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Efficacy evaluation of different biopesticides against leaf folder infesting rice

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Abstract

The study assessed the efficacy of six different biopesticides and one insecticide as a standard check against leaf folder of rice under field conditions. The field experiment was carried out at Model Agronomic Experiment (MAE) Farm, Mudre, Regional Agricultural Research Station, Karjat, Dist. Raigad to study the efficacy of different biopesticides against leaf folder in rice during Kharif, 2024. During this study, biopesticides viz, *Bacillus albus* NBAIR-BATP (1 x 10⁸cfu/ml), *Metarhizium anisopliae* NBAIR (1 x 10⁸cfu/ml), *Beauveria bassiana* NBAIR (1 x 10⁸cfu/ml), *Bacillus thuringiensis* NRRI (1 x 10⁸cfu/g), *Metarhizium anisopliae* DBSKKV (1 x 10⁸cfu/g), *Beauveria bassiana* DBSKKV (1 x 10⁸cfu/g) were evaluated. Cartap hydrochloride 4G was used as Standard check. Data on mean per cent infestation and reduction over control of leaf folder after two sprays showed that treatment T₇, Cartap hydrochloride 4G @ 18.75 kg ha⁻¹ was found significantly superior over other treatments with 1.46 per cent damaged leaves and 77.24 per cent reduction over control (ROC), followed by treatment T₄, *Bacillus thuringiensis* NRRI (1 x 10⁸cfu/g) @ 5 gm lit⁻¹ recorded (4.32 per cent infestation, 62.09 per cent ROC) and was at par with T₁, *Bacillus albus* NBAIR-BATP (1 x 10⁸cfu/ml) @ 10 ml lit⁻¹ (4.64 per cent infestation, 54.17 per cent ROC) and T₆, *Beauveria bassiana* DBSKKV (1 x 10⁸cfu/g) @ 5 gm lit⁻¹ (5.50 per cent infestation, 54.43 per cent ROC). It is concluded that, Cartap hydrochloride 4G was found most effective for controlling infestation of leaf folder. Among the different biopesticides, *Bacillus thuringiensis* NRRI (1 x 10⁸cfu/g) was most effective against infestation of leaf folder.

Keywords: Rice, infestation, leaf folder, biopesticides, efficacy, reduction over control

Introduction

Rice (*Oryza sativa* L.) a member of the family Poaceae and subfamily Oryzoideae. It is consumed by 70% of the world's population as a staple food and covers one-fifth of the total land under cultivation of cereal crops. It feeds more than 60 per cent population of India. The importance of rice has been identified for many centuries, and rice is also known as 'Dhanya' which means the sustainer of the human race (Panesar and Kaur, 2016) ^[11]. Konkan region is a major rice producing area of Maharashtra. The average rice productivity of Konkan region is 2.69 ton/ha (3.83 ton/ha rough rice) (Gawai *et al.*, 2024) ^[3]. Nearly 3.69 lakh ha area of Konkan is under rice crop with rough rice production of 15.70 lakh tones. Konkan region contributes 23.70% in area under rice crop and produces 29.65% rough rice at state level. Cultivation of rice in Maharashtra is divided into two major growing regions viz., North Konkan and South Konkan which shares area under paddy cultivation is about 65.07 per cent and 34.93 per cent respectively (Meshram *et al.*, 2020) ^[8]. The rice (*Oryza sativa* L.) productivity is often adversely disturbed by several abiotic and biotic stresses such as drought, submergence and pests like stem borer, leaf folder, brown plant hopper, ear head bug, etc. (Katti, 2013) ^[7]. In rice ecosystem of Konkan region, rice leaf folder, *Cnaphalocrocis medinalis* (Guenée) is now a day's considered as the major pest of rice (Dalvi *et al.*, 2021) ^[2]. For the effective control of pests, there are many pesticides available in market but regular use of these pesticides leads to the development of resistance in insects. To overcome this, biopesticides are developed as key components of Integrated Pest Management (IPM) programs, mainly as a means to reduce the load of synthetic chemical products that are being used for control of pests. In addition, biopesticides can be integrated into IPM systems, which combine biological, cultural, and chemical controls to manage pests in a balanced fashion, thus boosting both the tolerance and efficiency of rice production (Mishra, 2021) ^[9].

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The use of biopesticides for pest management in rice is becoming more important as global concerns about environmental sustainability, pesticide resistance, and food safety rise. They are often more selective, focusing on specific pests while avoiding harm to beneficial organisms such as pollinators and natural predators. (Ali, 2020) [1]. Additionally, biopesticides decay more quickly in the environment, eliminating the risk of soil and water contamination caused by synthetic chemical pesticides (Mishra, 2021) [9]. Therefore, biopesticides are a safer and more sustainable alternative for pest management.

The biopesticides used so far fall into two major categories viz., microbial pesticides and botanical pesticides (Ranga *et al.*, 2007) [13]. Microbial pesticides contain a microorganism (bacterium, fungus, virus, protozoan or alga) as the active ingredient which is relatively specific for its target pest. The most widely known microbial pesticides are derivatives of the bacterium, *Bacillus thuringiensis* (Bt) which produces a toxin protein that is harmful mainly to lepidopterans. Insect pathogen, *Bacillus thuringiensis* is reported to attack stem borer (Katti, 2013) [7].

Treatment details

Tr. No.	Treatments	Dose (ml/gm/lit. of water)
T ₁	<i>Bacillus albus</i> NBAIR-BATP (1 x 10 ⁸ cfu/ml)	10 ml/L
T ₂	<i>Metarhizium anisopliae</i> NBAIR (1 x 10 ⁸ cfu/ml)	10 ml/L
T ₃	<i>Beauveria bassiana</i> NBAIR (1 x 10 ⁸ cfu/ml)	10 ml/L
T ₄	<i>Bacillus thuringiensis</i> NRRI (1 x 10 ⁸ cfu/g)	5 g/L
T ₅	<i>Metarhizium anisopliae</i> DBSKKV (1 x 10 ⁸ cfu/g)	5 g/L
T ₆	<i>Beauveria bassiana</i> DBSKKV (1 x 10 ⁸ cfu/g)	5 g/L
T ₇	Cartap hydrochloride 4G (Standard check)	18.75 kg/ha
T ₈	Untreated control	-

Observations recorded

Ten hills were selected from each treated plot randomly in each replication and observations were recorded. Pre-count was taken 1 day before application and post-count was taken on 7th and 14th days after application of insecticides. Two foliar sprays of biopesticides of entomopathogens were given at 14 days interval.

Rice leaf folder (*Cnaphalocrocis medinalis*):

The leaf folder infestation was recorded at 7th DAS and 14th DAS on ten randomly selected hills per plot by counting total number of leaves as well as leaf folder infested leaves. The recorded data further converted into per cent leaf folder damage by using formula,

$$\text{Per cent leaf folder damage} = \frac{\text{Number of damaged leaves per hill}}{\text{Total number of leaves per hill}} \times 100$$

The average per cent leaf folder damage was worked out and transformed into arc sin and were analyzed statistically.

Results

In pre-treatment count day before application of treatments, mean per cent infestation of leaf folder per hill varied from 10.09 to 11.41 per cent. A day before treatment application, mean per cent infestation of leaf folder per hill across treatments was found to be non-significant. Which shows that pest was dispersed rather consistently throughout the rice crop.

Materials and methods

The present investigation was conducted at Model Agronomic Experiment (MAE) Farm, Mudre, Regional Agricultural Research Station, Karjat, Dist. Raigad during Kharif, 2024. For studying the efficacy of biopesticides, experimental plot was prepared in Randomized Block Design (RBD). The design consists of 3 replications and 8 treatments (six biopesticides, one insecticide treatment and one as untreated control). The seedlings of Karjat 7 variety of rice were prepared on raised nursery beds and transplanted on experimental plot with spacing of 20 cm x 15 cm.

Application of biopesticide treatments

The required quantity of water needed for spraying was calculated. The spray suspension of the required volume was prepared according to the treatments and spraying was done. Two rounds of sprays were taken of biopesticides. First spraying was done when infestation reaches ETL and second spray was given at 14 days interval from first spray. The observations were recorded on ten randomly selected hills in each treatment. The details of treatments are mentioned as below.

Efficacy of different biopesticides against leaf folder infesting rice after first spray

The data on efficacy of different biopesticide treatments against leaf folder at pre-count, 7th and 14th days after first spray are presented in the Table 1 and shown in Fig. 1

At seventh day after application of first spray data recorded revealed that infestation of leaf folder ranged from 4.80 to 12.28 per cent. The data showed that all the treatments were found significantly superior over untreated control (T₈). Treatment T₇ i.e. Cartap hydrochloride 4G @ 18.75 kg ha⁻¹ was found highly effective among all the treatments recorded least Per cent leaf folder infestation (4.80 per cent) and found to be significantly superior over all other treatments. The treatment T₄, *Bacillus thuringiensis* NRRI (1 x 10⁸cfu/g) @ 5 gm lit⁻¹ was found to be next best treatment which recorded 7.19 per cent leaf folder damage which was at par with the treatment T₁, *Bacillus albus* NBAIR-BATP (1 x 10⁸cfu/ml) @ 10 ml lit⁻¹ (7.95 per cent) and T₆, *Beauveria bassiana* DBSKKV (1 x 10⁸cfu/g) @ 5 gm lit⁻¹ (8.25 per cent). The treatment T₃, *Beauveria bassiana* NBAIR (1 x 10⁸cfu/ml) @ 10 ml lit⁻¹ recorded 9.86 per cent leaf folder damage and at par with the treatment T₅, *Metarhizium anisopliae* DBSKKV (1 x 10⁸cfu/g) @ 5 gm lit⁻¹ (9.70 per cent) and T₂, *Metarhizium anisopliae* NBAIR (1 x 10⁸cfu/ml) @ 10 ml lit⁻¹ (9.52 per cent). The maximum (12.28 per cent) leaf folder damage was found in untreated control (T₈).

Data recorded at fourteenth day after application of first spray, leaf folder damage varied from 5.39 to 13.11 per cent. The data revealed that all the treatments recorded

significantly lower leaf folder damage than treatment T₈, untreated control. Treatment T₇, Cartap hydrochloride 4G @ 18.75 kg ha⁻¹ was significantly superior over all the treatments and showed 5.39 per cent leaf folder damage. The treatment T₄, *Bacillus thuringiensis* NRRI (1 x 10⁸cfu/g) @ 5 gm lit⁻¹ was found to be next effective treatment which recorded 7.35 per cent leaf folder infestation and was at par with the treatment T₁, *Bacillus albus* NBAIR-BATP (1 x 10⁸cfu/ml) @ 10 ml lit⁻¹ (8.20 per cent) and T₆, *Beauveria bassiana* DBSKKV (1 x 10⁸cfu/g) @ 5 gm lit⁻¹ (8.41 per cent). The treatment T₃, *Beauveria bassiana* NBAIR (1 x 10⁸cfu/ml) @ 10 ml lit⁻¹ recorded 9.97 per cent leaf folder damage and at par with the treatment T₅, *Metarhizium anisopliae* DBSKKV (1 x 10⁸cfu/g) @ 5 gm lit⁻¹ (9.79 per cent) and T₂, *Metarhizium anisopliae* NBAIR (1 x 10⁸cfu/ml) @ 10 ml lit⁻¹ (9.74 per cent). The maximum (13.11 per cent) damaged leaves due to leaf folder were found in treatment (T₈), untreated control. Among the different treatments, T₇, Cartap hydrochloride 4G @ 18.75 kg ha⁻¹ was found most effective over remaining treatments by reducing the leaf folder damage upto the extent of 44.65 per cent over untreated control. The treatment T₄, *Bacillus thuringiensis* NRRI (1 x 10⁸cfu/g) @ 5 gm lit⁻¹ recorded 33.07 per cent reduction in leaf folder infestation over untreated control followed by T₁, *Bacillus albus* NBAIR-BATP (1 x 10⁸cfu/ml) @ 10 ml lit⁻¹, T₆, *Beauveria bassiana* DBSKKV (1 x 10⁸cfu/g) @ 5 gm lit⁻¹, T₃, *Beauveria bassiana* NBAIR (1 x 10⁸cfu/ml) @ 10 ml lit⁻¹, T₅, *Metarhizium anisopliae* DBSKKV (1 x 10⁸cfu/g) @ 5 gm lit⁻¹ and T₂, *Metarhizium anisopliae* NBAIR (1 x 10⁸cfu/ml) @ 10 ml lit⁻¹ with 27.82 per cent, 26.89 per cent, 19.62 per cent, 18.02 per cent and 16.02 per cent reduction over control (ROC), respectively.

Efficacy of different biopesticides against leaf folder infesting rice after second spray

The data related to the efficacy of different biopesticides against leaf folder at pre- count, 7th and 14th days after second spray are presented in the Table 2 and depicted in Fig. 2.

Pre- treatment count for second spray is considered as a mean per cent damage of leaf folder per hill at 14 DAS of first spray and it ranges from 5.39 to 13.11 per cent. At seventh day after application of first spray, the infestation of leaf folder ranged from 2.70 to 13.59 per cent. The data showed that all the treatments were found significantly superior over untreated control (T₈). Treatment T₇, Cartap hydrochloride 4G @ 18.75 kg ha⁻¹ was found effective among all the treatments. Per cent leaf folder infestation (2.70 per cent) was minimum in treatment T₇, Cartap hydrochloride 4G @ 18.75 kg ha⁻¹ and found to be significantly superior over all other treatments. The treatment T₄, *Bacillus thuringiensis* NRRI (1 x 10⁸cfu/g) @ 5 gm lit⁻¹ was found to be next effective treatment which recorded 4.24 per cent leaf folder damage and was at par with the treatment T₁, *Bacillus albus* NBAIR-BATP (1 x 10⁸cfu/ml) @ 10 ml lit⁻¹ (5.22 per cent) and T₆, *Beauveria bassiana* DBSKKV (1 x 10⁸cfu/g) @ 5 gm lit⁻¹ (6.05 per cent). The treatment T₃, *Beauveria bassiana* NBAIR (1 x 10⁸cfu/ml) @ 10 ml lit⁻¹ recorded 7.55 per cent leaf folder infestation and at par with the treatment T₅, *Metarhizium anisopliae* DBSKKV (1 x 10⁸cfu/g) @ 5 gm lit⁻¹ (7.73 per cent) and T₂, *Metarhizium anisopliae* NBAIR (1 x 10⁸cfu/ml) @ 10 ml lit⁻¹ (7.89 per cent). The highest (13.59

per cent) leaf folder damaged leaves were found in untreated control (T₈).

At fourteenth day after application of second spray, the infestation of leaf folder ranged from 1.46 to 15.28 per cent. The data revealed that all the treatments recorded less leaf folder damage than untreated control. While, treatment T₇, Cartap hydrochloride 4G @ 18.75 kg ha⁻¹ was found to be most effective treatment and significantly superior over all the treatments which showed 1.46 per cent leaf folder infestation. The treatment T₄, *Bacillus thuringiensis* NRRI (1 x 10⁸cfu/g) @ 5 gm lit⁻¹ was found to be next superior treatment which recorded 4.32 per cent leaf folder damage and was at par with the treatment T₁, *Bacillus albus* NBAIR-BATP (1 x 10⁸cfu/ml) @ 10 ml lit⁻¹ (4.64 per cent) and T₆, *Beauveria bassiana* DBSKKV (1 x 10⁸cfu/g) @ 5 gm lit⁻¹ (5.50 per cent). The treatment T₃, *Beauveria bassiana* NBAIR (1 x 10⁸cfu/ml) @ 10 ml lit⁻¹ recorded 5.94 per cent leaf folder damage and at par with the treatment T₅, *Metarhizium anisopliae* DBSKKV (1 x 10⁸cfu/g) @ 5 gm lit⁻¹ (6.54 per cent) and T₂, *Metarhizium anisopliae* NBAIR (1 x 10⁸cfu/ml) @ 10 ml lit⁻¹ (6.98 per cent). The maximum (15.28 per cent) leaf folder infested leaves were found in T₈, untreated control.

Data pertaining to reduction over control in Table 2 showed that among all the treatments, T₇, Cartap hydrochloride 4G @ 18.75 kg ha⁻¹ was found most effective over all other treatments by minimizing the leaf folder damage to the extent of 77.24 per cent over untreated control. The next effective treatment T₄, *Bacillus thuringiensis* NRRI (1 x 10⁸cfu/g) @ 5 gm lit⁻¹ recorded 62.09 per cent reduction over treated control followed by T₁, *Bacillus albus* NBAIR-BATP (1 x 10⁸cfu/ml) @ 10 ml lit⁻¹, T₆, *Beauveria bassiana* DBSKKV (1 x 10⁸cfu/g) @ 5 gm lit⁻¹, T₃, *Beauveria bassiana* NBAIR (1 x 10⁸cfu/ml) @ 10 ml lit⁻¹, T₅, *Metarhizium anisopliae* DBSKKV (1 x 10⁸cfu/g) @ 5 gm lit⁻¹ and T₂, *Metarhizium anisopliae* NBAIR (1 x 10⁸cfu/ml) @ 10 ml lit⁻¹ with 54.17 per cent, 54.43 per cent, 44.66 per cent, 42.69 per cent and 40.81 per cent reduction over control, respectively.

Discussion

The findings of current investigation are in accordance with Patel S K (2006) [12] who found that after fifteen days of application of treatment showed significant differences among the treatments. The lowest damaged leaves were recorded in Cartap 4G @ 1000 g a.i. ha⁻¹ (2.32 per cent) and it was most effective on treated plot.

Results of present investigation are on similar line with the previously reported findings by Muhammad *et al.* (2008) [10] who observed that *Bacillus thuringiensis* at (1g/litre) recorded lower leaf folder infestation (4.09%) followed by neem application (6.08%) by studying the relative efficacy of the microbial and botanical insecticide.

The results of the current investigation are in conformity with Kandibane *et al.* (2010) [5] who found that *Bacillus thuringiensis* Berliner formulation @ 2.5 kg/ha, against rice leaf folder had lowest infestation of 8.21 per cent.

The present research findings are corroborative with Janaki *et al.* (2023) [4] who reported that among all isolates, *Bacillus subtilis* (EB01) achieved the highest mortality (74%) against leaf folder larvae. The isolate *B. subtilis* treated diet significantly reduced the larval digestive enzyme activity of α and β galactosidase (88.17 and 91.88%

at 96 hr). Which conclude that the *B. subtilis* EB01 strain potentially inhibited the biological activity of *C. medinalis*. Also, present findings agreed with Kathirvelu (2018) [6] who found that among the dosages tested, increased dose of *Beauveria bassiana* 1.15% w/w had caused higher mortality

of larval population of *Cnaphalocrocis medinalis* and less infestation percentage of rice plants. The grain yield was observed higher in the plot treated with *Beauveria bassiana* 1.15% w/w @ 3 kg/ha than other treatments.

Table 1: Efficacy of different biopesticides against leaf folder infesting rice after first spray

Sr. No.	Treatments	Dose per Lit. (ml or g)	Mean per cent infestation of leaf folder			Reduction Over Control
			Pre- count	7 DAS	14 DAS	
1	T ₁ - <i>Bacillus albus</i> NBAIR- BATP (1 x 10 ⁸ cfu/ml)	10 ml	10.41 (18.78)*	7.95 (16.33)	8.20 (16.62)	27.82
2	T ₂ - <i>Metarhizium anisopliae</i> NBAIR (1 x 10 ⁸ cfu/ml)	10 ml	11.08 (19.41)	9.52 (17.93)	9.74 (18.16)	16.02
3	T ₃ - <i>Beauveria bassiana</i> NBAIR (1 x 10 ⁸ cfu/ml)	10 ml	10.32 (18.71)	9.86 (18.26)	9.97 (18.35)	19.62
4	T ₄ - <i>Bacillus thuringiensis</i> NRRI (1 x 10 ⁸ cfu/g)	5 g/L	10.09 (18.50)	7.19 (15.53)	7.35 (15.70)	33.07
5	T ₅ - <i>Metarhizium anisopliae</i> DBSKKV (1 x 10 ⁸ cfu/g)	5 g/L	10.69 (19.05)	9.70 (18.13)	9.79 (18.16)	18.02
6	T ₆ - <i>Beauveria bassiana</i> DBSKKV (1 x 10 ⁸ cfu/g)	5 g/L	10.25 (18.60)	8.25 (16.58)	8.41 (16.83)	26.89
7	T ₇ - Cartap hydrochloride 4G (Standard check)	18.75 kg/ha	10.18 (18.54)	4.80 (12.63)	5.39 (13.41)	44.65
8	T ₈ - Untreated control	-	11.41 (19.67)	12.28 (20.48)	13.11 (21.22)	-
SEm (±)			0.91	0.77	0.65	-
CD (p=0.05)			NS	2.36	2.00	

*Figures in the parenthesis are Arc sine transformed values DAS: Days after Spraying

Table 2: Efficacy of different biopesticides against leaf folder infesting rice after second spray

Sr. No.	Treatments	Dose per Lit. (ml or g)	Mean per cent infestation of leaf folder			Reduction Over Control
			Pre- count	7 DAS	14 DAS	
1	T ₁ - <i>Bacillus albus</i> NBAIR- BATP (1 x 10 ⁸ cfu/ml)	10 ml	8.20 (16.62)*	5.22 (12.25)	4.64 (12.39)	54.17
2	T ₂ - <i>Metarhizium anisopliae</i> NBAIR (1 x 10 ⁸ cfu/ml)	10 ml	9.97 (18.35)	7.89 (16.31)	6.98 (15.27)	40.81
3	T ₃ - <i>Beauveria bassiana</i> NBAIR (1 x 10 ⁸ cfu/ml)	10 ml	9.74 (18.16)	7.55 (15.94)	5.94 (14.05)	44.66
4	T ₄ - <i>Bacillus thuringiensis</i> NRRI (1 x 10 ⁸ cfu/g)	5 g/L	7.35 (15.70)	4.24 (13.06)	4.32 (11.92)	62.09
5	T ₅ - <i>Metarhizium anisopliae</i> DBSKKV (1 x 10 ⁸ cfu/g)	5 g/L	9.79 (18.16)	7.73 (16.09)	6.54 (14.80)	42.69
6	T ₆ - <i>Beauveria bassiana</i> DBSKKV (1 x 10 ⁸ cfu/g)	5 g/L	8.41 (16.83)	6.05 (14.22)	5.50 (13.53)	54.43
7	T ₇ - Cartap hydrochloride 4G (Standard check)	18.75 kg/ha	5.39 (13.41)	2.70 (6.49)	1.46 (6.93)	77.24
8	T ₈ - Untreated control	-	13.11 (21.22)	13.59 (19.55)	15.28 (22.99)	-
SEm (±)			0.65	0.79	0.62	-
CD (p=0.05)			2.00	2.40	1.91	

Figures in the parenthesis are Arc sine transformed values DAS: Days after Spraying

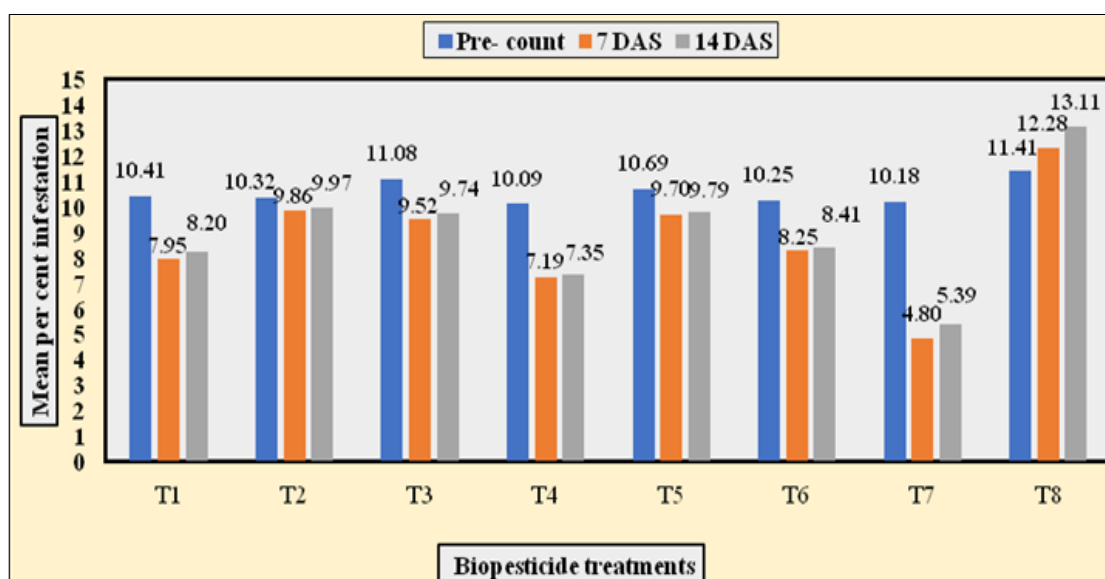


Fig 1: Efficacy of different biopesticides against leaf folder after first spray

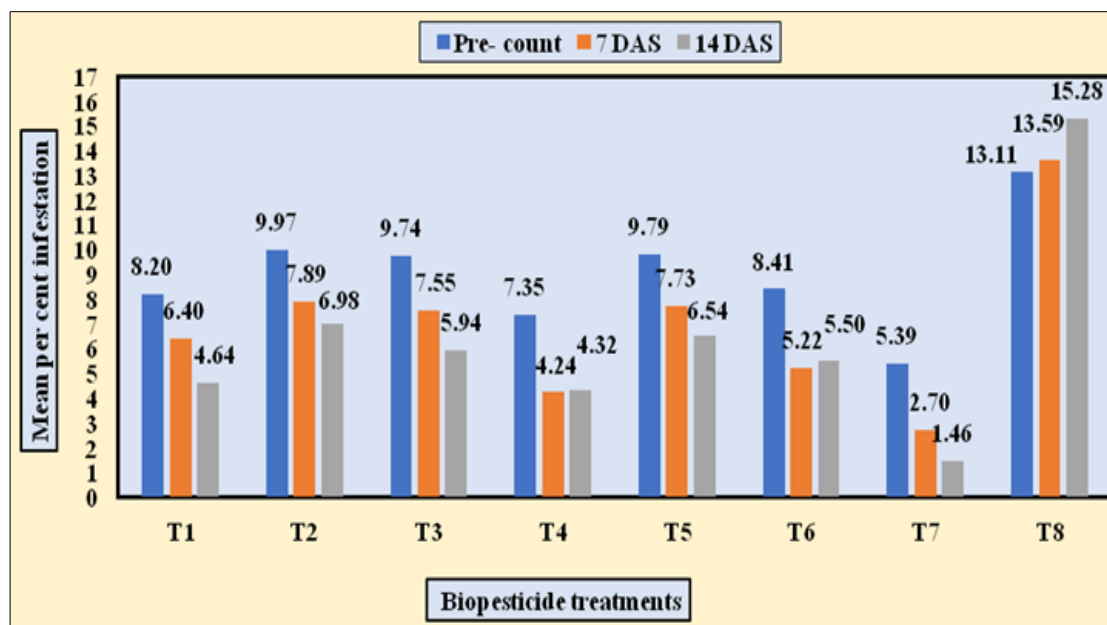


Fig 2: Efficacy of different biopesticides against leaf folder after second spray

Conclusion

From the above study it can be concluded that, as a standard check Cartap hydrochloride 4G was found most effective for managing infestation of leaf folder. Among the different biopesticides, *Bacillus thuringiensis* NRRI (1×10^8 cfu/g) was most effective against leaf folder.

Also, from the above experiment it can be concluded that microbial biopesticidal formulations of *Bacillus thuringiensis* and *Beauveria bassiana* could be used to control rice leaf folders as an organic method of managing insect pests.

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References

1. Ali S. Pest resistance in rice: strategies and developments. *Agricultural Research Journal*. 2020;45(3):234-245.
2. Dalvi NS, Desai VS, Narangalkar AL, Chavan SA, Mehendale SK, Dhekale JS. Effect of abiotic factors on incidence of leaf folder, *Cnaphalocrocis medinalis* (Guenée), in rice ecosystem of Konkan region. *Journal of Entomology and Zoology Studies*. 2021;9(1):1196-1200.
3. Gawai MP, Waghmode BD, Patil PD, Sagvekar VV, Sawant VP. Production oriented survey (POS) on different aspects of rice cultivation and farmers practices in Konkan region of Maharashtra state. *J Agric Res Technol*. 2024;49(3):426-430.
4. Janaki M, Sivadasan Unni PK, Stanley-Raja V, Senthil-Nathan S, Almutairi BO, Abdel-Megeed A. Biocontrol effect of *Bacillus subtilis* against *Cnaphalocrocis medinalis* (Guenée) (Lepidoptera: Pyralidae): a sustainable approach to rice pest management. *Agronomy*. 2023;14(2):310.
5. Kandibane MK, Kumar, Adiroubane D. Effect of *Bacillus thuringiensis* (Berliner) formulation against the rice leaf folder *Cnaphalocrocis medinalis* (Guenée) (Pyralidae: Lepidoptera). *Journal of Biopesticides*. 2010;3(2):445-447.
6. Kathirvelu C. Field evaluation of white muscardine fungus, *Beauveria bassiana* 1.15% w/w, against leaf folder, *Cnaphalocrocis medinalis* (Guenée), in rice. *International Journal of Current Research in Life Sciences*. 2018;7(4):1518-1520.
7. Katti G. Biopesticides for insect pest management in rice: present status and future scope. *Journal of Rice Research*. 2013;6(1):1-15.
8. Meshram AV, Talathi JM, Phuge SC, Thorat VA, Dhekale JS. Technological change in rice production in North Konkan region (Maharashtra). *International Journal of Conservation Science*. 2020;8(2):2013-2018.
9. Mishra A. Reducing pesticide use in rice cultivation: approaches and implications. *Journal of Agricultural and Food Chemistry*. 2021;69(7):1770-1779.
10. Muhammad S, Muhammad A, Mansoor H, Shahnaz AR. Integration of some biopesticides and *Trichogramma chilonis* (Ishii) for the sustainable management of rice leaf folder. *Pak J Agric Sci*. 2008;45(1):69-74.
11. Panesar PS, Kaur S. Rice: types and composition. In: *Rice production worldwide*. Amsterdam: Elsevier; 2016. p. 3-13.
12. Patel SK. Bio-efficacy of newer granular insecticide against major insect pests of rice and in-depth studies of promising rice genotype for resistance against BPH, *Nilaparvata lugens* (Stål) [MSc (Ag) thesis]. Raipur: Department of Entomology, Indira Gandhi Krishi Vishwavidyalaya; 2006. p. 70.
13. Ranga Rao GV, Rupela OP, Rameshwar Rao V, Reddy YVR. Role of biopesticides in crop protection: current status and future prospects. *Indian Journal of Plant Protection*. 2007;35:1-9.