethxam 75% WG (89.58%) followed by *lecanii* (25%) + *Beauveria bassiana* (25%) + Imidachloprid 17.8% SL (50%) (82.08%) and *L. lecanii* (25%) + *Beauveria bassiana* (25%) + Thiomethoxm 75% WG (50%) (81.25%) and least per cent reduction of aphid infestation was recorded at treatment *L. lecanii*-10% (70.00%).

Whitefly infestation in green gram

Mean per cent reduction of leaf infestation over control was recorded maximum 85.66% at standard check treatment Imidachloroid 17.8% SL + *L. lecanii*0.33 ml + 10 ml⁻¹ water followed by Thiomethxam 75% WG + *L. lecanii*(81.45%) and *Beauveria bassiana* 50% + *L. lecanii*50% (76.16%).Least per cent reduction of leaf

Table 1. Bioefficacy of *Lecanicillium lecanii* against aphid (*Aphis craccivora*) of French bean

	% Reduction over control					Mean
	% infection	3 rd DAS	5 th DAS	7 th DAS		
T ₁ - <i>Lecanicillium lecanii</i>	66.66	25.66 (30.42)	44.84 (41.99)	70.00 (56.76)	46.83	
T ₂ - <i>L. lecanii</i> (50%) + Thiomethoxam 75% WG% (50%)	100	33.51 (38.69)	53.77 (47.14)	76.50 (60.56)	54.59	
T ₃ - <i>L. lecanii</i> (25%) + <i>Paecilomyces lilacinus</i> (25%) + Thiomethoxam 75% WG (50%)	88.66	35.14 (36.04)	52.39 (46.35)	75.33 (61.01)	54.28	
T ₄ - <i>L. lecanii</i> (25%) + <i>Beauveria bassiana</i> (25%) + Thiomethoxm 75% WG (50%)	77.66	41.66 (40.18)	59.51 (48.27)	81.25 (62.86)	60.80	
T ₅ - Thiomethoxam 75% WG	88.66	49.16 (44.50)	66.90 (55.01)	89.58 (71.34)	68.54	
T ₆ - <i>L. lecanii</i> (50%) + Imidachlorpid 17.8% SL (50%)	66.66	39.11 (37.74)	55.72 (50.32)	79.16 (64.31)	57.99	
T ₇ - <i>L. lecanii</i> (25%) + <i>Paecilomyces lilacinus</i> (25%) + Imidachlorpid 17.8% SL (50%)	88.66	37.5 (40.69)	54.77 (47.72)	77.08 (61.42)	56.45	
T ₈ - <i>L. Lecanii</i> (25%) + <i>Beauveria bassiana</i> (25%) + Imidachlorpid 17.8% SL (50%)	77.66	46.38 (42.90)	61.59 (51.72)	82.08 (65.50)	63.35	
T ₉ - Imidachlorpid 17.8 SL	66.66	51.11 (45.61)	68.76 (56.08)	92.08 (73.93)	70.65	
T ₁₀ - Untreated control	88.66					
Mean		36.82	51.79	72.29		
SEm±		1.5	1.86	2.43		
CD at 5%		4.49	5.59	7.28		
CV		7.28	7.27	7.29		

DAS- Days after spray; BS- Before spray; Data given in parenthesis shows arcsine percentage transformation

Table 2. Bioefficacy of *Lecanicillium lecanii* against white fly (*Bemisia tabaci*) of green gram

	% Reduction over control					Mean
	BS	3 rd DAS	5 th DAS	7 th DAS		
T ₁ - <i>Lecanicillium lecanii</i> -1.5%	8	20.00(26.49)	30.00(33.14)	46.02(42.69)	32.00	
T ₂ - <i>L. lecanii</i> -5%	9	23.33(28.64)	35.66(36.65)	52.38(46.34)	37.12	
T ₃ - <i>L. lecanii</i> -10%	8	29.50(32.88)	45.33(42.28)	68.25(55.78)	47.69	
T ₄ - <i>L. lecanii</i> 50% + <i>Paecilomyces lilacinus</i> 50%	7	31.17(33.92)	48.66(44.21)	69.38(56.76)	49.73	
T ₅ - <i>Beauveria bassiana</i> 50% + <i>L. lecanii</i> 50%	10	34.50(35.95)	54.00(47.38)	76.18(60.96)	54.89	
T ₆ - <i>L. lecanii</i> 50% +BT 50%	9	33.47(35.31)	52.66(46.51)	73.10(58.74)	53.07	
T ₇ - <i>L. lecanii</i> 50% + <i>Metarhiziumanisopliae</i> 50%	8	32.84(34.95)	50.00(44.98)	71.42(57.66)	51.42	
T ₈ - Thiamethoxam 75% WG + <i>L. lecanii</i> 50%	7	39.00(38.55)	58.33(49.82)	81.45(64.42)	59.59	
T ₉ - Imidachloprid 17.8% SL + <i>L. lecanii</i> 50%	8	41.33(39.93)	61.66(51.75)	85.66(68.26)	62.88	
T ₁₀ - Untreated control	10					
Mean		28.51	43.63	62.42		
SEM±		1.32	1.76	2.25		
CD at 5%		3.89	5.28	6.75		
CV		7.51	7.70	7.63		

infestation was recorded 46.02 % by treatment *L. lecanii* 1.5%. Per cent reduction of leaf infestation was gradually increased from 28.51 % to 43.63 % and 62.42 % over control from 3rd, 5th and 7th DAS respectively. Mortality at 7th DAS, was recorded at standard check Imidachloroid 17.8% SL + *L. lecanii* 50% @ 0.33 ml l⁻¹ water (85.66%) and standard check Thiomethxam 75% WG + *L. lecanii* 50% (81.45%) followed by *Beauveria bassiana* 50% + *L. lecanii* 50% (76.18%) and *L. lecanii* 50% + BT 50% (73.10%) and least per cent reduction of white fly infestation was recorded at treatment *L. lecanii*-1.5% (46.02%).

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