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Efficacy of different biopesticides against stem borer infesting rice

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Abstract
The field experiment was carried out at Model Agronomic Experiment (MAE) Farm, Regional Agricultural Research Station, Karjat, Dist. Raigad to study the efficacy of different biopesticides against stem borer of rice during *Kharif*, 2024. The study assessed the efficacy of six different biopesticides and one insecticide as a standard check against stem borer in rice under field conditions. The biopesticides evaluated includes, *Bacillus albus* NBAIR-BATP (1 x 10^8cfu/ml), *Metarhizium anisopliae* NBAIR (1 x 10^8cfu/ml), *Beauveria bassiana* NBAIR (1 x 10^8cfu/ml), *Bacillus thuringiensis* NRRI (1 x 10^8cfu/g), *Metarhizium anisopliae* DBSKKV (1 x 10^8cfu/g), *Beauveria bassiana* DBSKKV (1 x 10^8cfu/g), Cartap hydrochloride 4G (Standard check). Data on mean percent infestation and reduction over control of stem borer after two spray showed that treatment having Cartap hydrochloride 4G @ 18.75 kg ha^{-1} was significantly superior over all treatments with least 0.98 percent infestation and 83.51 percent reduction over control, followed by *Bacillus thuringiensis* NRRI (1 x 10^8cfu/g) @ 5 gm lit^{-1} recorded (3.25 percent infestation, 65.72 percent reduction) and was at par with the treatment of *Bacillus albus* NBAIR-BATP (1 x 10^8cfu/ml) @ 10 ml lit^{-1} (3.39 percent infestation, 64.13 percent reduction) and *Beauveria bassiana* DBSKKV (1 x 10^8cfu/g) @ 5 gm lit^{-1} (3.84 percent infestation, 59.49 percent reduction). It is concluded that, Cartap hydrochloride 4G was found most effective for controlling infestation of stem borer. Among the different biopesticides, *Bacillus thuringiensis* NRRI (1 x 10^8cfu/g) was most effective against infestation of stem borer.

Keywords: Rice, stem borer, infestation, efficacy, biopesticides

Introduction
Rice (*Oryza sativa* L.) is 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. The importance of rice has been identified from many centuries, and rice is also known as 'dhanya' which means the sustainer of the human race (Panesar and Kaur, 2016) [6]. Konkan region is a major rice producing area of Maharashtra. The average rice productivity of Konkan region is 2.69 t ha^{-1} (3.83 t ha^{-1} rough rice) (Gawai *et al*. 2024) [2]. 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 Konkan region of Maharashtra is divided into two major growing regions *viz.*, North Konkan and South Konkan which shares area under paddy cultivation is about 65.07 percent and 34.93 percent respectively (Meshram *et al*., 2020) [4]. Rice productivity is often adversely disturbed by several abiotic stresses such as drought, submergence and biotic stresses as pest like stem borer, leaf folder, brown plant hopper, ear head bug, etc. (Katti, 2013) [3]. Among several species of stem borer infesting rice crop, yellow stem borer *Scirpophaga incertulas* (Walker) is found relatively in high abundance at all the stages of crop growth. Rice varieties are found most susceptible to stem borer attack resulted in higher percent dead hearts at tillering stage and higher percent white earheads at maturity stage. (Singh and Tiwari, 2019). Microbial pesticides contain a microorganism (bacterium, fungus, virus, protozoan or alga) as the active ingredient which is relatively specific for its target pests. 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) [3].

In addition, biopesticides can be integrated into Integrated Pest Management (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) [5].

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 IPM programs, mainly as a means to reduce the load of synthetic chemical products that are being used for control of pests. The biopesticides used so far fall into two major categories *viz.*, microbial pesticides and botanical pesticides. 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) [5]. Therefore, biopesticides are a safer and more sustainable alternative for pest management. In this context, the experiment was formulated with an objective to study the efficacy of different biopesticides against stem borer in rice.

Materials and Methods

The present investigation was conducted at Model Agronomic Experiment (MAE) Farm, 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). This 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 along with standard check and untreated control was given to respective 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 the spraying was done. The two sprays were taken of biopesticides. First spraying was done when infestation reaches upto 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.

Treatment details

Tr. No.	Treatments	Dose (ml/gm/lit. of water)
T_1	*Bacillus albus* NBAIR-BATP (1 x 10^8cfu/ml)	10 ml/L
T_2	*Metarhizium anisopliae* NBAIR (1 x 10^8cfu/ml)	10 ml/L
T_3	*Beauveria bassiana* NBAIR (1 x 10^8cfu/ml)	10 ml/L
T_4	*Bacillus thuringiensis* NRRI (1 x 10^8cfu/g)	5 g/L
T_5	*Metarhizium anisopliae* DBSKKV (1 x 10^8cfu/g)	5 g/L
T_6	*Beauveria bassiana* DBSKKV (1 x 10^8cfu/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 taken on 7th and 14th days after application of insecticides. Two foliar sprays of biopesticides of entomopathogens were given at 14 days interval.

The observations of yellow stem borer infestation in terms of dead hearts and white earheads were recorded. Average number of tillers or panicles per hill was calculated by counting total tillers or panicles from ten randomly selected hills. Total dead hearts or white ear heads from those ten hills were also counted to arrive at percent stem borer infestation by using formulae,

$$\text{Per cent dead heart (\%DH)} = \frac{\text{Number of dead hearts (DH)}}{\text{Number of total tillers}} \times 100$$

$$\text{Per cent white earheads (\%WE)} = \frac{\text{Number of white earheads (WE)}}{\text{Number of Panicle Bearing Tillers (PBT)}} \times 100$$

The average percent dead heart/white ears infestation was worked out and transformed into arc sin and were analyzed statistically.

Results

Efficacy of different biopesticides against stem borer infesting rice

In pre- treatment count prior to application of treatments, mean percent infestation of stem borer per hill varied from 6.25 to 8.78 percent. Pest was dispersed rather consistently throughout the rice crop indicated that day before treatment application, mean percent infestation of stem borer per hill across treatments was found to be non-significant.

After first spray

The data pertaining to the efficacy of different biopesticide treatments against stem borer 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, the infestation of stem borer ranged from 3.10 to 9.59 percent. The data showed that all the treatments under study were found significantly superior over untreated control (T_8). The percent stem borer infestation (3.10 percent) was minimum in treatment T_7 i.e. Cartap hydrochloride 4G @ 18.75 kg ha^{-1} and found to be significantly superior over all other treatments. Among the biopesticidal treatment, treatment T_4 i.e. *Bacillus thuringiensis* NRRI (1 x 10^8cfu/g) @ 5 gm lit^{-1} was found to be next effective treatment which recorded 4.57 percent stem borer infestation and was at par with the treatment T_1, *Bacillus albus* NBAIR-BATP (1 x 10^8cfu/ml)

@ 10 ml lit^{-1} (4.86 percent) and T_6, *Beauveria bassiana* DBSKKV (1 x 10^8cfu/g) @ 5 gm lit^{-1} (5.24 percent). The treatment T_3, *Beauveria bassiana* NBAIR (1 x 10^8cfu/ml) 10 ml lit^{-1} recorded 5.80 percent stem borer infestation and at par with the treatment T_5, *Metarhizium anisopliae* DBSKKV (1 x 10^8cfu/g) 5 gm lit^{-1} (6.32 percent) and T_2, *Metarhizium anisopliae* NBAIR (1 x 10^8cfu/ml) @ 10 ml lit^{-1} (6.72 percent). The maximum (9.59 percent) stem borer infestation in terms of dead hearts was found in untreated control (T_8).

At fourteenth day after application of first spray, the infestation of stem borer varied from 3.58 to 10.79 percent. The data indicated that all the treatments recorded significantly less stem borer infestation than treatment T_8 (untreated control). Application of Cartap hydrochloride 4G @ 18.75 kg ha^{-1} (T_7) was significantly superior over rest of the treatments and found to be most effective treatment which showed 3.58 percent stem borer infestation. While the treatments having different biopesticies, the treatment T_4, *Bacillus thuringiensis* NRRI (1 x 10^8cfu/g) @ 5 gm lit^{-1} was found to be next effective treatment which recorded 5.33 percent stem borer infestation and was at par with the treatment T_1, *Bacillus albus* NBAIR-BATP (1 x 10^8cfu/ml) @ 10 ml lit^{-1} (5.57 percent) and T_6, *Beauveria bassiana* DBSKKV (1 x 10^8cfu/g) @ 5 gm lit^{-1} (5.94 percent). The treatment T_3, *Beauveria bassiana* NBAIR (1 x 10^8cfu/ml) @ 10 ml lit^{-1} recorded 6.75 percent stem borer infestation and at par with the treatment T_5, *Metarhizium anisopliae* DBSKKV (1 x 10^8cfu/g) @ 5 gm lit^{-1} (6.99 percent) and T_2, *Metarhizium anisopliae* NBAIR (1 x 10^8cfu/ml) @ 10 ml lit^{-1} (7.39 percent). The maximum (10.79 percent) stem borer infestation in terms of dead hearts was found in treatment (T_8), untreated control. Among all the treatments, T_7, Cartap hydrochloride 4G @ 18.75 kg ha^{-1} was found to be significantly superior over all other treatments by minimizing infestation to the extent of 54.26 percent over untreated control. The treatment T_4, *Bacillus thuringiensis* NRRI (1 x 10^8cfu/g) @ 5 gm lit^{-1} recorded 44.62 percent reduction in stem borer infestation over untreated control followed by T_1, *Bacillus albus* NBAIR-BATP (1 x 10^8cfu/ml) @ 10 ml lit^{-1}, T_6, *Beauveria bassiana* DBSKKV (1 x 10^8cfu/g) @ 5 gm lit^{-1}, T_3, *Beauveria bassiana* NBAIR (1 x 10^8cfu/ml) @ 10 ml $lit^{-1,}$ T_5, *Metarhizium anisopliae* DBSKKV (1 x 10^8cfu/g) @ 5 gm lit^{-1}, and T_2, *Metarhizium anisopliae* NBAIR (1 x 10^8cfu/ml) @ 10 ml $lit^{-1}$with 41.98 percent, 39.97 percent, 35.14 percent, 29.48 percent and 25.55 percent reduction over control, respectively.

After second spray

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

Pre-count for second spray varied from 3.58 to 10.79 percent. At seventh day after application of second spray, the infestation of stem borer ranged from 1.28 to 11.21 percent. The data showed that all the treatments were significantly superior over the untreated control. Treatment T_7, Cartap hydrochloride 4G @ 18.75 kg ha^{-1} was found to be most effective treatment which showed minimum infestation of stem borer i.e.,1.28 percent. The treatment T_4, *Bacillus thuringiensis* NRRI (1 x 10^8cfu/g) @ 5 gm lit^{-1} was found to be next effective treatment which recorded 3.55 percent stem borer infestation and was at par with the treatment T_1, *Bacillus albus* NBAIR-BATP (1 x 10^8cfu/ml) @ 10 ml lit^{-1} (3.73 percent) and T_6, *Beauveria bassiana* DBSKKV (1 x 10^8cfu/g) @ 5 gm lit^{-1} (4.55 percent). The treatment T_3, *Beauveria bassiana* NBAIR (1 x 10^8cfu/ml) @ 10 ml lit^{-1} recorded 5.03 percent stem borer infestation and at par with the treatment T_5, *Metarhizium anisopliae* DBSKKV (1 x 10^8cfu/g) @ 5 gm lit^{-1} (5.22 percent) and T_2, *Metarhizium anisopliae* NBAIR (1 x 10^8cfu/ml) @ 10 ml lit^{-1} (5.56 percent). The highest (11.21 percent) stem borer infestation in terms of dead hearts was found in T_8, untreated control.

The infestation of stem borer varied from 0.98 to 13.39 percent at fourteenth day after application of second spray. The data showed that all the treatments recorded significantly less stem borer infestation than untreated control. While, treatment T_7 i.e. Cartap hydrochloride 4G @ 18.75 kg ha^{-1} was significantly superior over all the treatments. It was found to be most effective treatment which showed 0.98 percent stem borer infestation. The treatment T_4, *Bacillus thuringiensis* NRRI (1 x 10^8cfu/g) @ 5 gm lit^{-1} was found to be next superior treatment which recorded 3.25 percent stem borer infestation and was at par with the treatment T_1, *Bacillus albus* NBAIR-BATP (1 x 10^8cfu/ml) @ 10 ml lit^{-1} (3.39 percent) and T_6, *Beauveria bassiana* DBSKKV (1 x 10^8cfu/g) @ 5 gm lit^{-1} (3.84 percent). The treatment T_3, *Beauveria bassiana* NBAIR (1 x 10^8cfu/ml) @ 10 ml lit^{-1} recorded 4.80 percent stem borer infestation and at par with the treatment T_5, *Metarhizium anisopliae* DBSKKV (1 x 10^8cfu/g) @ 5 gm lit^{-1} (4.96 percent) and T_2, *Metarhizium anisopliae* NBAIR (1 x 10^8cfu/ml) @ 10 ml lit^{-1} (5.23 percent). The maximum (13.39 percent) stem borer infestation in terms of dead hearts was found in T_8, untreated control. Data presented in Table 2 showed that among all the treatments, T_7, Cartap hydrochloride 4G @ 18.75 kg ha^{-1} was found most effective over all other treatments by reducing the stem borer infestation to the extent of 83.51 percent over untreated control. The treatment T_4, *Bacillus thuringiensis* NRRI (1 x 10^8cfu/g) @ 5 gm lit^{-1} recorded 65.72 percent reduction in stem borer infestation over treated control followed by T_1, *Bacillus albus* NBAIR-BATP (1 x 10^8cfu/ml) @ 10 ml lit^{-1}, T_6, *Beauveria bassiana* DBSKKV (1 x 10^8cfu/g) @ 5 gm lit^{-1}, T_3, *Beauveria bassiana* NBAIR (1 x 10^8cfu/ml) @ 10 ml lit^{-1} , T_5, *Metarhizium anisopliae* DBSKKV (1 x 10^8cfu/g) @ 5 gm lit^{-1} and T_2, *Metarhizium anisopliae* NBAIR (1 x 10^8cfu/ml) @ 10 ml lit^{-1} with 64.13 percent, 59.49 percent, 53.15 percent, 51.50 percent and 48.58 percent reduction over control, respectively.

Discussion

The results of current investigation are in conformity with Patel *et al* (2006) [7] who found that among the treatments, Cartap hydrochloride 4G @ 1000 g a.i. ha^{-1} was most effective against stem borer in rice. It was followed by Carbofuran 3G @ 1000 g a.i. ha^{-1} and Dursban 10G (with BLO as solvent) @ 1250 g a.i. ha^{-1}. The results of present investigation are on similar line with the results obtained by Singh and Chatterjee (2021) [9] who observed that white ear head damage was recorded lowest in spinosad (8.04%) followed by *B. bassiana* + *B. thuringiensis var. kurstaki* (9.25%) and *M. anisopliae* treatment (9.48%).The findings of current investigation are in accordance with previously reported results by Sah and Sharma (2023) [8] who reported that *Bacillus thuringiensis var kurtaski* resulted in the lowest dead heart infestation (0.4889%), followed by Neembicide (0.5776%). *B. thuringiensis* var. *kurtaski* also had the lowest white earhead infestation (0.367%), followed by *Beauveria bassiana* (0.544%).

Figures

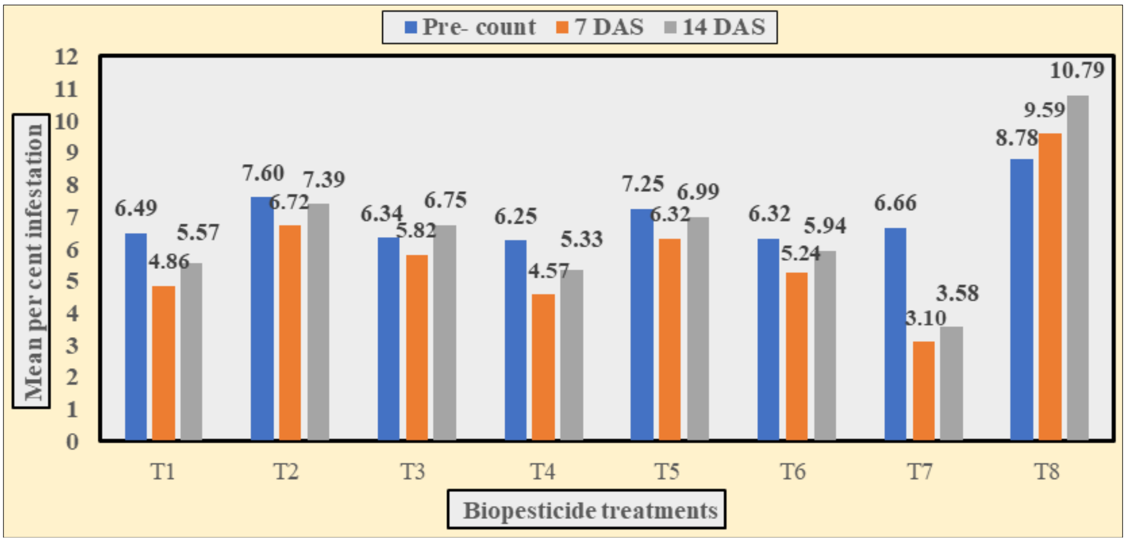

Fig 1: Efficacy of different biopesticides against stem borer after first spray

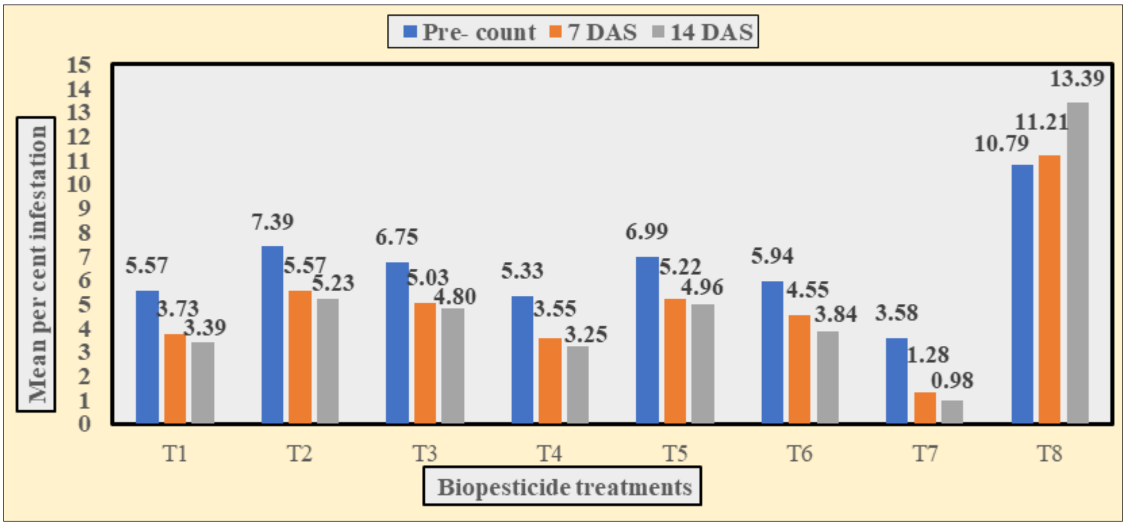

Fig 2: Efficacy of different biopesticides against stem borer after second spray

Tables

Table 1: Efficacy of different biopesticides against stem borer infesting rice after first spray

Sr. No.	Treatments	Dose per Lit. (ml or g)	Mean percent infestation of stem borer			Reduction Over control
			Pre-scount	7 DAS	14 DAS	
1	T_1-*Bacillus albus* NBAIR- BATP (1 x 10^8cfu/ml)	10 ml	6.49 (14.48)*	4.86 (12.71)	5.57 (13.62)	41.98
2	T_2-*Metarhizium anisopliae* NBAIR (1 x 10^8cfu/ml)	10 ml	7.60 (14.72)	6.72 (14.99)	7.39 (15.75)	25.55
3	T_3 - *Beauveria bassiana* NBAIR (1 x 10^8cfu/ml)	10 ml	6.34 (14.56)	5.80 (13.91)	6.75 (15.04)	35.14
4	T_4 - *Bacillus thuringiensis* NRRI (1 x 10^8cfu/g)	5 g/L	6.25 (14.35)	4.57 (12.31)	5.33 (13.32)	44.62
5	T_5-*Metarhizium anisopliae* DBSKKV (1 x10^8cfu/g)	5 g/L	7.25 (15.33)	6.32 (14.54)	6.99 (15.32)	29.48
6	T_6-*Beauveria bassiana* DBSKKV (1 x 10^8cfu/g)	5 g/L	6.32 (14.53)	5.24 (13.20)	5.94 (14.10)	39.97
7	T_7-Cartap hydrochloride 4G (Standard check)	18.75 kg/ha	6.66 (14.27)	3.10 (10.13)	3.58 (10.83)	54.26
8	T_8- Untreated control	-	8.78 (13.82)	9.59 (18.03)	10.79 (19.17)	-
S.Em (±)			0.62	0.52	0.56	
CD (p=0.05)			NS	1.59	1.70	

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

Table 2: Efficacy of different biopesticides against stem borer infesting rice after second spray

Sr No.	Treatments	Dose per Lit. (ml or g)	Mean percent infestation of stem borer			Reduction Over control
			Pre-count	7 DAS	14 DAS	
1	T_1-*Bacillus albus* NBAIR-BATP (1 x 10^8cfu/ml)	10 ml	5.57 (13.62)*	3.73 (11.08)	3.39 (10.56)	64.13
2	T_2-*Metarhizium anisopliae* NBAIR (1 x 10^8cfu/ml)	10 ml	7.39 (15.75)	5.56 (13.61)	5.23 (13.18)	48.58
3	T_3 - *Beauveria bassiana* NBAIR (1 x 10^8cfu/ml)	10 ml	6.75 (15.04)	5.03 (13.92)	4.80 (12.62)	53.15
4	T_4 - *Bacillus thuringiensis* NRRI (1 x 10^8cfu/g)	5 g/L	5.33 (13.32)	3.55 (10.79)	3.25 (10.29)	65.72
5	T_5-*Metarhizium anisopliae* DBSKKV (1 x 10^8cfu/g)	5 g/L	6.99 (15.32)	5.22 (13.10)	4.96 (12.84)	51.50
6	T_6-*Beauveria bassiana* DBSKKV (1 x 10^8cfu/g)	5 g/L	5.94 (14.10)	4.55 (12.25)	3.84 (11.29)	59.49
7	T_7-Cartap hydrochloride 4G (Standard check)	18.75 kg/ha	3.58 (10.83)	1.28 (6.49)	0.98 (5.64)	83.51
8	T_8-Untreated control	-	10.79 (19.17)	11.21 (19.55)	13.39 (21.43)	-
SEm (±)			0.56	0.90	0.69	
CD (p=0.05)			1.70	1.95	2.11	

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

Conclusion

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

It can also be concluded from the experimental results that for organic way to manage yellow stem borer in rice, biopesticides *viz.*, *Bacillus thuringiensis* and *Beauveria bassiana* could be used.

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References

1. Ali S. Pest resistance in rice: strategies and developments. Agric Res J. 45(3):234-45.
2. Gawai MP, Waghmode BD, Patil PD, Sagvekar VV, Sawant VP. Production oriented survey on different aspects of rice cultivation and farmers practices in Konkan region of Maharashtra state. J Agric Res Technol. 49(3):426-30.
3. Katti G. Biopesticides for insect pest management in rice: present status and future scope. J Rice Res. 6(1):1-15.
4. Meshram AV, Talathi JM, Phuge SC, Thorat VA, Dhekale JS. Technological change in rice production in north Konkan region (M.S.). Int J Conserv Sci. 8(2):2013-18.
5. Mishra A. Reducing pesticide use in rice cultivation: approaches and implications. J Agric Food Chem. 69(7):1770-9.
6. Panesar PS, Kaur S. Rice: types and composition. 2016.
7. 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* (Stal.). M.Sc. (Ag) Thesis. Department of Entomology, IGKV, Raipur; p.70.
8. Sah S, Sharma R. Efficacy of eco-friendly insecticides against yellow stem borer under spring rice crop ecosystem of Saptari district, Nepal. Arch Agric Environ Sci. 8(2):112-5.
9. Singh B, Chatterjee S. Relative efficacy of some biorational and microbial insecticides against yellow stem borer and whorl maggot of boro paddy. J Biopesticides. 14(2):90-6.
10. Singh DP, Tiwari T. Assessment of extent of damage and yield loss caused by stem borer in rice. J Pharmacogn Phytochem. 8(2):2112-5.