Biospectra : ISSN: 0973-7057, Vol. 20(1), March, 2025, pp. 101-104 **Animal Science**

An International Biannual Refereed Journal of Life Sciences

ISSN : 0973-7057

Evaluation of integrated pest management approaches using pheromone traps and biocontrol agents against *Tryporiza nivella* in sugarcane in Samastipur, Bihar

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Received : 15th January, 2025 ; Revised : 15th February, 2025

DOI:-https://doi.org/10.5281/zenodo.16397055

Abstract- *Tryporiza nivella*, commonly known as the sugarcane shoot borer, is a major pest that causes substantial damage to sugarcane crops by attacking the central shoot and inducing "dead heart" symptom. This field-based study conducted in Samastipur, Bihar, aimed to assess the effectiveness of an Integrated Pest Management (IPM) strategy combining pheromone traps, the egg parasitoid *Trichogramma chilonis*, and the entomopathogenic fungus *Beauveria bassiana*. The treatments were applied individually and in combination, and their effects were evaluated on larval populations, dead heart incidence, and overall cane yield. Results revealed that the integrated application of all three IPM components significantly outperformed single treatments and untreated controls, reducing pest pressure and improving crop productivity. Statistical analysis using OPSTAT software confirmed the superiority of the combined approach in minimizing pest incidence and maximizing yield. This study highlights the potential of IPM as a sustainable alternative to chemical-based pest control in sugarcane cultivation.

Keywords: Sugarcane, Shoot Borer, *Tryporiza nivella*, IPM, *Trichogramma chilonis, Beauveria bassiana*, Pheromone Traps

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is a vital commercial crop in India, serving as a primary source of sugar, ethanol, jaggery, and several value-added by-products. The crop sustains millions of livelihoods and is cultivated extensively in tropical and subtropical regions of the country. In Bihar, districts like Samastipur (located at approximately 25.86°N latitude and 85.78°E longitude) contribute significantly to sugarcane cultivation, owing to favorable agro-climatic conditions and fertile alluvial soils.

Despite its economic importance, sugarcane productivity is often threatened by a range of insect pests. One of the most destructive among these is the shoot borer, *Tryporiza nivella* (Fabricius), a lepidopteran pest that infests the young shoots of the crop. The larvae bore into the central whorl of the cane, resulting in the characteristic "dead heart" symptom, which causes early shoot death and considerable yield losses.[1]

Historically, chemical insecticides have been the primary means of pest suppression. However, the overuse and misuse of synthetic pesticides have led to multiple challenges, including pest resistance, ecological imbalance, resurgence of secondary pests, and adverse effects on non-target organisms.[2] These concerns have accelerated the transition toward environmentally sustainable alternatives such as Integrated Pest Management (IPM).

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IPM emphasizes the use of multiple, compatible pest control tactics to achieve effective and sustainable pest suppression. In the context of sugarcane pest management, eco-friendly interventions such as behavioral, biological, and microbial control agents are gaining prominence. This study evaluates the efficacy of three such components within an IPM framework for managing *T. nivella* in Samastipur:

- Pheromone traps: Used for both mass trapping and real-time monitoring of adult moth populations.
- Egg parasitoid (*Trichogramma chilonis*): A biological control agent deployed to parasitize the eggs of the pest, thereby reducing larval emergence.
- Entomopathogenic fungus (*Beauveria bassiana*): Applied to suppress the larval population through pathogenic infection.

By analyzing the individual and combined effects of these tools under field conditions, the study aims to offer insights into their synergistic potential in reducing pest pressure and enhancing crop yield. The findings could contribute to developing region-specific, sustainable pest management protocols for sugarcane cultivation in Bihar.

MATERIALS & METHODS

Study Area and Experimental Design

The field experiment was carried out during the 2021-2022 sugarcane cropping season at the Experimental Farm affiliated with B.R. Ambedkar Bihar University, located in Samastipur district of Bihar, India (latitude: 25.86°N, longitude: 85.78°E). The site falls within the Indo-Gangetic plains and experiences a subtropical monsoonal climate, characterized by hot summers and moderate rainfall. During the study period, average daytime temperatures ranged from 25°C to 38°C, with relative humidity varying between 60% and 80%, conditions favorable for both sugarcane growth and pest development.

The soil at the experimental location was classified as loamy, possessing good water retention and aeration properties-ideal for sugarcane cultivation.[3] A Randomized Block Design (RBD) was employed to ensure statistical reliability and minimize experimental error. The trial consisted of five treatments replicated thrice, with each experimental plot measuring 5 meters × 4 meters. Uniform spacing of 90 cm between rows and 60 cm between plants was maintained across all plots to ensure consistency in plant density.

Treatment Protocols

Five treatment protocols were implemented to evaluate the effectiveness of biological and behavioral pest control measures against *Tryporiza nivella*. The treatments were as follows:

Table 1- Five Treatments with different pest control measures.

Treatment Code	Description
T1	Installation of pheromone traps (five traps per acre), placed at crop canopy height and regularly monitored and replaced every 30 days.
T2	Periodic release of the egg parasitoid *Trichogramma chilonis* at a rate of 50,000 individuals per hectare, initiated 30 days after planting and repeated every 15 days during the early growth stages.
T3	Foliar application of *Beauveria bassiana* fungal suspension (2×10^8 conidia/mL), sprayed using a knapsack sprayer with a spreader-sticker every 20 days, beginning 30 days after planting.
T4	Integrated application of T1 + T2 + T3, representing the complete IPM approach.
T5	Untreated control, where no pest management practices were employed.

All inputs were sourced from verified bio-agents suppliers and applied following recommended agronomic and safety guidelines.[4]

Data Collection

Data were systematically collected at different growth stages to assess pest incidence, infestation levels, and yield performance. The parameters studied included:

- **Dead Heart Incidence (%):** At 45 and 60 days after planting (DAP), 25 sugarcane plants were randomly selected from each plot. The number of plants showing "dead heart" symptoms was recorded, and incidence was calculated as a percentage of total plants observed.
- **Larval Population Density:** At 60 DAP, destructive sampling was performed on 10 randomly selected plants per plot. Plants were uprooted and dissected to count the number of *T. nivella* larvae present in the shoot or whorl.
- **Cane Yield (tons per hectare):** At harvest, the total weight of harvested canes from each plot was measured using a portable field scale. The

yield data were then extrapolated to estimate tons per hectare (t/ha) for each treatment.

Statistical Analysis

The data collected for all parameters were statistically analyzed using Analysis of Variance (ANOVA) to test for significant differences among treatments. The software OPSTAT, developed by the Department of Mathematics and Statistics, CCS Haryana Agricultural University, Hisar, was used for computation. Treatment means were separated using the Critical Difference (CD) test at a 5% probability level ($p \leq 0.05$) to determine the statistical significance of observed effects.[5]

RESULTS & DISCUSSION

Dead Heart Incidence

The "dead heart" symptom-caused by the larval boring activity of *Tryporiza nivella* in young sugarcane shoots-is a critical early indicator of crop damage and yield loss. The present study revealed significant variation in dead heart incidence across different treatments (Figure 1). The integrated pest management (IPM) treatment (T4), which combined pheromone traps, *Trichogramma chilonis,* and *Beauveria bassiana,* recorded the lowest incidence at 4.5%, demonstrating a statistically significant reduction ($p \leq 0.05$) when compared to all other treatments.

Table 2- Average Result on Treatment Effects on Dead Heart Incidence

Treatment	Dead Heart Incidence (%)
T1 (Pheromone traps)	12.3
T2 (*T. chilonis*)	9.9
T3 (*B. bassiana*)	11.1
T4 (Integrated approach)	4.5
T5 (Control)	18.7

The untreated control (T5) showed the highest incidence at 18.7%, confirming the vulnerability of unprotected crops to shoot borer infestation. Among individual components, *T. chilonis* (T2) was more effective than the mechanical (T1) and fungal (T3) methods, aligning with findings by Kaur *et al.* (2019)[6], who reported significant early-stage protection through egg parasitism. The superior performance of T4 indicates the synergistic effect of using multiple complementary pest control strategies in an IPM framework.[7]

Larval Population per Plant

Monitoring the larval population provided further insights into the effectiveness of different treatments. The integrated treatment (T4) again demonstrated the highest efficacy, recording only 0.5 larvae per plant, significantly lower than the other treatments.

Table 3- Different Treatments on Average Larvae per Plant.

Treatment	Average Larvae per Plant
T1 (Pheromone traps)	1.9
T2 (*T. chilonis*)	1.2
T3 (*B. bassiana*)	1.4
T4 (Integrated approach)	0.5
T5 (Control)	2.6

The reduction in larval population under T4 can be attributed to the multi-pronged suppression mechanism: pheromone traps reduce adult male populations, *T. chilonis* targets eggs before hatching, and *B. bassiana* infects and kills larvae. This integrated strategy disrupts multiple stages of the pest life cycle, reducing larval survival rates. Similar observations were made by Prasad *et al.* (2021)[8], who highlighted that combined biocontrol agents often result in higher pest suppression than when used in isolation.

Table 4- Different Treatments on Average Sugarcane Yield (tons/ha).

Treatment	Sugarcane Yield (tons/ha)
T1 (Pheromone traps)	66.3
T2 (*T. chilonis*)	68.1
T3 (*B. bassiana*)	67.4
T4 (Integrated approach)	76.8
T5 (Control)	59.2

Sugarcane Yield

Yield data further corroborated the efficacy of the pest control treatments. The highest yield was obtained under the IPM treatment (T4), recording 76.8 tons/ha, which represented a 29.7% increase compared to the untreated control (T5), which yielded only 59.2 tons/ha.

Moderate yield increases were observed in all individual treatments (T1, T2, T3), suggesting that even standalone IPM components can significantly enhance plant performance by reducing pest-induced stress. However, the integrated approach provided the greatest return, both in terms of pest suppression and yield enhancement. These findings support those of Singh *et al.* (2020)[9], who reported that comprehensive IPM practices not only reduce pesticide reliance but also lead to better crop vigor and enhanced productivity.

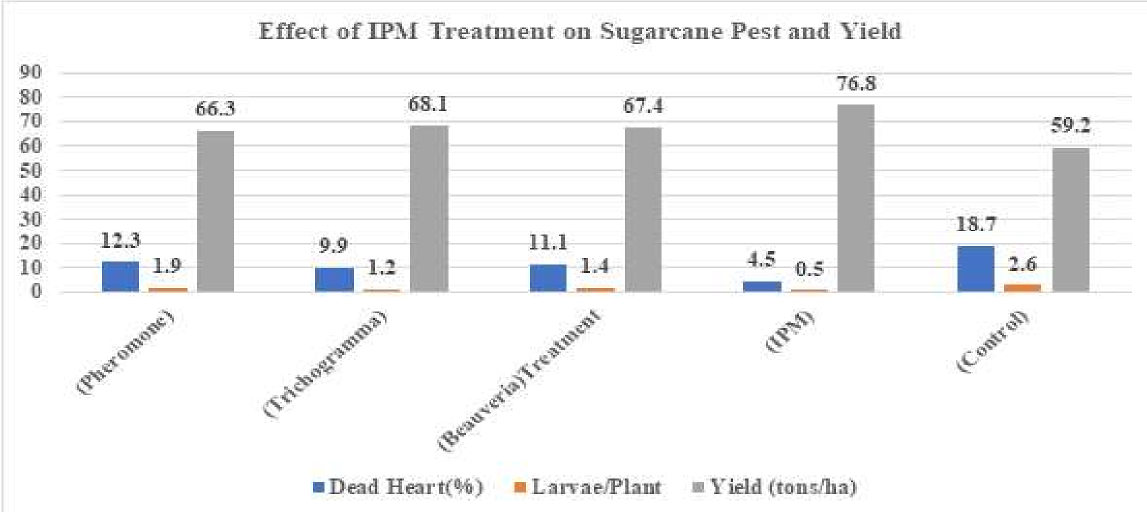

Figure 1- Effect of IPM Treatment on Sugarcane Pest and Yield

CONCLUSION

The study confirms that integrated pest management (IPM), using pheromone traps, *Trichogramma chilonis,* and *Beauveria bassiana,* is highly effective against *Tryporiza nivella* in sugarcane. The integrated strategy significantly reduced dead heart incidence by over 75% and larval population by 81%, while increasing cane yield by nearly 30%. These eco-friendly methods offer a sustainable alternative to chemical pesticides, promoting crop health and environmental safety. Adoption of such practices can enhance sugarcane productivity and sustainability in regions like Samastipur, Bihar.

ACKNOWLEDGEMENTS

The author expresses sincere gratitude to the Head of the Department of Zoology, B. R. Ambedkar Bihar University, Muzaffarpur, Bihar, for their invaluable support, guidance, and encouragement throughout the course of this research. Their insightful suggestions and consistent motivation played a crucial role in the successful completion of this work. The author is deeply thankful for the academic environment and research facilities provided by the department, which greatly contributed to the smooth execution of this study.

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