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# Evaluate the efficacy of insecticides against brown plant hopper

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**Abstract**
A field experiment was conducted to determine the efficacy insecticides against Brown plant hopper (BPH), *Nilaparvata lugens* (Stål), in rice during *kharif* 2022 and *kharif* 2023. at Agricultural Research Station Shirgaon Dist. Ratnagiri, under Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. Evaluation of different insecticides against BPH on rice indicated that all the treatments were found significantly superior in recording the minimum number of BPH over untreated control. Among all treatments, $T_3$ (Triflumezopyrim 10 SC), was found most effective against BPH which was found statistically at par with $T_8$ (Fipronil 15 + Flonicamid 15 WDG), followed by $T_4$ (Dinotefuran 20 SG), $T_6$ (Buprofezin 22 + Fipronil 3 SC), $T_7$ (Pymetrozine 50 WG), $T_1$ (Sulfoxaflor 21.8 SC), $T_2$ (Imidacloprid 6 + Lambda cyhalothrin 4 SL) and $T_5$ (Flonicamid 50 WG). Economics of all the treatments revealed that $T_6$-Buprofezin 22 + Fipronil 3 SC @ 1ml /lit emerged as the most economical one recording the highest ICBR 1:14.14 It was followed by, $T_4$- Dinotefuran 20 SG @ 0.3 gm/lit and $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL @ 0.6 ml /lit recording ICBR of 1:9.68 and 1:8.24, respectively.

**Keywords:** Brown plant hopper, insecticides, rice, cost-benefit-ratio, *kharif*, grain yield

## Introduction

Rice (*Oryza sativa* L.) belonging to the family Poaceae is one of the most crucial foodgrains in India and globally. Rice first originated in East Asia over 10,000 years ago, it was domesticated and widely grown throughout Asia, and later it was made known to the rest of the world. Rice is a staple food in many parts of Asia due to its ability to grow in various climates and soil types. India ranks $2^{nd}$ in production followed by China. India has the largest area of land under rice cultivation in the world. In India, the area occupied under rice cultivation is 413.15 lakh hectares with production of 1114.58 lakh tonne and productivity is 2698 kg/ha (MOA&FW, Govt. of India. 2023-24).

In Maharashtra, rice is cultivated over an area of 15.29 lakh hectares with a production of 34.97 lakh tonnes and productivity of 2287 kg/ha. (MOA&FW, Govt. of India. 2023-24). The average productivity of the Maharashtra state is low as compared to other rice-growing states *viz.*, West Bengal, Uttar Pradesh, Punjab, Odisha, Tamil Nadu, Haryana, Andhra Pradesh, etc. West Bengal is the highest rice-producing state in India.

In Konkan, rice is cultivated over an area of 3568.86 hundred hectares with a production of 9465.35 tons and productivity of around 2652.21 kg/ha. The area, production, and average productivity of the Konkan region are more as compared to Western Maharashtra, Marathwada, and Vidarbha. The Konkan region comprises five districts *viz.*, Palghar, Raigad, Thane, Ratnagiri and Sindhudurg. The area under rice cultivation in Raigad district is 960.40 hundred hectares with a production of 2542.23 hundred tonnes, which is the highest in the Konkan region and the productivity of the Konkan region is 2647.05 kg/ha. The area under rice cultivation in Ratnagiri district is 668.76 hundred hectares with a production of 2018.52 hundred tonnes and productivity is 3018.33 kg/ha which is the highest productivity in Konkan region. The area of rice cultivation in Sindhudurg district is 601.65 hundred hectares with a production of 1655.14 hundred tonnes and productivity is 2751.00 kg/ha the area under rice cultivation in Palghar district is 782.02 hundred hectares with a production of 1849.47 hundred tonnes and productivity is 2365.00 kg/ha.

Thane is supposed to be the lowest area of rice cultivation at 556.04 hundred hectares with production of 1399.99 hundred tonnes and productivity of 2517.80 kg/ha (Third Advance Estimate Govt. of Maharashtra 2023).

Rice is consumed regularly and is vital for the food security of over half the world's population. Rice production on a global scale is predicted to rise by 58 to 567 million tonnes (Mt) by 2030 (Mohidem *et al*., 2022) [10]. But this is not achievable through relying solely on traditional farming methods and there is an urgent need to adopt some techniques, such as monitoring major pests like brown plant hopper which allows farmers to implement timely control measures, reducing crop damage and improving rice yield,

## Materials and Methods

The field experiment was conducted at Agricultural Research Station Shirgaon Dist. Ratnagiri DBSKKV, Dapoli during *Kharif* 2022 and *Kharif* 2023 to study the efficacy of insecticides against brown plant hopper. The quantity of spray suspension required for each treatment was calibrated by spraying water over three plots of untreated control in the experiment prior to the application of insecticide. Spray suspension of the desired strength of each insecticide was prepared against a brown plant hopper.

The treatment wise insecticides were applied at ETL of brown plant hopper and the interval between two sprays was fifteen days.

The BPH population (nymphs and adults) was recorded in two phases i.e., a day before spray (DBS) and 1st, 3rd, 7th, 10th and 14th days after spraying (DAS). The observations were recorded at randomly selected 10 hills in each treatment field and there were three replications in each treatment. The total count of the BPH population was averaged and expressed on per hill basis.

The data on BPH infested rice were averaged. Then, observations on the population of BPH were transformed into $\sqrt{X + 0.5}$ values and percent infestation obtained was converted into arcsine transformation subjected to analysis of variance.

## Results

### Pooled data of first spray (*Kharif* 2022 and *Kharif* 2023)

The pooled data pertaining to the efficacy of different insecticides against the BPH population on the rice during both the years one day before first spraying and 1,3, 7, 10 and 14 days after each spray are presented in (Table 1) and depicted in Fig. 1.

### First spray

#### One day before spraying (Pre-count)

The data revealed that the BPH population one day before first spraying ranged from 6.84 to 8.09 per hill and it was statistically non-significant.

#### One day after spraying (1DAS)

The data on one day after spraying indicated that a significant difference was found among the different treatments. All the treatments recorded a significantly lower population of BPH than the untreated control. The minimum population of BPH was observed in $T_3$- Triflumezopyrim 10 SC (3.66/hill), which was found statistically at par with $T_8$- Fipronil 15 + Flonicamid 15 WDG (4.13/hill). Next best treatment was observed to be $T_4$- Dinotefuran 20 SG (4.54/hill), it was followed by $T_6$- Buprofezin 22 + Fipronil 3 SC (5.29/hill), $T_7$- Pymetrozine 50 WG (5.59/hill), $T_1$- Sulfoxaflor 21.8 SC (6.29/hill), $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL (6.61/hill) and $T_5$- Flonicamid 50 WG (6.64/hill). The maximum population of BPH was observed in $T_9$- untreated control (10.72/hill).

#### Three days after spraying (3DAS)

The data on three days after spraying indicated that a significant difference was found among the different treatments. All the treatments recorded a significantly lower population of BPH than the untreated control. The minimum population of BPH was observed in $T_3$- Triflumezopyrim 10 SC (2.34/hill), which was found statistically at par with $T_8$- Fipronil 15 + Flonicamid 15 WDG (2.70/hill). Next best treatment was observed to be $T_4$- Dinotefuran 20 SG (3.00/hill), which was found statistically at par with $T_6$- Buprofezin 22 + Fipronil 3 SC (3.51/hill). It was followed by $T_7$- Pymetrozine 50 WG (4.43/hill), $T_1$- Sulfoxaflor 21.8 SC (5.27/hill), $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL (5.85/hill) and $T_5$- Flonicamid 50 WG (6.01/hill). The maximum population of BPH was observed in $T_9$- untreated control (12.72/hill).

#### Seven days after spraying (7DAS)

The data on seven days after spraying indicated that a significant difference was found among the different treatments. All the treatments recorded a significantly lower population of BPH than the untreated control. The minimum population of BPH was observed in $T_3$- Triflumezopyrim 10 SC (0.91/hill), which was found statistically at par with $T_8$- Fipronil 15 + Flonicamid 15 WDG (1.13/hill). Next best treatment was observed to be $T_4$- Dinotefuran 20 SG (1.61/hill) which was found statistically at par with $T_7$- Pymetrozine 50 WG (1.90/hill), $T_6$- Buprofezin 22 + Fipronil 3 SC (1.93/hill) and $T_1$- Sulfoxaflor 21.8 SC (2.16/hill). It was followed by, $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL (2.56/hill) and $T_5$- Flonicamid 50 WG (2.73/hill). The maximum population of BPH was observed in $T_9$- untreated control (13.84/hill).

#### Ten days after spraying (10DAS)

The data on ten days after spraying showed that the BPH population gradually increased in all the treatments. The population of BPH ranged from 1.06 to 15.56 per hill, significantdifference was found among the different treatments. All the treatments recorded a significantly lower population of BPH than the untreated control. The minimum population of BPH was observed in $T_3$- Triflumezopyrim 10 SC (1.06/hill) which was found statistically at par with $T_8$- Fipronil 15 + Flonicamid 15 WDG (1.37/hill). Next best treatment was observed to be $T_4$- Dinotefuran 20 SG (1.82/hill), which was found statistically at par with $T_6$- Buprofezin 22 + Fipronil 3 SC (2.11/hill) and $T_7$- Pymetrozine 50 WG (2.33/hill). It was followed by, $T_1$- Sulfoxaflor 21.8 SC (2.48/hill), $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL (2.78/hill) and $T_5$- Flonicamid 50 WG (2.94/hill). The maximum population of BPH was observed in $T_9$- untreated control (15.56/hill).

#### Fourteen days after spraying (14DAS)

The data on Fourteen days after spraying showed that BPH population gradually increased in all the treatments. The population of BPH ranged from 1.17 to 18.49 per hill, significant difference was found among the different treatments. All the treatments recorded a significantly lower population of BPH than the untreated control. The minimum population of BPH was observed in $T_3$- Triflumezopyrim 10 SC (1.17/hill), which was found statistically at par with $T_8$- Fipronil 15 + Flonicamid 15 WDG (1.59/hill). Next best treatment was observed to be $T_4$- Dinotefuran 20 SG (2.04/hill) which was found statistically at par with $T_6$- Buprofezin 22 + Fipronil 3 SC (2.39/hill) and $T_7$- Pymetrozine 50 WG (2.41/hill), and $T_1$- Sulfoxaflor 21.8 SC (2.59/hill). It was followed by $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL (2.84/hill) and $T_5$- Flonicamid 50 WG (3.06/hill). The maximum population of BPH was observed in $T_9$- untreated control (18.49/hill).

**Overall mean of first spray**

The data on the overall mean of the first spray revealed that a significant difference was found among the different treatments. All the treatments recorded a significantly lower population of BPH than the untreated control. The minimum population of BPH was observed in $T_3$- Triflumezopyrim 10 SC (1.83/hill), which was found statistically at par with $T_8$- Fipronil 15 + Flonicamid 15 WDG (2.18/hill). Next best treatment was observed $T_4$- Dinotefuran 20 SG (2.60/hill) which was found statistically at par with $T_6$- Buprofezin 22 + Fipronil 3 SC (3.05/hill). It was followed by, $T_7$- Pymetrozine 50 WG (3.33/hill), $T_1$- Sulfoxaflor 21.8 SC (3.76/hill), $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL (4.13/hill) and $T_5$- Flonicamid 50 WG (4.27/hill). The maximum population of BPH was observed in $T_9$- Untreated control (14.26/hill).

The ascending order of BPH population was $T_3$ (Triflumezopyrim 10 SC), $T_8$ (Fipronil 15 + Flonicamid 15 WDG), $T_4$ (Dinotefuran 20 SG), $T_6$ (Buprofezin 22 + Fipronil 3 SC), $T_7$ (Pymetrozine 50 WG), $T_1$ (Sulfoxaflor 21.8 SC), $T_2$ (Imidacloprid 6 + Lambda cyhalothrin 4 SL), $T_5$ (Flonicamid 50 WG) and $T_9$ (untreated control).

**Per cent reduction over untreated control**

The data revealed that highest per cent reduction of BPH population over untreated control was observed in $T_3$- Triflumezopyrim 10 SC (87.18) followed by $T_8$- Fipronil 15 + Flonicamid 15 WDG (84.70), $T_4$- Dinotefuran 20 SG (81.75), $T_6$- Buprofezin 22 + Fipronil 3 SC (78.64), $T_7$- Pymetrozine 50 WG (76.64), $T_1$- Sulfoxaflor 21.8 SC (73.65) $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL (71.05) and $T_5$- Flonicamid 50 WG (70.04).

**Table 1:** Efficacy of insecticides against brown plant hopper infesting rice (pooled data *Kharif* 2022, *Kharif* 2023)

| Tr. No. | Insecticide Name and dose/lit | Mean population/ hill | | | | | | Overall Mean | Per cent reduction over untreated control |
|---|---|---|---|---|---|---|---|---|---|
| | | First Spray | | | | | | | |
| | | Pre count | 1DAS | 3DAS | 7DAS | 10DAS | 14DAS | | |
| $T_1$ | Sulfoxaflor 21.8 SC @ 0.75 ml | 7.92 (2.90) | 6.29 (2.60) | 5.27 (2.40) | 2.16 (1.62) | 2.48 (1.72) | 2.59 (1.75) | 3.76 (2.06) | 73.65 |
| $T_2$ | Imidacloprid 6 + Lambda cyhalothrin 4 SL @ 0.6 ml | 7.82 (2.88) | 6.61 (2.66) | 5.85 (2.52) | 2.56 (1.74) | 2.78 (1.81) | 2.84 (1.82) | 4.13 (2.15) | 71.05 |
| $T_3$ | Triflumezopyrim 10 SC @ 0.5 ml | 6.97 (2.73) | 3.66 (2.04) | 2.34 (1.68) | 0.91 (1.17) | 1.06 (1.24) | 1.17 (1.28) | 1.83 (1.52) | 87.18 |
| $T_4$ | Dinotefuran 20 SG @ 0.3 gm | 7.12 (2.76) | 4.54 (2.25) | 3.00 (1.87) | 1.61 (1.45) | 1.82 (1.52) | 2.04 (1.59) | 2.60 (1.76) | 81.75 |
| $T_5$ | Flonicamid 50 WG @ 0.3 gm | 8.09 (2.93) | 6.64 (2.67) | 6.01 (2.55) | 2.73 (1.80) | 2.94 (1.85) | 3.06 (1.89) | 4.27 (2.18) | 70.04 |
| $T_6$ | Buprofezin 22 + Fipronil 3 SC @ 1ml | 6.84 (2.71) | 5.29 (2.41) | 3.51 (2.00) | 1.93 (1.56) | 2.11 (1.62) | 2.39 (1.70) | 3.05 (1.88) | 78.64 |
| $T_7$ | Pymetrozine 50 WG @ 0.6 gm | 7.44 (2.82) | 5.59 (2.47) | 4.43 (2.22) | 1.90 (1.55) | 2.33 (1.68) | 2.41 (1.71) | 3.33 (1.96) | 76.64 |
| $T_8$ | Fipronil 15 + Flonicamid 15 WDG @ 0.8 gm | 7.02 (2.74) | 4.13 (2.15) | 2.70 (1.79) | 1.13 (1.28) | 1.37 (1.37) | 1.59 (1.44) | 2.18 (1.64) | 84.70 |
| $T_9$ | Control | 7.72 (2.87) | 10.72 (3.35) | 12.72 (3.63) | 13.84 (3.79) | 15.56 (4.01) | 18.49 (4.36) | 14.26 (3.84) | - |
| SE | | 0.05 | 0.05 | 0.05 | 0.06 | 0.06 | 0.07 | 0.05 | - |
| CD at 5% | | NS | 0.15 | 0.14 | 0.19 | 0.17 | 0.20 | 0.16 | - |

*Figures in the parentheses are square root ($\sqrt{X + 0.5}$) transformed values DAS- Days After Spraying

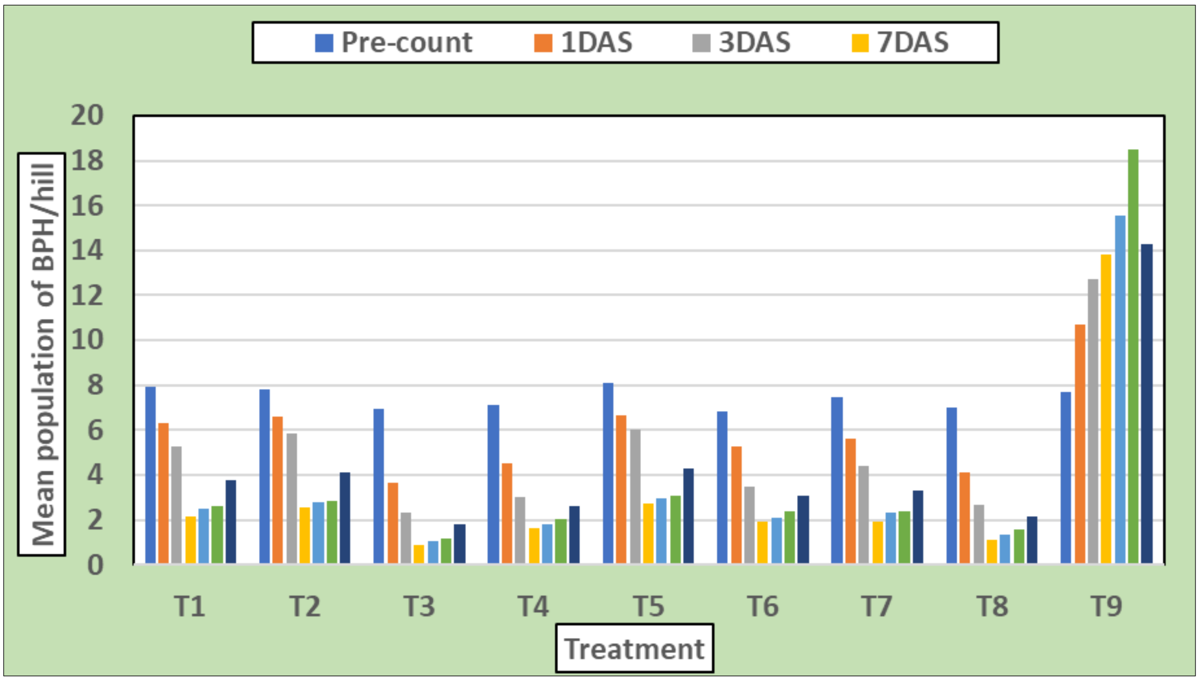


**Fig 1:** Efficacy of insecticides against brown plant hopper infesting rice (pooled data *Kharif* 2022, *Kharif* 2023) (First spray)

**Pooled data of Second spray (*Kharif* 2022 and *Kharif* 2023)**

The pooled data pertaining to the efficacy of different insecticides against the BPH population on the rice during both the years one day before first spraying and 1,3, 7, 10 and 14 days after each spray are presented in (Table 2) and depicted in Fig. 2.

**Second spray**

**One day after spraying (1DAS)**

The data on one day after spraying indicated that a significant difference was found among the different treatments. All the treatments recorded a significantly lower population of BPH than the untreated control. The minimum population of BPH was observed in $T_3$- Triflumezopyrim 10 SC (0.94/hill), which was found significantly superior treatment than others. The next best treatment was observed to be $T_8$- Fipronil 15 + Flonicamid 15 WDG (1.28/hill), which was found statistically at par with $T_4$- Dinotefuran 20 SG (1.64/hill). It was followed by, $T_6$- Buprofezin 22 + Fipronil 3 SC (2.06/hill), $T_7$- Pymetrozine 50 WG (2.57/hill), $T_1$- Sulfoxaflor 21.8 SC (2.93/hill), $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL (3.32/hill) and $T_5$- Flonicamid 50 WG (3.90/hill). The maximum population of BPH was observed in $T_9$- untreated control (20.94/hill). (Table 21)

**Three days after spraying (3DAS)**

The data on three days after spraying indicated that a significant difference was found among the different treatments. All the treatments recorded a significantly lower population of BPH than the untreated control. The minimum population of BPH was observed in $T_3$- Triflumezopyrim 10 SC (0.55/hill), which was found statistically at par with $T_8$- Fipronil 15 + Flonicamid 15 WDG (0.73/hill). Next best treatment was observed to be $T_4$- Dinotefuran 20 SG (1.13/hill) which was found statistically at par with $T_6$- Buprofezin 22 + Fipronil 3 SC (1.64/hill). It was followed by, $T_7$- Pymetrozine 50 WG (2.08/hill), $T_1$- Sulfoxaflor 21.8 SC (2.37/hill), $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL (2.74/hill) and $T_5$- Flonicamid 50 WG (3.24/hill). The maximum population of BPH was observed in $T_9$- untreated control (17.21/hill).

**Seven days after spraying (7DAS)**

The data on seven days after spraying indicated that a significant difference was found among the different treatments. All the treatments recorded a significantly lower population of BPH than the untreated control. The minimum population of BPH was observed in $T_3$- Triflumezopyrim 10 SC (0.00/hill), which was found statistically at par with $T_8$- Fipronil 15 + Flonicamid 15 WDG (0.00/hill). Next best treatment was observed to be $T_4$- Dinotefuran 20 SG (0.32/hill) which was found statistically at par with $T_6$- Buprofezin 22 + Fipronil 3 SC (0.51/hill). It was followed by, $T_7$- Pymetrozine 50 WG (0.82/hill), and $T_1$- Sulfoxaflor 21.8 SC (1.45/hill), $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL (1.69/hill) and $T_5$- Flonicamid 50 WG (2.16/hill). The maximum population of BPH was observed in $T_9$- untreated control (13.58/hill).

**Ten days after spraying (10DAS)**

The data on ten days after spraying showed that a significant difference was found among the different treatments. All the treatments recorded a significantly lower population of BPH than the untreated control. The minimum population of BPH was observed in $T_3$- Triflumezopyrim 10 SC (0.00/hill), which was found statistically at par with $T_8$- Fipronil 15 + Flonicamid 15 WDG (0.00/hill). Next best treatment was observed to be $T_4$- Dinotefuran 20 SG (0.07/hill). It was followed by, $T_6$- Buprofezin 22 + Fipronil 3 SC (0.39/hill) and $T_7$- Pymetrozine 50 WG (0.49/hill), $T_1$- Sulfoxaflor 21.8 SC (0.77/hill), $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL (1.14/hill) and $T_5$- Flonicamid 50 WG (1.38/hill). The maximum population of BPH was observed in $T_9$- untreated control (11.91/hill).

**Fourteen days after spraying (14DAS)**

The data on Fourteen days after spraying showed that a significant difference was found among the different treatments. All the treatments recorded a significantly lower population of BPH than the untreated control. The minimum population of BPH was observed in $T_3$- Triflumezopyrim 10 SC (0.00/hill) which was found statistically at par with $T_8$- Fipronil 15 + Flonicamid 15 WDG (0.00/hill) and $T_4$- Dinotefuran 20 SG (0.17/hill). Next best treatment was observed to be $T_6$- Buprofezin 22 + Fipronil 3 SC (0.73/hill), it was followed by $T_7$- Pymetrozine 50 WG (1.27/hill), $T_1$- Sulfoxaflor 21.8 SC (1.62/hill), $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL (2.14/hill) and $T_5$- Flonicamid 50 WG (2.69/hill). The maximum population of BPH was observed in $T_9$- untreated control (9.01/hill).

**Overall mean of the second spray**

The data on the overall mean of the second spray revealed that a significant difference was found among the different treatments. All the treatments recorded a significantly lower population of BPH than the untreated control. The minimum population of BPH was observed in $T_3$- Triflumezopyrim 10 SC (0.30/hill), which was found statistically at par with $T_8$- Fipronil 15 + Flonicamid 15 WDG (0.40/hill). Next best treatment was observed $T_4$- Dinotefuran 20 SG (0.66/hill) It was followed by, $T_6$- Buprofezin 22 + Fipronil 3 SC (1.07/hill) $T_7$- Pymetrozine 50 WG (1.45/hill), $T_1$- Sulfoxaflor 21.8 SC (1.83/hill), $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL (2.21/hill) and $T_5$- Flonicamid 50 WG (2.68/hill). The maximum population of BPH was observed in $T_9$- Untreated control (14.53/hill).

The ascending order of BPH population was $T_3$ (Triflumezopyrim 10 SC), $T_8$ (Fipronil 15 + Flonicamid 15 WDG), $T_4$ (Dinotefuran 20 SG), $T_6$(Buprofezin 22 + Fipronil 3 SC), $T_7$ (Pymetrozine 50 WG), $T_1$ (Sulfoxaflor 21.8 SC), $T_2$ (Imidacloprid 6 + Lambda cyhalothrin 4 SL), $T_5$ (Flonicamid 50 WG) and $T_9$ (untreated control).

**Per cent reduction over untreated control**

The data revealed that highest per cent reduction of BPH population over untreated control was observed in $T_3$- Triflumezopyrim 10 SC (97.96) followed by $T_8$- Fipronil 15 + Flonicamid 15 WDG (97.23), $T_4$- Dinotefuran 20 SG (95.43), $T_6$- Buprofezin 22 + Fipronil 3 SC (92.65), $T_7$- Pymetrozine 50 WG (90.04), $T_1$- Sulfoxaflor 21.8 SC (87.42) $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL (84.81) and $T_5$- Flonicamid 50 WG (81.59).

**Table 2:** Efficacy of insecticides against brown plant hopper infesting rice (pooled data *Kharif* 2022, *Kharif* 2023)

| Tr. No. | Insecticide Name and dose/lit | Mean population/ hill Second Spray | | | | | Overall Mean | Per cent reduction over untreated control |
|---|---|---|---|---|---|---|---|---|
| | | 1DAS | 3DAS | 7DAS | 10DAS | 14DAS | | |
| $T_1$ | Sulfoxaflor 21.8 SC @ 0.75 ml | 2.93 (1.85) | 2.37 (1.69) | 1.45 (1.39) | 0.77 (1.11) | 1.62 (1.45) | 1.83 (1.52) | 87.42 |
| $T_2$ | Imidacloprid 6 + Lambda cyhalothrin 4 SL @ 0.6 ml | 3.32 (1.95) | 2.74 (1.79) | 1.69 (1.47) | 1.14 (1.27) | 2.14 (1.62) | 2.21 (1.64) | 84.81 |
| $T_3$ | Triflumezopyrim 10 SC @ 0.5 ml | 0.94 (1.19) | 0.55 (1.00) | 0.00 (0.71) | 0.00 (0.71) | 0.00 (0.71) | 0.30 (0.89) | 97.96 |
| $T_4$ | Dinotefuran 20 SG @ 0.3 gm | 1.64 (1.46) | 1.13 (1.27) | 0.32 (0.91) | 0.07 (0.75) | 0.17 (0.82) | 0.66 (1.08) | 95.43 |
| $T_5$ | Flonicamid 50 WG @ 0.3 gm | 3.90 (2.10) | 3.24 (1.93) | 2.16 (1.63) | 1.38 (1.37) | 2.69 (1.79) | 2.68 (1.78) | 81.59 |
| $T_6$ | Buprofezin 22 + Fipronil 3 SC @ 1ml | 2.06 (1.60) | 1.64 (1.45) | 0.51 (0.99) | 0.39 (0.94) | 0.73 (1.10) | 1.07 (1.25) | 92.65 |
| $T_7$ | Pymetrozine 50 WG @ 0.6 gm | 2.57 (1.75) | 2.08 (1.60) | 0.82 (1.14) | 0.49 (0.99) | 1.27 (1.32) | 1.45 (1.39) | 90.04 |
| $T_8$ | Fipronil 15 + Flonicamid 15 WDG @ 0.8 gm | 1.28 (1.33) | 0.73 (1.09) | 0.00 (0.71) | 0.00 (0.71) | 0.00 (0.71) | 0.40 (0.95) | 97.23 |
| $T_9$ | Control | 20.94 (4.63) | 17.21 (4.21) | 13.58 (3.75) | 11.91 (3.52) | 9.01 (3.08) | 14.53 (3.88) | - |
| SE | | 0.04 | 0.06 | 0.05 | 0.06 | 0.05 | 0.04 | - |
| CD at 5% | | 0.13 | 0.19 | 0.16 | 0.17 | 0.14 | 0.13 | - |

*Figures in the parentheses are square root ($\sqrt{X + 0.5}$) transformed values DAS- Days After Spraying

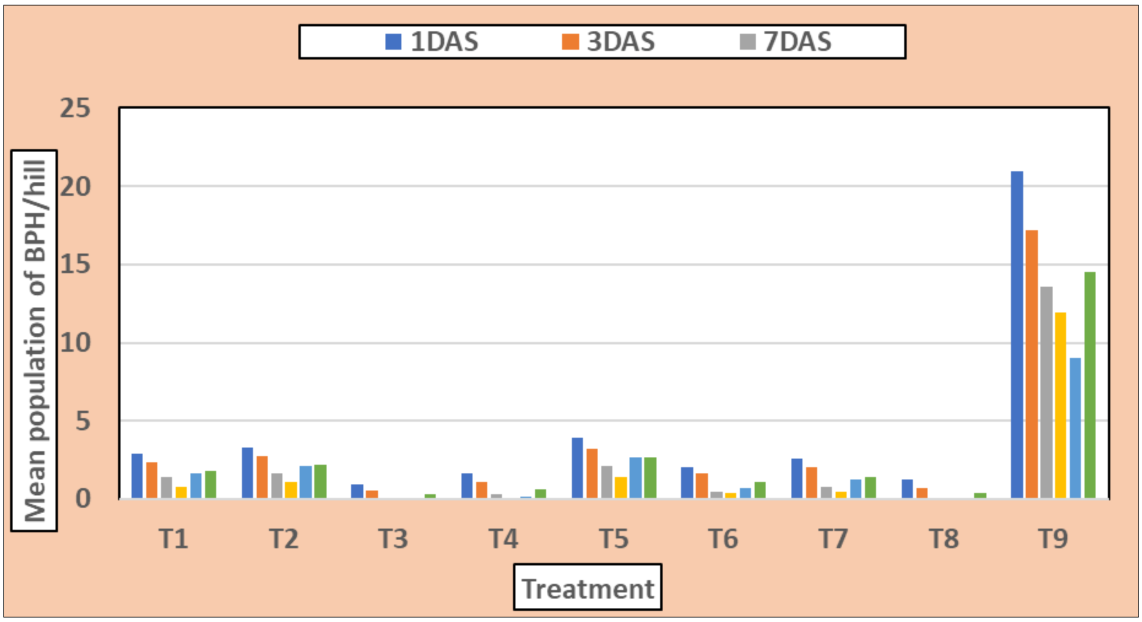


**Fig 2:** Efficacy of insecticides against brown plant hopper infesting rice (pooled data *Kharif* 2022, *Kharif* 2023) (Second spray)

**Effect of different insecticide treatments on the yield of rice**

The data on the yield of rice due to the effect of different insecticide treatments were recorded during *Kharif* 2022, *Kharif* 2023 and pooled data are presented in (Table 3)

The data revealed that during *Kharif* 2022 the higher marketable grain yield of rice was recorded in the treatment $T_3$- Triflumezopyrim 10 SC @ 0.5 ml /lit (57.48 qt/ha) and it was at par with treatments $T_8$- Fipronil 15 + Flonicamid 15 WDG @ 0.8 gm /lit, which was recorded marketable grain yield 55.46 qt/ha. Next best treatment observed was $T_4$- Dinotefuran 20 SG @ 0.3 gm/lit (51.47 qt/ha) and it was at par with treatments $T_6$- Buprofezin 22 + Fipronil 3 SC @ 1ml /lit and $T_7$- Pymetrozine 50 WG @ 0.6 gm /lit, which were recorded marketable grain yield 51.40 and 49.48 qt/ha, respectively. Rest of the treatments *viz*., $T_1$- Sulfoxaflor 21.8 SC @ 0.75 ml /lit, $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL @ 0.6 ml /lit and $T_5$- Flonicamid 50 WG @ 0.3 gm/lit which were recorded marketable grain yield 46.23, 43.65 and 43.08 qt/ha, respectively. The lower marketable fruit yield of rice (29.21 qt/ha) was recorded in $T_9$- (untreated control).

During *Kharif* 2023 the higher marketable grain yield of rice was recorded in the treatment $T_3$- Triflumezopyrim 10 SC @ 0.5 ml /lit (58.41 qt/ha), which was found significantly superior treatment than others Next best treatment was $T_8$- Fipronil 15 + Flonicamid 15 WDG @ 0.8 gm /lit, which was recorded marketable grain yield 55.52 qt/ha. It was followed by, $T_4$- Dinotefuran 20 SG @ 0.3 gm/lit, $T_6$- Buprofezin 22 + Fipronil 3 SC @ 1ml /lit, $T_7$- Pymetrozine 50 WG @ 0.6 gm /lit, $T_1$- Sulfoxaflor 21.8 SC @ 0.75 ml/lit, $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL @ 0.6 ml /lit and $T_5$- Flonicamid 50 WG @ 0.3 gm/lit, which were recorded marketable grain yield 52.42, 52.30, 50.55, 47.15, 44.35 and 42.13 qt/ha, respectively. The lower marketable fruit yield of rice (30.31 qt/ha) was recorded in $T_9$- (untreated control).

The pooled data analysis of both years revealed that a higher marketable grain yield of rice was recorded in the treatment $T_3$- Triflumezopyrim 10 SC @ 0.5 ml /lit (57.95 qt/ha), which was found significantly superior treatment than others Next best treatment was $T_8$- Fipronil 15 + Flonicamid 15 WDG @ 0.8 gm /lit which was recorded marketable grain yield 55.49 qt/ha. It was followed by, $T_4$- Dinotefuran 20 SG @ 0.3 gm/lit, $T_6$- Buprofezin 22 + Fipronil 3 SC @ 1ml /lit, $T_7$- Pymetrozine 50 WG @ 0.6 gm, $T_1$- Sulfoxaflor 21.8 SC @ 0.75 ml/lit, $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL @ 0.6 ml /lit and $T_5$- Flonicamid 50 WG @ 0.3 gm/lit, which was recorded marketable grain yield 51.95, 51.85, 50.02, 46.69, 44.00 and 42.61 qt/ha, respectively. The lower marketable fruit yield of rice (29.76 qt/ha) was recorded in $T_9$- (untreated control).

**Table 3:** Effect of different insecticide treatments on rice yield during (*Kharif* 2022, *Kharif* 2023 and Mean)

| Sr. No. | Treatment | Yield (qt/ha) | | |
|---|---|---|---|---|
| | | 2022 | 2023 | Mean |
| $T_1$ | Sulfoxaflor 21.8 SC | 46.23 | 47.15 | 46.69 |
| $T_2$ | Imidacloprid 6 + Lambda cyhalothrin 4 SL | 43.65 | 44.35 | 44.00 |
| $T_3$ | Triflumezopyrim 10 SC | 57.48 | 58.41 | 57.95 |
| $T_4$ | Dinotefuran 20 SG | 51.47 | 52.42 | 51.95 |
| $T_5$ | Flonicamid 50 WG | 43.08 | 42.13 | 42.61 |
| $T_6$ | Buprofezin 22 + Fipronil 3 SC | 51.40 | 52.30 | 51.85 |
| $T_7$ | Pymetrozine 50 WG | 49.48 | 50.55 | 50.02 |
| $T_8$ | Fipronil 15 + Flonicamid 15 WDG | 55.46 | 55.52 | 55.49 |
| $T_9$ | Control | 29.21 | 30.31 | 29.76 |
| | SE | 0.89 | 0.73 | 0.52 |
| | CD at 5% | 2.67 | 2.19 | 1.57 |

**Incremental cost-benefit ratio (ICBR)**

Considering the cost of inputs for different treatments and the corresponding yield from the treatments, the incremental cost-benefit ratio (ICBR) of all treatments was worked out at prevailing market rates and the data is presented in (Table 4). The data revealed that the treatment $T_6$- Buprofezin 22 + Fipronil 3 SC @ 1ml /lit emerged as the most economical one recording the highest ICBR 1:14.14. It was followed by, $T_4$- Dinotefuran 20 SG @ 0.3 gm/lit and $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL @ 0.6 ml /lit recording ICBR of 1:9.68 and 1:8.24, respectively. Next economic treatments were $T_8$- Fipronil 15 + Flonicamid 15 WDG @ 0.8 gm/lit, $T_7$- Pymetrozine 50 WG @ 0.6 gm/lit, $T_3$- Triflumezopyrim 10 SC @ 0.5 ml /lit $T_1$- Sulfoxaflor 21.8 SC @ 0.75 ml /lit and $T_5$- Flonicamid 50 WG @ 0.3 gm/lit which recorded ICBR 1:7.26, 1:4.74, 1:4.43, 1:4.03 and 3.77, respectively.

**Table 4:** Yield and incremental cost-benefit ratio for different insecticide treatments (Mean of *Kharif* 2022, *Kharif* 2023)

| Tr. No. | Treatments | Price of product (Rs. /lit or kg) | Qty. of Insecticide req./ha for two spray | Cost of treatment (Rs/ha) for two spray | | Total cost (A) | Yield qt/ha | Increased yield over control (qt/ha) | Value of increased yield (Rs/ha) (B) | Increment benefit (C)= (B-A) | ICBR (C/A) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Insecticides | Labour + Sprayer charges | | | | | | |
| $T_1$ | Sulfoxaflor 21.8 SC | 7353 | 750 | 5515 | 1836 | 7351 | 46.69 | 16.93 | 36958.19 | 29607.19 | 4.03 |
| $T_2$ | Imidacloprid 6 + Lambda cyhalothrin 4 SL | 2550 | 600 | 1530 | 1836 | 3366 | 44.00 | 14.24 | 31085.92 | 27719.92 | 8.24 |
| $T_3$ | Triflumezopyrim10 SC | 19000 | 500 | 9500 | 1836 | 11336 | 57.95 | 28.19 | 61538.77 | 50202.77 | 4.43 |
| $T_4$ | Dinotefuran 20 SG | 9000 | 300 | 2700 | 1836 | 4536 | 51.95 | 22.19 | 48440.77 | 43904.77 | 9.68 |
| $T_5$ | Flonicamid 50 WG | 13500 | 300 | 4050 | 1836 | 5886 | 42.61 | 12.85 | 28051.55 | 22165.55 | 3.77 |
| $T_6$ | Buprofezin 22 + Fipronil 3 SC | 1350 | 1000 | 1350 | 1836 | 3186 | 51.85 | 22.09 | 48222.47 | 45036.47 | 14.14 |
| $T_7$ | Pymetrozine 50 WG | 9791 | 600 | 5875 | 1836 | 7711 | 50.02 | 20.26 | 44227.58 | 36516.58 | 4.74 |
| $T_8$ | Fipronil 15 + Flonicamid 15 WDG | 6200 | 800 | 4960 | 1836 | 6796 | 55.49 | 25.73 | 56168.59 | 49372.59 | 7.26 |
| $T_9$ | Untreated Control | - | - | - | - | 0 | 29.76 | - | - | - | - |

Market value of Rice- Rs.2183/qt Labour charges-Rs.409/day (2 labours required for 1 ha spraying) Sprayer charges-100/spray

**Discussion**

**Pooled data of the first spray (*Kharif* 2022 and *Kharif* 2023)**

**Overall mean of first spray**

The data on the overall mean of the first spray revealed that a significant difference was found among the different treatments. All the treatments recorded a significantly lower population of BPH than the untreated control. The minimum population of BPH was observed in $T_3$- Triflumezopyrim 10 SC (1.83/hill), which was found statistically at par with $T_8$- Fipronil 15 + Flonicamid 15 WDG (2.18/hill). Next best treatment was observed in $T_4$- Dinotefuran 20 SG (2.60/hill) which was found statistically at par with $T_6$- Buprofezin 22 + Fipronil 3 SC (3.05/hill). It was followed by, $T_7$- Pymetrozine 50 WG (3.33/hill), $T_1$- Sulfoxaflor 21.8 SC (3.76/hill), $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL (4.13/hill) and $T_5$- Flonicamid 50 WG (4.27/hill). The maximum population of BPH was observed in $T_9$- Untreated control (14.26/hill).

The ascending order of BPH population was $T_3$ (Triflumezopyrim 10 SC), $T_8$ (Fipronil 15 + Flonicamid 15 WDG), $T_4$ (Dinotefuran 20 SG), $T_6$ (Buprofezin 22 + Fipronil 3 SC), $T_7$ (Pymetrozine 50 WG), $T_1$ (Sulfoxaflor 21.8 SC), $T_2$ (Imidacloprid 6 + Lambda cyhalothrin 4 SL), $T_5$ (Flonicamid 50 WG) and $T_9$ (untreated control).

**5.2 Per cent reduction over untreated control**

The data revealed that, highest per cent reduction of BPH population over untreated control was observed in $T_3$- Triflumezopyrim 10 SC (87.18) followed by $T_8$- Fipronil 15 + Flonicamid 15 WDG (84.70), $T_4$- Dinotefuran 20 SG (81.75), $T_6$- Buprofezin 22 + Fipronil 3 SC (78.64), $T_7$- Pymetrozine 50 WG (76.64), $T_1$- Sulfoxaflor 21.8 SC (73.65) $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL (71.05) and $T_5$- Flonicamid 50 WG (70.04).

**Pooled data of the second spray (*Kharif* 2022 and *Kharif* 2023)**

**Overall mean of second spray**

The data on the overall mean of the second spray revealed that a significant difference was found among the different treatments. All the treatments recorded a significantly lower population of BPH than the untreated control. The minimum population of BPH was observed in $T_3$- Triflumezopyrim 10 SC (0.30/hill), which was found statistically at par with $T_8$- Fipronil 15 + Flonicamid 15 WDG (0.40/hill). Next best treatment was observed $T_4$- Dinotefuran 20 SG (0.66/hill) It was followed by, $T_6$- Buprofezin 22 + Fipronil 3 SC (1.07/hill) $T_7$- Pymetrozine 50 WG (1.45/hill), $T_1$- Sulfoxaflor 21.8 SC (1.83/hill), $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL (2.21/hill) and $T_5$-

Flonicamid 50 WG (2.68/hill). The maximum population of BPH was observed in $T_9$- Untreated control (14.53/hill).
The ascending order of BPH population was $T_3$ (Triflumezopyrim 10 SC), $T_8$ (Fipronil 15 + Flonicamid 15 WDG), $T_4$ (Dinotefuran 20 SG), $T_6$ (Buprofezin 22 + Fipronil 3 SC), $T_7$ (Pymetrozine 50 WG), $T_1$ (Sulfoxaflor 21.8 SC), $T_2$ (Imidacloprid 6 + Lambda cyhalothrin 4 SL), $T_5$ (Flonicamid 50 WG) and $T_9$ (untreated control).

**Per cent reduction over untreated control**
The data revealed that highest per cent reduction of BPH population over untreated control was observed in $T_3$- Triflumezopyrim 10 SC (97.96), followed by $T_8$- Fipronil 15 + Flonicamid 15 WDG (97.23), $T_4$- Dinotefuran 20 SG (95.43), $T_6$- Buprofezin 22 + Fipronil 3 SC (92.65), $T_7$- Pymetrozine 50 WG (90.04), $T_1$- Sulfoxaflor 21.8 SC (87.42) $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL (84.81) and $T_5$- Flonicamid 50 WG (81.59).
The present findings are in close agreement with earlier research workers. Kumar *et al.,* (2017) [7] revealed that Treatment Triflumezopyrim 10.6 SC @ 237 ml/ ha recorded significantly lower number of BPH population (2.23 hoppers/hill), which was followed by Dinotefuran 20% SG @ 200 g/ ha, Pymetrozine 50 WG @ 400 g/ ha and Ethiprole + Imidacloprid 80 WG @ 150 g/ ha, Buprofezin 15 + Acephate 35 WP @ 500 g/ ha, Acephate 50 + Imidacloprid 1.8 WG @ 500 g/ ha, Buprofezin 25 SC @ 500 g/ ha (4.53, 4.63, 5.07, 9.57, 10.07 and 10.50 hoppers/hill, respectively), but these treatments were at par with each other. However, the highest population of BPH was noticed in the untreated control (11.50 hoppers/hill). Randhawa *et al*., (2022) [14] recorded that The pooled data of two years of both locations revealed that the comparative effectiveness of insecticides molecules indicates that with the application of Osheen (Dinotefuran) 20 WG recorded the highest reduction in plant hopper population (92.10%,) followed by Pexalon (Triflumezopyrim) 10 SC (90.63%), Chess (Pymetrozine) 50 WG (90.29%) and Confidor (Imidacloprid) 200 SL (88.75%) over untreated control. However, in blank water spray a negligible reduction (1.63%) was observed. Therefore, it was observed that the newly tested insecticidal molecules proved to be more essential insecticides against the live population of rice plant hoppers.
Konchada *et al*., (2017) [6] revealed that the data after the second spray showed that at 3 days after the second spray lowest mean population of BPH was observed in Dinotefuran 20 SG @ 0.4 g l-1 (8.07/hill) by recording 60.75 per cent population reduction over control. The insecticide treatments Pymetrozine 50 WG @ 0.5 g l-1 and Sulfoxaflor 25 SC @ 0.75 ml l-1 were on par with each other and with Dinotefuran. On 5 days after second spray, Pymetrozine 50 WG @ 0.5 g l-1 was found to be superior with lowest mean population of BPH (5.03/hill), followed by Dinotefuran 20 SG @ 0.4 g l-1 (6.33/hill) and Sulfoxaflor 25 SC @ 0.75 ml l-1(6.33/hill) and on par with each other and recorded 74.43, 68.91 and 65.53 per cent reduction of BPH over untreated control respectively. Harika and Deole, (2023) [4] reported that the overall maximum BPH population reduction over control was recorded in T4 - Pymetrozine 50% WG @ 150 g a.i./ha (79.86%) followed by T2 - Sulfoxaflor 24% SC @ 175 ml a.i./ha (74.49%), T5 - Dinotefuran 20% SG @ 40 g a.i./ha (72.70%), T6 - Flonicamid 50% WG @ 75 g a.i./ha (70.13%), T1 - Imidacloprid 17.8% SL @ 25 ml a.i./ha (68.56%) and it was lowest in T3 - Thiamethoxam 25% WG @ 25 g a.i./ha (66.44%) (Table 2). The overall mean population of BPH was noticed lowest in Pymetrozine 50% WG having 2.21 BPH/hill after the first spray and 1.80 BPH/hill after the second spray followed by Sulfoxaflor 24% SC having 2.38 BPH/hill after first spray and 2.28 BPH/hill after second spray.
Patil *et al.*, (2021) [11] found that Fipronil 5 SC @ 2.0 ml/L was found to the most effective treatment for the control of BPH by recording the highest per cent reduction of 85.45% over untreated control among all the treatments and it was followed Clothianidin 50 WDG @ 0.05g/L (85.09), Thiamethoxam 25 WG @ 0.20g/L (84.53) Acephate 75 SP @ 1.50g/L (84.31), Imidacloprid 17.8 SL @ 0.20ml/L (84.17) and Flonicamid 50 WG @ 0.30g/L (83.21). The Untreated control recorded a maximum of 36.23, 39.27 and 41.20 number of BPH/hill at 3, 7 and 14 days after the second spray.

**Effect of different insecticide treatments on the yield of rice**
The pooled data analysis of both years revealed that a higher marketable grain yield of rice was recorded in the treatment $T_3$- Triflumezopyrim 10 SC @ 0.5 ml /lit (57.95 qt/ha) which was found significantly superior treatment than others. Next best treatment was $T_8$- Fipronil 15 + Flonicamid 15 WDG @ 0.8 gm /lit which recorded marketable grain yield of 55.49 qt/ha. It was followed by, $T_4$- Dinotefuran 20 SG @ 0.3 gm/lit, $T_6$- Buprofezin 22 + Fipronil 3 SC @ 1ml /lit, $T_7$- Pymetrozine 50 WG @ 0.6 gm, $T_1$- Sulfoxaflor 21.8 SC @ 0.75 ml/lit, $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL @ 0.6 ml /lit and $T_5$- Flonicamid 50 WG @ 0.3 gm/lit, which was recorded marketable grain yield 51.95, 51.85, 50.02, 46.69, 44.00 and 42.61 qt/ha, respectively. The lower marketable fruit yield of rice (29.76 qt/ha) was recorded in $T_9$- (untreated control).
The present results are corroborative with earlier research workers, Kumar *et al*., (2017) [7] reported that all the treatments resulted in higher grain yield and proved significantly superior over untreated control. The highest seed yield of 62.64 q/ha was harvested with Triflumezopyrim 10.6 SC @ 237 ml/ ha while, Dinotefuran 20SG @ 200 g/ ha, Pymetrozine 50 WG @ 400 g/ ha and Ethiprole + Imidacloprid 80 WG @ 150 g/ ha, Buprofezin 15 + Acephate 35 WP @ 500 g/ ha and Acephate 50 + Imidachloprid 1.8 WG @ 500 g/ ha were next best treatments. Randhawa *et al*., (2022) [14] observed that the data on pooled (both years) grain yield per hectare ranged from 73.89 to 74.61 quintal with application of different green chemistry insecticidal molecules. The highest grain (unshelled) yield per hectare (74.61q) was obtained with application of Osheen (Dinotefuran) (500 g/ha) and it was on par with spray of Pexalon (Triflumezopyrim) (74.36qt/ha), Chess (Pymetrozine) (74.28 q/ha) and Confidor (Imidacloprid) (73.89 q/ha). The yield analysis of the field experiment demonstrated the bioefficacy of green chemistry molecules in increasing significantly grain yield as compared to blank water spray (65.80 q/ha) and untreated control (65.42 q/ha).
Konchada *et al*., (2017) [6] showed in the case of grain yield Buprofezin (5400 kg ha-1) Pymetrozine (5266 kg ha-1) and Dinotefuran (5228 kg ha-1) recorded the highest grain yields and were on par with each other by recording 67.98, 63.81 and 62.62 per cent increase over control respectively. The other treatments also recorded with higher grain yield were, Sulfoxaflor (4967 kg ha-1), Acetamiprid (4763 kg ha-1), Imidacloprid (4633 kg ha-1), Thiamethoxam (4613 kg ha-1) and Monocrotophos + Dichlorvos (4133 kg ha-1) compared to untreated control. Patil *et al*., (2021) [11] reported that the treatment with Fipronil 5 SC @ 2.0 ml/L recorded the highest yield of 55.43 q/ha. However, it was at par with Clothianidin 50 WDG @ 0.05g/L (53.97), Imidacloprid 17.8 SL @ 0.20ml/L (53.61), Thiamethoxam 25 WG @ 0.20g/L (53.30), Flonicamid 50 WG @ 0.30g/L (53.24) and Acephate 75

SP @ 1.50g/L (51.42). The lowest 37.35 q/ha grain yield was recorded in the untreated control. The highest 97.40 per cent increase in yield over control was recorded in treatment with Fipronil 5 SC @ 2.0 ml/L. It was followed by Clothianidin 50 WDG @ 0.05g/L (92.20), Imidacloprid 17.8 SL @ 0.20ml/L (90.91), Thiamethoxam 25 WG @ 0.20g/L (89.81), Flonicamid 50 WG @ 0.30g/L (89.60) and Acephate 75 SP @ 1.50g/L (83.12).

**Incremental cost-benefit ratio (ICBR)**

The data revealed that the treatment $T_6$- Buprofezin 22 + Fipronil 3 SC @ 1ml /lit emerged as the most economical one recording the highest ICBR 1:14.14. It was followed by, $T_4$- Dinotefuran 20 SG @ 0.3 gm/lit and $T_2$- Imidacloprid 6 + Lambda cyhalothrin 4 SL @ 0.6 ml /lit recording ICBR of 1:9.68 and 1:8.24, respectively.

The findings of the present investigations are more or less similar to the findings of Randhawa *et al*., (2022) [14] found that however, the highest cost: benefit was achieved with the application of Confidor (Imidacloprid) (100 ml/ha) i. e. Rs. 1: 23 and it was followed by Osheen (Dinotefuran) 20 SG (500 g/ha) and Chess (Pymetrozine) 50 WG with C: B @ Rs. 1:10 and 1:9. The least cost-benefit ratio (Rs. 1: 4) was obtained with Pexalon (Triflumezopyrim) 10 SC (235 ml/ha). Seni and Naik (2017) [16] revealed that the maximum cost-benefit ratio was recorded in Acephate 95 SG @ 682 g a.i /ha (1:5.62), followed by Cartap hydrochloride 50 WP @ 375 g a.i/ha, Lamda cyhalothrin 5 EC @ 30 g a.i /ha, Thiamethoxam 25 WG @ 37.50 g a.i /ha, Rynaxypyr 20 SC @ 30 g a.i/ha, Fipronil 5 SC @ 75 g a.i/ha, Dinotefuran 20 SG @ 40 g a.i /ha and Buprofezin 25 SC @ 250 g a.i /ha treated plots.

Badariprasad *et al*., (2020) [1] recorded that during the first season treatment of Buprofezin 15% + Acephate 35% WP @ 1500 g/ha recorded the highest yield with 69.32 q/ha and it was found statistically on par with Buprofezin 15% + Acephate 35% WP @ 1250 g/ha@ (67.68q/Ha). However, all the treatments were found significantly superior to the untreated control, which recorded the lowest yield i.e. 47.85q/ha (Table 3). The treatment of Buprofezin 15% + Acephate 35% WP @ 1250 g/ha exhibited the highest Cost - benefit ratio. During the second season, treatment of Buprofezin 15% + Acephate 35% WP @ 1500 g/ha recorded the highest yield with 66.40 q/ha and it was found statistically at par with Buprofezin 15% + Acephate 35% WP @ 1250 g/ha (64.77/ha). However, all the treatments were found significantly superior over the untreated control which recorded the lowest yield i.e. 345.12 q/ha. The treatment of Buprofezin 15% + Acephate 35% WP @ 1250 g/ha exhibited the highest Cost - benefit ratio.

Chakraborty *et al*., (2022) [2] reported that the grain yield was the least with neem oil @ 3% (3.58 t/ ha) along with that of Imidacloprid 17.8%SL @ 125 ml/ ha (3.99 t/ ha). Economics of insecticide revealed that maximum net realization (94,242.41 Rs/ ha) was found with Buprofezin 24%+ Fipronil 40%SC @ 875 ml/ha followed by its dose of 750 ml/ha (93193.33 Rs/ ha), while incremental cost-benefit was found to be 1:5.83 and 1:6.11, respectively. Thus, Buprofezin 24%+ Fipronil 40%SC (MAIRM-10) @ 875 ml/ha was found to be the most effective in BPH management. Kirankumar and Reddy (2022) [5] found that the data indicated, that the treatment T4 (Dinotefuran 20% SG) was the most economically viable treatment recording the highest ICBR (3.72) due to its high yield and additional returns over the control which stands 1st rank among all the treatments. The second rank was observed in treatment T3 (Dinotefuran 20% SG), the per cent increase in the yield was 16.52% over the control with an incremental benefit-cost ratio was 3.65. and the least incremental benefit-cost ratio was found in the case of treatment T6 (Buprofezin 25% SC). These two treatments were found the highest in yield and cost in the study period.

**Conclusion**

Evaluation of different insecticides against BPH of rice indicated that all the treatments were found to be significantly superior in recording the minimum number of BPH over untreated control. Among all treatments, the treatment $T_3$ (Triflumezopyrim 10 SC), was found most effective against BPH which was found statistically at par with $T_8$ (Fipronil 15 + Flonicamid 15 WDG), followed by $T_4$ (Dinotefuran 20 SG), $T_6$ (Buprofezin 22 + Fipronil 3 SC), $T_7$ (Pymetrozine 50 WG), $T_1$ (Sulfoxaflor 21.8 SC), $T_2$ (Imidacloprid 6 + Lambda cyhalothrin 4 SL) and $T_5$ (Flonicamid 50 WG). Economics of all the treatments revealed that the $T_6$- Buprofezin 22 + Fipronil 3 SC @ 1ml /lit emerged as the most economical one recording the highest ICBR 1:14.14 It was followed by, $T_4$- Dinotefuran 20 SG @ 0.3 gm/lit and $T_2$- Imidacloprid 6 + Lambda Cyhalothrin 4 SL @ 0.6 ml /lit recording ICBR of 1:9.68 and 1:8.24, respectively.

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