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BIO-EFFICACY OF *Metarhizium anisopliae* (METCHNIKOFF) SOROKIN IN COMBINATION WITH BIOPESTICIDES AGAINST JASSID, *Amrasca biguttula biguttula* (ISHIDA) INFESTING BRINJAL

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ABSTRACT

A study evaluating the bio-efficacy of entomopathogenic fungus *Metarhizium anisopliae*, alone and in combination with other biopesticides against jassid (*Amrasca biguttula biguttula*) infesting brinjal was conducted at the Biological Control Research Farm, ICAR Unit-9, Anand Agricultural University, Anand, Gujarat, India, during the *kharif-rabi* season of 2025–26. The entomopathogenic fungus, *M. anisopliae* was evaluated at half its recommended concentration in combination with half-recommended concentrations of companion biopesticides against jassid infestation in brinjal (eggplant). Among the treatments, the triple combination of *M. anisopliae* 2.0% WP + *Beauveria bassiana* 1.15% WP + *Lecanicillium lecanii* 1.15% WP emerged as the most effective, significantly suppressing the jassid population and producing the maximum fruit yield. This was followed closely by the dual combinations of *M. anisopliae* 2.0% WP + *L. lecanii* 1.15% WP and *M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP. Among the standalone applications, *M. anisopliae* 2.0% WP proved to be the most effective, whereas sole applications of *B. bassiana* 1.15% WP and *L. lecanii* 1.15% WP exhibited comparatively lower efficacy. In terms of economic returns, the triple microbial combination recorded the highest Incremental Cost-Benefit Ratio (ICBR) of 1:20.53, followed by *M. anisopliae* 2.0% WP + *L. lecanii* 1.15% WP (1:18.98).
***Keywords* :** Bio-efficacy, *Metarhizium anisopliae*, Jassid, *Amrasca biguttula biguttula*.

Introduction

Brinjal (*Solanum melongena* L.) is one of the most vital vegetable crops cultivated throughout tropical and subtropical regions, owing to its high nutritional value, year-round availability and economic significance. Globally, it ranks as the fifth most economically important solanaceous crop, following potato, tomato, pepper and tobacco (Taher *et al*., 2017). India is the world's second-largest producer of brinjal, cultivating 6.83 lakh hectares with an annual production of 12.99 million tonnes; within the country, Gujarat stands out as a major producing state, contributing substantially to the national yield (Anonymous, 2025). Despite its extensive cultivation, brinjal productivity is severely constrained by a complex of insect-pests that attack the crop from the nursery stage to harvest, leading to drastic quantitative and qualitative losses. Notably, yield losses attributable to insect-pest infestations have been reported to range from 20 to 89 percent (Kumar *et al*., 2015).

Among the major insect-pests infesting brinjal, jassid, *Amrasca biguttula biguttula* (Ishida), is regarded as one of the most destructive sucking pests. Both nymphs and adults feed by extracting cell sap from tender leaves, causing curling, yellowing and hopper burn, which adversely affect plant growth and fruit yield. Besides direct feeding damage, jassids are also known to transmit plant pathogens, including viruses and phytoplasmas, thereby aggravating crop losses (Stiller, 2009). Their role as vectors of several plant diseases has been well documented (Bennett, 1967; Nault and Ammar, 1989; Kumar *et al*., 2017). Therefore, effective management of jassid is essential for achieving sustainable brinjal production.

Management of jassids relies heavily on repeated synthetic insecticide applications. However, their indiscriminate use causes severe drawbacks, including environmental contamination, pesticides residues in food, insecticide resistance and harm to non-target organisms (Arthur, 1992; Ferizli *et al*., 2005; Sajid *et al*., 2017). These risks underscore the urgent need for sustainable, eco-friendly alternatives that effectively suppress pest populations.

Entomopathogenic fungi (EPF) are promising biological control agents due to their broad host range, safety and compatibility with Integrated Pest Management (IPM) programs. Among them, *Metarhizium anisopliae* (Metchnikoff) Sorokin is widely studied for its ability to infect over 200 arthropod species, causing green muscardine disease (Yin *et al*., 2021). The fungus adheres to the cuticle via conidia, germinates, forms an appressorium, penetrates the host and proliferates internally to cause death (Gao *et al*., 2011). Its persistence in the soil and rhizosphere further enhances its biocontrol efficacy (Hu and Leger, 2002). Similarly, other EPF species like *Beauveria bassiana* and *Lecanicillium lecanii* have shown high efficacy against various sucking pests.

This field study evaluated the combined efficacy of the entomopathogenic fungi *M. anisopliae*, *B. bassiana* and *L. lecanii* for sustainable brinjal jassid management. We assess their combined impact on pest suppression, fruit yield and economic returns to address a critical gap in sustainable pest control.

Materials and Methods

The field experiment evaluating the bio-efficacy of *M. anisopliae* combined with biopesticides against brinjal jassids was conducted at the Biocontrol Research Farm, ICAR Unit-9, AAU, Anand, Gujarat, India during the *kharif–rabi* seasons of 2025–26.

Details of treatments

Tr. No.	Treatments	Spore count (cfu/g)	Quantity (mL or g)/ 10 L of water
T_1	*M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP	$1×10^8 + 1×10^8$	20 + 20
T_2	*M. anisopliae* 2.0% WP + *L. lecanii* 1.15% WP	$1×10^8 + 1×10^8$	20 + 20
T_3	*M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP + *L. lecanii* 1.15% WP	$1×10^8 + 1×10^8 + 1×10^8$	13.33+13.33+13.33
T_4	*M. anisopliae* 2.0% WP	$1×10^8$	40
T_5	*B. bassiana* 1.15% WP	$1×10^8$	40
T_6	*L. lecanii* 1.15% WP	$1×10^8$	40
T_7	Untreated control	-	-

Methodology

Brinjal seedlings were transplanted during the second week of August 2025, following recommended agronomic practices. The first foliar application combining a half-dose of *M. anisopliae* with a half-dose of biopesticides was initiated at the onset of jassid infestation, with two subsequent sprays applied at 10-day intervals. Jassid populations were monitored on five randomly selected plants per net plot, recording counts from three leaves (upper, middle and lower) per plant. Observations were taken pre-spray and at 3, 5, 7 and 9 days after each application. Fruit yield was recorded by treatment at each picking, extrapolated to a per-hectare basis and the data were analyzed using standard statistical techniques.

Per cent Increase in Yield Over Control and Avoidable Losses in Yield

The increase in yield over control was worked out by using the following formula given by Khosla (1977).

Increase in yield over control (%)

$$= \frac{\text{Yield in treatment (T) - Yield in control (C)}}{\text{Yield in control (C)}} \times 100$$

The avoidable losses due to jassid was calculated with the help of formula described by Paul (1976).

$$\text{Avoidable losses (\%)} = \frac{A - B}{A} \times 100$$

Where,

A = Yield in treatment which gave the highest yield

B = Yield in other treatment

Economics

The economics of the various combinations of *M. anisopliae* with biopesticides against *A. biguttula biguttula* were evaluated using the Incremental Cost-Benefit Ratio (ICBR). Total treatment costs per hectare were calculated using prevailing market prices. Gross realization was obtained by multiplying fruit yield by the market price of brinjal. Net gain over the control (Rs./ha) was computed by subtracting the treatment cost from the value of gross realization over control. The ICBR was then determined by dividing the net return by the total treatment cost.

Statistical analysis

The data on population of jassid and fruit yield of brinjal were subjected to analysis of variance (ANOVA). The data on jassid population were subjected to using square root transformation ($\sqrt{x+0.5}$). The treatment means were compared using Duncan's New Multiple Range Test (Steel & Torrie, 1980).

Results and Discussion

Jassid population

The periodical data on jassid population recorded are presented in Table 1, 2 and 3, whereas pooled over periods and sprays data are presented in Table 4.

First spray

Considering the pooled mean of all observations recorded after the first spray (Table 1), the treatments exhibited significant variation in suppressing the jassid population. The treatment comprising *M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP + *L. lecanii* 1.15% WP was the most effective, recording the lowest jassid population (2.26 jassids/leaf) and showing significant superiority over all other treatments. The dual combinations of *M. anisopliae* 2.0% WP + *L. lecanii* 1.15% WP (2.89 jassids/leaf) and *M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP (3.15 jassids/leaf) were the next most effective treatments, with significantly lower jassid populations than the remaining treatments and statistical parity between them. Among the individual biopesticides, *M. anisopliae* 2.0% WP recorded the lowest jassid population (3.91 jassids/leaf), followed by *L. lecanii* 1.15% WP (4.56 jassids/leaf) and *B. bassiana* 1.15% WP (4.70 jassids/leaf). However, these treatments did not differ significantly from one another. In contrast, the untreated control recorded the highest jassid population (6.79 jassids/leaf), which was significantly greater than that observed in all treated plots.

Second spray

The pooled mean of all observations recorded after the second spray (Table 2) revealed significant differences in jassid population among the all treatments.

The lowest jassid population was recorded in the triple combination of *M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP + *L. lecanii* 1.15% WP (1.72 jassids/leaf), which was statistically at par with the dual combination of *M. anisopliae* 2.0% WP + *L. lecanii* 1.15% WP (1.96 jassids/leaf) and statistically superior to all remaining treatments.

The dual combination of *M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP (2.96 jassids/leaf) was statistically distinct from both the two most effective treatments and individual application of *M. anisopliae* 2.0% WP (3.62 jassids/leaf). When applied alone, *B. bassiana* 1.15% WP (4.30 jassids/leaf) and *L. lecanii* 1.15% WP (4.47 jassids/leaf) demonstrated comparatively lower efficacy and were statistically at par with each other. While, the untreated control recorded the significantly highest pooled jassid population (6.79 jassids/leaf).

Third spray

When the pooled mean of all observation periods after the third spray (Table 3) was considered, significant differences in jassid population was observed among the treatments. The triple combination of *M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP + *L. lecanii* 1.15% WP recorded the lowest pooled population (1.22 jassids/leaf) and was statistically superior to all other treatments. This was followed by *M. anisopliae* 2.0% WP + *L. lecanii* 1.15% WP (1.90 jassids/leaf) and *M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP (2.53 jassids/leaf). Among single biopesticide applications, *M. anisopliae* 2.0% WP (3.46 jassids/leaf), *B. bassiana* 1.15% WP (4.08 jassids/leaf) and *L. lecanii* 1.15% WP (4.08 jassids/leaf) were statistically at par with each other. The untreated control registered significantly the highest pooled jassid population (6.74 jassids/leaf), distinctly exceeding all fungal treatments.

Pooled over periods and sprays

Considering the pooled mean across all three sprays (Table 4), significantly the lowest pooled jassid population was recorded in triple combination of *M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP + *L. lecanii* 1.15% WP (1.72 jassids/leaf). It was followed in order of effectiveness by the dual combination of *M. anisopliae* 2.0% WP + *L. lecanii* 1.15% WP (2.22 jassids/leaf) and *M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP (2.85 jassids/leaf), both of which were statistically distinct from each other and from all remaining treatments. The individual application of *M. anisopliae* 2.0% WP (3.66 jassids/leaf) was likewise statistically distinct from all other treatments. When applied alone, *B. bassiana* 1.15% WP (4.34 jassids/leaf) and *L. lecanii* 1.15% WP (4.38 jassids/leaf) demonstrated comparatively lower efficacy and were statistically at par with each other. The untreated control recorded significantly the highest jassid population (6.79 jassids/leaf) than rest of the treatments.

Findings of earlier researchers pertaining to the bio-efficacy of *M. anisopliae* in combination with other biopesticides against jassid infesting brinjal are not available. Hence, the results of the present investigation are discussed in line with findings on related crops and pests. Palthiya *et al*. (2015) reported that the combined application of *V. lecanii* 1.15% WP + *M. anisopliae* 2.0% WP and triple combination of *B. bassiana* 1.15% WP + *M. anisopliae* 2.0% WP + *V. lecanii* 1.15% WP were the most effective treatments for suppression of jassids in okra, while the individual application of *B. bassiana* 1.15% WP demonstrated comparatively lower efficacy. Similarly, Hole *et al.* (2015) reported that the dual combination of *V. lecanii* + *M. anisopliae* was superior to all other treatments in reducing jassid population in cotton. Turkhade *et al.* (2015) further observed that the triple combination of *V. lecanii* + *M. anisopliae* + *B. bassiana* was the most effective treatment against mango hopper.

Fruit Yield

The fruit yield data of brinjal revealed significant differences among all treatments (Table 5). The highest fruit yield was recorded in triple combination of *M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP + *L. lecanii* 1.15% WP (42.73 t/ha), which was statistically at par with dual combination of *M. anisopliae* 2.0% WP + *L. lecanii* 1.15% WP (39.63 t/ha). The dual combination of *M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP (35.05 t/ha) and individual application of *M. anisopliae* 2.0% WP (33.76 t/ha) were statistically at par with each other. Among individual applications, *B. bassiana* 1.15% WP (30.43 t/ha) and *L. lecanii* 1.15% WP (28.58 t/ha) were statistically comparable with each other, though both yielded significantly less than all combination treatments. The untreated control recorded significantly the lowest fruit yield (22.15 t/ha), falling markedly below all fungal treatments.

Economics

The highest ICBR (1:20.53) was recorded for triple combination of *M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP + *L. lecanii* 1.15% WP, followed by dual combination of *M. anisopliae* 2.0% WP + *L. lecanii* 1.15% WP (1:18.98) and individual application of *M. anisopliae* 2.0% WP (1:17.38). The dual combination of *M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP and *B. bassiana* 1.15% WP alone recorded ICBR values of 1:13.75 and 1:6.41, respectively, while the lowest ICBR (1:4.75) was observed in the individual application of *L. lecanii* 1.15% WP (Table 6).

Table 1: Bio-efficacy of *M. anisopliae* in combination with biopesticides against jassid infesting brinjal after first spray.

Tr. No.	Treatments	Spore count (cfu/g)	Quantity required (g) / 10 L of water	No. of jassids/leaf					
				Before spray	3 DAS	5 DAS	7 DAS	9 DAS	Pooled
T_1	*M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP	1×10^8 + 1×10^8	20 + 20	2.47 (5.60)	2.17^{abc} (4.21)	2.01^{ab} (3.54)	1.51^{a} (1.78)	1.94^{bc} (3.26)	1.91^{b} (3.15)
T_2	*M. anisopliae* 2.0% WP + *L. lecanii* 1.15% WP	1×10^8 + 1×10^8	20 + 20	2.48 (5.65)	2.11^{ab} (3.95)	1.91^{ab} (3.15)	1.69^{ab} (2.36)	1.64^{ab} (2.19)	1.84^{b} (2.89)
T_3	*M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP + *L. lecanii* 1.15% WP	1×10^8 + 1×10^8 + 1×10^8	13.33 + 13.33 + 13.33	2.48 (5.65)	2.02^{a} (3.58)	1.80^{a} (2.74)	1.33^{a} (1.27)	1.51^{a} (1.78)	1.66^{a} (2.26)
T_4	*M. anisopliae* 2.0% WP	1×10^8	40	2.57 (6.10)	2.40^{bcd} (5.26)	2.02^{ab} (3.58)	1.87^{bc} (3.00)	2.10^{c} (3.91)	2.10^{c} (3.91)
T_5	*B. bassiana* 1.15% WP	1×10^8	40	2.37 (5.12)	2.52^{cd} (5.85)	2.24^{b} (4.52)	2.12^{c} (3.99)	2.24^{c} (4.52)	2.28^{d} (4.70)
T_6	*L. lecanii* 1.15% WP	1×10^8	40	2.52 (5.85)	2.38^{abcd} (5.16)	2.15^{b} (4.12)	2.23^{c} (4.47)	2.25^{c} (4.56)	2.25^{cd} (4.56)
T_7	Untreated control	-	-	2.43 (5.40)	2.74^{d} (7.01)	2.66^{c} (6.58)	2.65^{d} (6.52)	2.76^{d} (7.12)	2.70^{e} (6.79)
S. Em. ±			Treatment (T)	0.16	0.11	0.10	0.11	0.10	0.06
			Period (P)	-	-	-	-	-	0.04
			T × P	-	-	-	-	-	0.11

C.D. at 5%	T	NS	0.34	0.31	0.35	0.29	0.16
	P	-	-	-	-	-	0.11
	T × P	-	-	-	-	-	NS
C.V. (%)		10.99	8.23	8.32	10.29	8.03	8.69

Notes:

(1) Figures outside the parentheses are $\sqrt{x+0.5}$ transformed values and those inside the parentheses are retransformed values

(2) Treatment means followed by the same letter within a column are not significantly different by DNMRT at 5% level of significance

(3) DAS: Days after spray; NS: Non-Significant

Table 2: Bio-efficacy of *M. anisopliae* in combination with biopesticides against jassid infesting brinjal after second spray.

Tr. No.	Treatments	Spore count (cfu/g)	Quantity required (g)/ 10 L of water	No. of jassids/leaf				
				3 DAS	5 DAS	7 DAS	9 DAS	Pooled
T_1	*M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP	1×10^8 + 1×10^8	20 + 20	1.97^{abc} (3.38)	1.95^{bc} (3.30)	1.73^{ab} (2.49)	1.77^{bc} (2.63)	1.86^{b} (2.96)
T_2	*M. anisopliae* 2.0% WP + *L. lecanii* 1.15% WP	1×10^8 + 1×10^8	20 + 20	1.63^{a} (2.16)	1.83^{ab} (2.85)	1.40^{a} (1.46)	1.42^{ab} (1.52)	1.57^{a} (1.96)
T_3	*M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP + *L. lecanii* 1.15% WP	1×10^8 + 1×10^8 + 1×10^8	13.33 + 13.33 + 13.33	1.69^{ab} (2.36)	1.52^{a} (1.81)	1.35^{a} (1.32)	1.41^{a} (1.49)	1.49^{a} (1.72)
T_4	*M. anisopliae* 2.0% WP	1×10^8	40	2.02^{bc} (3.58)	2.09^{bc} (3.87)	1.99^{bc} (3.46)	2.04^{cd} (3.66)	2.03^{c} (3.62)
T_5	*B. bassiana* 1.15% WP	1×10^8	40	2.22^{c} (4.43)	2.24^{c} (4.52)	2.08^{bc} (3.83)	2.21^{d} (4.38)	2.19^{cd} (4.30)
T_6	*L. lecanii* 1.15% WP	1×10^8	40	2.25^{c} (4.56)	2.24^{c} (4.52)	2.23^{c} (4.47)	2.21^{d} (4.38)	2.23^{d} (4.47)
T_7	Untreated control	-	-	2.81^{d} (7.40)	2.70^{d} (6.79)	2.68^{d} (6.68)	2.63^{e} (6.42)	2.70^{e} (6.79)
S. Em. ± (T)			Treatment	0.14	0.11	0.12	0.11	0.06
			Period (P)	-	-	-	-	0.05
			T × P	-	-	-	-	0.12
C.D. at 5% T				0.43	0.35	0.36	0.35	0.16
			P	-	-	-	-	0.14
			T × P	-	-	-	-	NS
C.V. (%)				11.48	9.32	10.57	9.95	10.37

Notes:

(1) Figures outside the parentheses are $\sqrt{x+0.5}$ transformed values and those inside the parentheses are retransformed values

(2) Treatment means followed by the same letter within a column are not significantly different by DNMRT at 5% level of significance

(3) DAS: Days after spray; NS: Non-Significant

Table 3: Bio-efficacy of *M. anisopliae* in combination with biopesticides against jassid infesting brinjal after third spray

Tr. No.	Treatments	Spore count (cfu/g)	Quantity required (g)/ 10 L of water	No. of jassid(s)/leaf				
				3 DAS	5 DAS	7 DAS	9 DAS	Pooled
T_1	*M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP	1×10^8 + 1×10^8	20 + 20	1.98^{bc} (3.42)	1.76^{bc} (2.60)	1.55^{b} (1.90)	1.67^{ab} (2.29)	1.74^{c} (2.53)
T_2	*M. anisopliae* 2.0% WP + *L. lecanii* 1.15% WP	1×10^8 + 1×10^8	20 + 20	1.78^{b} (2.67)	1.58^{b} (2.00)	1.35^{ab} (1.32)	1.50^{a} (1.75)	1.55^{b} (1.90)
T_3	*M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP + *L. lecanii* 1.15% WP	1×10^8 + 1×10^8 + 1×10^8	13.33 + 13.33 + 13.33	1.35^{a} (1.32)	1.19^{a} (0.92)	1.18^{a} (0.89)	1.51^{a} (1.78)	1.31^{a} (1.22)
T_4	*M. anisopliae* 2.0% WP	1×10^8	40	2.07^{bc} (3.78)	2.03^{cd} (3.62)	1.92^{c} (3.19)	1.92^{bc} (3.19)	1.99^{d} (3.46)

T_5	*B. bassiana* 1.15% WP	1 × 10^8	40	2.30^c (4.79)	2.06^{cd} (3.74)	2.06^c (3.74)	2.15^c (4.12)	2.14^d (4.08)
T_6	*L. lecanii* 1.15% WP	1 × 10^8	40	2.21^c (4.38)	2.12^d (3.99)	2.11^c (3.95)	2.11^c (3.95)	2.14^d (4.08)
T_7	Untreated control	-	-	2.69^d (6.74)	2.65^e (6.52)	2.66^d (6.58)	2.76^d (7.12)	2.69^e (6.74)
S. Em. ± Treatment (T)				0.11	0.10	0.11	0.11	0.05
			Period (P)	-	-	-	-	0.04
			T × P	-	-	-	-	0.11
C.D. at 5% T				0.35	0.30	0.33	0.33	0.15
			P	-	-	-	-	0.11
			T × P	-	-	-	-	NS
C.V. (%)				9.68	8.77	10.19	9.41	9.52

Notes:

(1) Figures outside the parentheses are $\sqrt{x + 0.5}$ transformed values and those inside the parentheses are retransformed values

(2) Treatment means followed by the same letter within a column are not significantly different by DNMRT at 5% level of significance

(3) DAS: Days after spray; NS: Non-Significant

Table 4: Bio-efficacy of *M. anisopliae* in combination with biopesticides against jassid infesting brinjal (Pooled over sprays)

Tr. No.	Treatments	Spore count (cfu/g)	Quantity required (g)/ 10 L of water	No. of jassids/leaf			
				1st spray	2nd spray	3rd spray	Pooled
T_1	*M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP	1 × 10^8 + 1 × 10^8	20 + 20	1.91^b (3.15)	1.86^b (2.96)	1.74^c (2.53)	1.83^c (2.85)
T_2	*M. anisopliae* 2.0% WP + *L. lecanii* 1.15% WP	1 × 10^8 + 1 × 10^8	20 + 20	1.84^b (2.89)	1.57^a (1.96)	1.55^b (1.90)	1.65^b (2.22)
T_3	*M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP + *L. lecanii* 1.15% WP	1 × 10^8 + 1 × 10^8 + 1 × 10^8	13.33 + 13.33 + 13.33	1.66^a (2.26)	1.49^a (1.72)	1.31^a (1.22)	1.49^a (1.72)
T_4	*M. anisopliae* 2.0% WP	1 × 10^8	40	2.10^c (3.91)	2.03^c (3.62)	1.99^d (3.46)	2.04^d (3.66)
T_5	*B. bassiana* 1.15% WP	1 × 10^8	40	2.28^d (4.70)	2.19^{cd} (4.30)	2.14^d (4.08)	2.20^e (4.34)
T_6	*L. lecanii* 1.15% WP	1 × 10^8	40	2.25^{cd} (4.56)	2.23^d (4.47)	2.14^d (4.08)	2.21^e (4.38)
T_7	Untreated control	-	-	2.70^e (6.79)	2.70^e (6.79)	2.69^e (6.74)	2.70^f (6.79)
S. Em. ± Treatment (T)				0.06	0.06	0.05	0.03
			Period (P)	0.04	0.05	0.04	0.02
			Spray (S)	-	-	-	0.02
			T × P	0.11	0.12	0.11	0.06
			T × S	-	-	-	0.06
			P × S	-	-	-	0.04
			T × P × S	-	-	-	0.11
C.D. at 5%	Treatment (T)			0.16	0.16	0.15	0.09
			Period (P)	0.11	0.14	0.11	0.07
			Spray (S)	-	-	-	0.06
			T × P	NS	NS	NS	NS
			T × S	-	-	-	NS
			P × S	-	-	-	0.12
			T × P × S	-	-	-	NS
C.V. (%)				8.69	10.37	9.52	9.49

Notes:

(1) Figures outside the parentheses are $\sqrt{x + 0.5}$ transformed values and those inside the parentheses are retransformed values

(2) Treatment means followed by the same letter within a column are not significantly different by DNMRT at 5% level of significance

(3) NS: Non-Significant

Table 5: Impact of *M. anisopliae* in combination with biopesticides on fruit yield of brinjal

Tr. No.	Treatments	Fruit yield (t/ha)	Increase in yield over control (%)	Avoidable losses (%)
T_1	*M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP	35.05[bc]	58.24	17.97
T_2	*M. anisopliae* 2.0% WP + *L. lecanii* 1.15% WP	39.63[ab]	78.92	7.25
T_3	*M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP + *L. lecanii* 1.15% WP	42.73[a]	92.91	-
T_4	*M. anisopliae* 2.0% WP	33.76[bc]	52.42	20.99
T_5	*B. bassiana* 1.15% WP	30.43[c]	37.38	28.79
T_6	*L. lecanii* 1.15% WP	28.58[c]	29.03	33.11
T_7	Untreated Control	22.15[d]	-	48.16
S. Em. ±		1.97	-	-
C.D. at 5%		6.06	-	-
C.V. (%)		10.26	-	-

Note: Treatment means followed by the same letter within a column are not significantly different by DNMRT at 5% level of significance

Table 6: Economics of different treatments evaluated against jassid infesting brinjal

Tr. No.	Treatments	Quantity required for 3 sprays (kg/ha)	Price (Rs./kg or L)	Cost of insecticides and biopesticides (Rs./ha)	Labour charge (Rs./ha)	Total cost of treat-ment (Rs./ha)	Fruit yield (t/ha)	Net gain in fruit yield over control (t/ha)	Gross realization over control (Rs./ha)	Net realization (Rs./ha)	ICBR
T_1	*M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP	3.0 + 3.0	150 + 960	450 + 2880 = 3330	5418	8748	35.05	12.9	129000	120252	1:13.75
T_2	*M. anisopliae* 2.0% WP + *L. lecanii* 1.15% WP	3.0 + 3.0	150 + 960	450 + 2880 = 3330	5418	8748	39.63	17.48	174800	166052	1:18.98
T_3	*M. anisopliae* 2.0% WP + *B. bassiana* 1.15% WP + *L. lecanii* 1.15% WP	2.0 + 2.0 + 2.0	150 + 960 + 960	300 + 1920 + 1920 = 4140	5418	9558	42.73	20.58	205800	196242	1:20.53
T_4	*M. anisopliae* 2.0% WP	6.0	150	900	5418	6318	33.76	11.61	116100	109782	1:17.38
T_5	*B. bassiana* 1.15% WP	6.0	960	5760	5418	11178	30.43	8.28	82800	71622	1:6.41
T_6	*L. lecanii* 1.15% WP	6.0	960	5760	5418	11178	28.58	6.43	64300	53122	1:4.75
T_7	Untreated control	-	-	-	-	-	22.15	-	-	-	-

Notes:

(1) Labour charges: Semi skilled labour @ Rs. 501 per day × 2 labour = Rs. 1002/ha, Farm labour @ Rs. 402/day x 2 labour = Rs. 804/ha, Labour cost for one spray: Rs. 1806/ha. Total labour charge for three sprays 1806 × 3 sprays = Rs. 5418/ha

(2) Price of fruit of brinjal: Rs. 10/kg

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