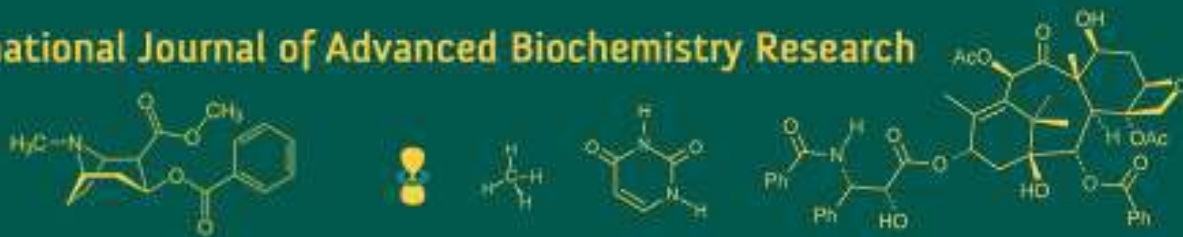


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## Bio-efficacy of plant-based materials against major insect pest under organic rice cultivation system

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### Abstract

The investigation entitled "Bio-efficacy of plant-based materials against major insect pest under organic rice cultivation system." was carried out at Research cum Instructional Farm of IGKV, Raipur (C.G.) during *Kharif*, 2024- 25. A total of seven treatments and an untreated control was taken against major insect pest of organic rice under field conditions. In bio-efficacy studies among different plant-based materials the least incidence of dead heart (2.79%/ hill) and white ear heads (7.97%/ hill) was in Agniastra, which was statistically at par with Brahmastra + Agniastra, whereas for leaf folder overall mean of three spray indicates that Brahmastra gave best result in management of leaf folder (2.18%) which was closely followed by Agniastra and Brahmastra. While for the management of rice butterfly larva incidence, Neemastra gave best result (2.16 larvae/hill) was closely followed by Neemastra + Brahmastra + Agniastra.

**Keywords:** Dead heart, white ear head, neemastra, brahmastra, agniastra

### Introduction

Rice (*Oryza sativa* L.) is one of the most cultivated and consumed staple foods in Asia and more particularly in South Asia, where rice accounts for more than 40% of calorie intake in the Indian subcontinent (Shankar *et al.*, 2021) [8]. Rice (*Oryza sativa* L.) is the primary staple food for over 2 billion people. It is grown worldwide in over 124 million hectares under diverse cultural conditions and over a wide geographical range. More than half of the world's population consumes rice as a main staple food, making it the third most widely grown cereal grain in the world. Due to its vast ability to adapt to different environments and lower cultivation risk, rice farming is favoured by many farmers on a larger scale (Al Mamun *et al.* 2021) [1].

Chhattisgarh is known as the "rice bowl of India" because paddy is cultivated in more than 88% of the total agricultural area of the state and various varieties of paddy are produced. The land in fertile plains and nutrient rich soil of Chhattisgarh, combined with its ample water resources, make it an ideal location for rice cultivation. Rice is one of the staple foods of the people of the state, and the state produces a large amount of rice every year. The state government has also taken several steps to promote rice cultivation and increase the productivity of rice farms (Anonymous, 2022) [2].

Chhattisgarh is ranked as major contributors of rice to the central pool occupying an area of 3.74 million hectare with a production of 9.703 million tonnes (Paddy outlook 2023-24) [6].

Amongst various constraints for low productivity of paddy, the infestation of insect pests which attack the crop right from nursery till the harvest of the crop causing about 25 – 30% of loss (Murlidharan and Pasalu, 2006) [4]. A large number of insect pests cause damage to the rice crop; among them rice stem borer (*Scirpophaga incertulas*) is one of the most important borers which are responsible for yield losses in rice. This pest causes dead hearts at the vegetative stage and white ears at the reproductive stage, which causes significant economic harm. Only 5-20 per cent of damage is caused by the rice stem borer in India (Satpathi *et al.* 2012).

There are almost 800 species of rice insect pests known worldwide, with 20 of them having significant financial effects in tropical Asia (Yadav *et al.*, 2021) [9]. Some of these are the rice yellow stem borer (*Scirpophaga incertulas*), leaf folder (*Cnaphalocrocis medinalis*), gall

midge (*Orseolia oryzae*), brown plant hopper (*Nilaparvata lugens*), and white-backed plant hopper (*Sogatella furcifera*). These pests are of national importance because their incidence has a considerable influence on rice yields in various rice ecosystems. Other insect pests in rice-growing areas include climbing cutworm (*Leptocorisa* spp.), rice bug (*Diuraphis armigera*), green leafhopper (*Nephotettix virescens*), and armyworms (*Mythimna separata*). Recently, leaf and panicle mites, black bugs, and blue beetles have also begun to cause concern as developing pests.

Over 98% of sprayed insecticides and 95% of herbicides reach a destination other than their target species, as they are sprayed across the entire field (Miller, 2004)<sup>[3]</sup>. These issues can be addressed by using cow urine-based plant products for insect pest management.

Organic farming is becoming more and more popular as a substitute for conventional agriculture because of its emphasis on environment friendly ecosystem and sustainable practices. Organic farming practices have gained popularity as a sustainable and environmentally friendly approach to agriculture, with potential implications for the nutritional status of crops.

Neem is one of the most reliable botanical sources of biopesticides. Neem plant has been known for three decades for its potential against insect pests. Leaves and seed extract of Neem plant have been observed for their deleterious effects on insects. The principal component that has insecticidal activity in Neem extracts is a limonoid, Azadirachtin. Azadirachtin is non-toxic to mammals, rat, oral acute LD50 is more than 5000 mg/kg. A 90-day oral feeding of rats with 10,000 ppm of azadirachtin did not show chronic toxicity (Mehlhorn *et al.*, 2011)<sup>[5]</sup>.

## Materials and Methods

An experiment was conducted during the *kharif* season of 2024 at IGKV Raipur (C.G.) to study the seasonal occurrence of various insect pests and their natural enemies. The rice variety Lokti Machi was grown specifically for this study. Observations of the seasonal incidence of insect pests were made on a separate 100m<sup>2</sup> plot, divided into four equal sections. Seedlings aged 20–25 days were transplanted into the main field, following a hill spacing of 25 cm × 10 cm. Standard agronomical practices, including irrigation,

fertilizer application, and intercultural operations, were carried out as recommended for organic rice cultivation in the region to ensure proper crop growth. No chemical or botanical pesticides were used during the crop period to allow natural pest incidence. The pest population in the unprotected plot was recorded at seven-day intervals from the onset of infestation until crop maturity. Observations for each pest were made on five randomly selected hills within the plot.

**Method of Insecticide application**—The doses of insecticides were applied after duly mixing with water (375–500 l/ha) with due care for preventing insecticides drift. Bunds were formed around the treatment plot to avoid the mixing of running water from one plot to another. Initial application of all insecticides was given as soon as pest infestation was noticed.

## Observation

In case of rice horned caterpillar, the number of caterpillars on the 5 randomly selected plants per hills was recorded. The total count was averaged and expressed on per plant basis.

In case of yellow stem borer counts was taken on a number of dead hearts and white ears and the total number of tillers and panicle from 5 selected hills per plant. The percent incidence (dead heart/ white ear head) was calculated as follows.

$$\text{Dead heart incidence (\%)} = \frac{\text{No. of dead hearts}}{\text{Total no. of tillers}} \times 100$$

$$\text{White ear incidence (\%)} = \frac{\text{No. of white ears}}{\text{Total no. of panicles}} \times 100$$

For leaf folder, the damaged leaves and total leaves from 5 randomly selected hills per plant were observed in each plot. The percent of leaf damaged was calculated as follows,

$$\text{Leaf damage (\%)} = \frac{\text{No. of damaged leaves}}{\text{Total no. of leaves}} \times 100$$

Table 1: treatment details of plant-based materials against major pest of organic rice

| S. No. | Tr. No.        | Name of the treatment                                                                             | Dose/hectare                      | Dose/ltr of water |
|--------|----------------|---------------------------------------------------------------------------------------------------|-----------------------------------|-------------------|
| 1.     | T <sub>1</sub> | Untreated control                                                                                 | -----                             | --                |
| 2.     | T <sub>2</sub> | Neemastra (Cow urine + Cow dung+ Neem leaves)                                                     | 10 litres                         | 20ml/litre        |
| 3.     | T <sub>3</sub> | Brahmastra (Cow urine + leaves of plant like Neem, Papaya, Pomegranate, custard apple, and Guava) | 10 litres                         | 20ml/litre        |
| 4.     | T <sub>4</sub> | Agniastra (Cow urine + Tobacco+ Green Chilli + Garlic+ Neem leaf)                                 | 10 litres                         | 20ml/litre        |
| 5.     | T <sub>5</sub> | Neemastra + Brahmastra                                                                            | 10(5+5) litres                    | 20ml/litre        |
| 6.     | T <sub>6</sub> | Neemastra+ Agniastra                                                                              | 10(5+5) litres                    | 20ml/litre        |
| 7.     | T <sub>7</sub> | Brahmastra + Agniastra                                                                            | 10(5+5) litres                    | 20ml/litre        |
| 8.     | T <sub>8</sub> | Neemastra+ Brahmastra + Agniastra                                                                 | 10 litres (3.33+3.33+3.33) litres | 20ml/litre        |

\*Treatment taken as per protocol from Indian Institute of Farming System Research, Meerut, U.P. (2023)

## Result and discussion

### 1. Yellow stem borer

The data on Per cent of dead hearts and white heads showed that all the insecticides were significantly superior over control in reducing the infestation per cent of stem borer which were the mean of 3, 7, and 14 DAS after insecticidal application. Overall mean of three spray indicates that

Agniastra gave best result for the management of dead heart incidence by yellow stem borer (2.79% /hill) along with maximum reduction (68.86%) over control which was closely followed by T<sub>7</sub> Brahmastra + Agniastra (3.30%) with a reduction of 63.16%, T<sub>8</sub> i.e. Neemastra + Brahmastra + Agniastra (3.97%) with a reduction of 55.69% and T<sub>6</sub> i.e. Neemastra + Agniastra (4.62%) with a reduction of

48.43%, T<sub>5</sub> Neemastra + Brahmastra (5.23%) with a reduction of 41.62%, T<sub>3</sub> Brahmastra (6.38%) with a reduction of 28.79% and T<sub>2</sub> Neemastra (7.06%) with a reduction of 21.20%. However, the maximum dead heart incidence was noticed in untreated plot (8.96%) Overall minimum white ear head /plant was observed in T<sub>4</sub> i.e. Agniastra (7.97%) which was statistically less than any other treatment. It was followed by T<sub>7</sub> i.e. Brahmastra + Agniastra (9.54%), T<sub>8</sub> Neemastra + Brahmastra + Agniastra (12.83%), T<sub>6</sub> Neemastra + Agniastra (15.14), T<sub>5</sub> Neemastra + Brahmastra (17.56%), T<sub>3</sub> Brahmastra (19.05%) and T<sub>2</sub> Neemastra (23.13%). The highest incidence of white ear head was found in untreated plot (28.04%).

## 2. Leaf folder

The data on leaf folder damage revealed that all insecticidal treatments were significantly more effective than the untreated control in reducing the percentage of leaf damage. These results represent the mean values recorded at 3, 7, and 14 days after spraying (DAS). Overall mean of three spray indicates that Brahmastra gave best result in management of leaf folder (2.18%) which was statistically at par with T<sub>4</sub>, T<sub>5</sub>, T<sub>7</sub> and T<sub>2</sub>. Brahmastra was closely followed by T<sub>4</sub> Agniastra (2.60%), T<sub>5</sub> Neemastra + Brahmastra (3.17%), T<sub>7</sub> Brahmastra + Agniastra (3.85%), T<sub>2</sub> Neemastra (4.14%), Neemastra + Agniastra (4.85%), T<sub>8</sub> Neemastra + Brahmastra + Agniastra (5.07%). The highest percentage leaf damage was recorded in untreated plot (6.42%).

## 3. Rice butterfly

The average number of larvae per hill indicated that all insecticidal treatments were significantly more effective than the untreated control in mitigating rice butterfly damage. These findings are based on mean observations recorded at 3, 7, and 14 days after spraying (DAS). Overall mean of three spray indicates that Neemastra gave best

result in management of rice butterfly (2.16%) which was statistically at par with T<sub>2</sub> and T<sub>5</sub> which was closely followed by T<sub>5</sub> Neemastra + Brahmastra (2.97%), T<sub>6</sub> Neemastra + Agniastra (3.23%). The highest population was recorded in T<sub>1</sub> i.e. control plot (6.44%).



**Plate 1:** Damaging stage of rice butterfly (horned)



**Plate 2:** Damaging stage of rice leaf folder (larva)

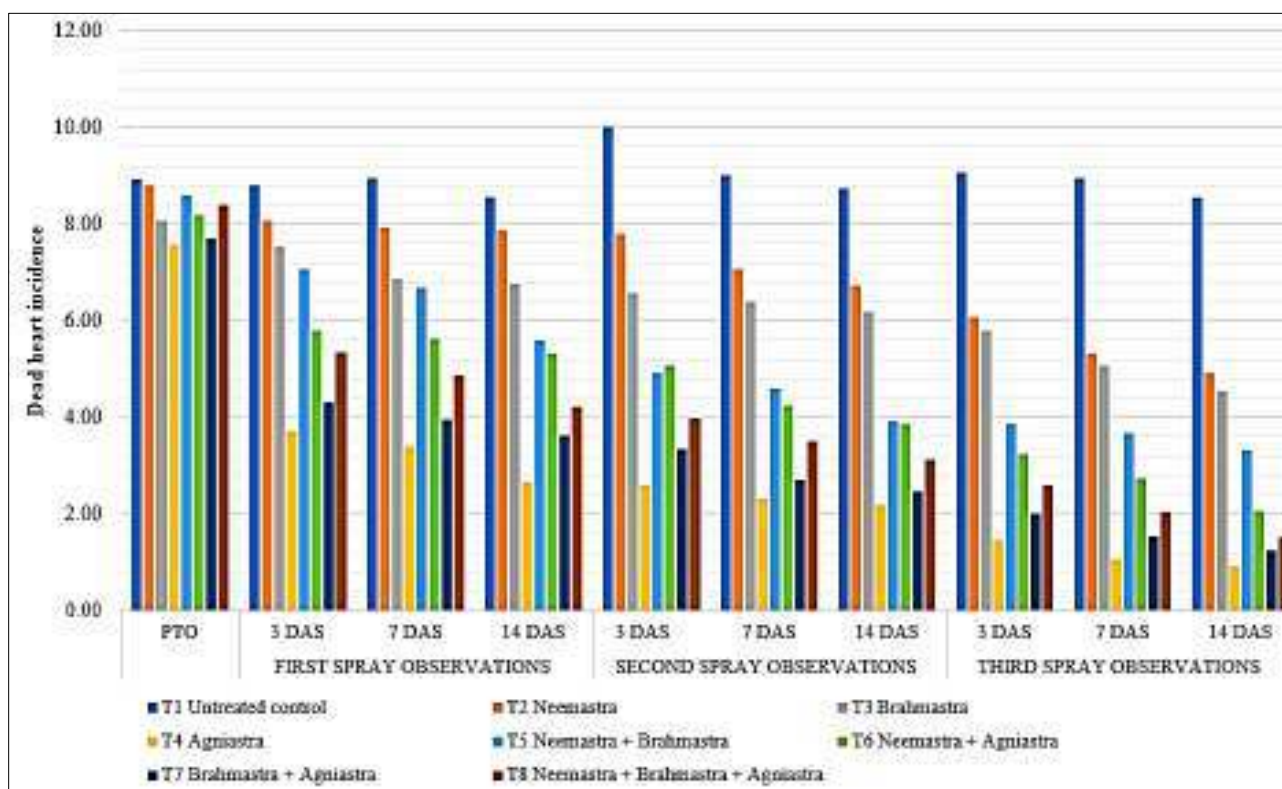


**Plate 3:** Damaging stage of rice yellow stem borer (larva)

**Table 1:** Bio-efficacy of plant-based materials against mean percent dead heart incidence during *kharif* 2024.

| Treatment no.  | Treatment name                     | First Spray |         |         |         | Second spray |         |         | Third Spray |         |         | mean |
|----------------|------------------------------------|-------------|---------|---------|---------|--------------|---------|---------|-------------|---------|---------|------|
|                |                                    | PTO         | 3 DAS   | 7 DAS   | 14 DAS  | 3 DAS        | 7 DAS   | 14 DAS  | 3 DAS       | 7 DAS   | 14 DAS  |      |
| T <sub>1</sub> | Untreated                          | 8.93        | 8.80    | 8.95    | 8.56    | 10.01        | 9.01    | 8.74    | 9.05        | 8.95    | 8.56    | 8.96 |
|                | control                            | (17.32)     | (17.22) | (17.40) | (16.97) | (18.41)      | (17.43) | (17.16) | (17.49)     | (17.40) | (17.00) |      |
| T <sub>2</sub> | Neemastra                          | 8.80        | 8.07    | 7.93    | 7.87    | 7.80         | 7.07    | 6.73    | 6.07        | 5.33    | 4.93    | 7.06 |
|                |                                    | (17.22)     | (16.49) | (16.35) | (16.24) | (16.21)      | (15.38) | (15.01) | (14.15)     | (13.34) | (12.77) |      |
| T <sub>3</sub> | Brahmastra                         | 8.07        | 7.53    | 6.87    | 6.76    | 6.58         | 6.40    | 6.18    | 5.80        | 5.07    | 4.53    | 6.38 |
|                |                                    | (16.42)     | (15.91) | (15.19) | (14.94) | (14.82)      | (14.61) | (14.35) | (13.89)     | (13.01) | (12.28) |      |
| T <sub>4</sub> | Agniastra                          | 7.57        | 3.73    | 3.40    | 2.67    | 2.60         | 2.33    | 2.20    | 1.47        | 1.07    | 0.93    | 2.79 |
|                |                                    | (15.93)     | (11.07) | (10.27) | (9.28)  | (9.15)       | (8.63)  | (8.36)  | (6.64)      | (5.79)  | (5.53)  |      |
| T <sub>5</sub> | Neemastra +                        | 8.60        | 7.07    | 6.67    | 5.60    | 4.93         | 4.60    | 3.93    | 3.87        | 3.68    | 3.33    | 5.23 |
|                | Brahmastra                         | (17.00)     | (15.38) | (14.87) | (13.55) | (12.77)      | (12.31) | (11.35) | (11.26)     | (10.78) | (10.44) |      |
| T <sub>6</sub> | Neemastra +                        | 8.19        | 5.80    | 5.63    | 5.33    | 5.07         | 4.25    | 3.86    | 3.24        | 2.73    | 2.07    | 4.62 |
|                | Agniastra                          | (16.61)     | (13.93) | (13.69) | (13.31) | (12.97)      | (11.85) | (11.33) | (10.27)     | (9.00)  | (8.27)  |      |
| T <sub>7</sub> | Brahmastra + Agniastra             | 7.70        | 4.32    | 3.96    | 3.64    | 3.35         | 2.72    | 2.48    | 2.01        | 1.55    | 1.26    | 3.30 |
|                |                                    | (16.09)     | (11.92) | (11.40) | (10.91) | (10.45)      | (9.49)  | (8.91)  | (8.15)      | (7.15)  | (6.32)  |      |
| T <sub>8</sub> | Neemastra + Brahmastra + Agniastra | 8.39        | 5.35    | 4.87    | 4.23    | 3.98         | 3.51    | 3.14    | 2.59        | 2.06    | 1.54    | 3.97 |
|                |                                    | (16.80)     | (13.34) | (12.74) | (11.65) | (11.42)      | (10.79) | (9.83)  | (9.15)      | (8.09)  | (7.11)  |      |
| C.D.           |                                    | NS          | 2.15    | 2.31    | 2.22    | 2.14         | 2.40    | 2.52    | 2.12        | 2.69    | 1.83    |      |
| SE(m)±         |                                    | 0.91        | 0.70    | 0.76    | 0.73    | 0.70         | 0.78    | 0.82    | 0.69        | 0.88    | 0.60    |      |

DAS= Days after spray, PTO= Pre-treatment observation, ( ) Figures in parentheses are square root transformed value, NS= non- significant, ROC= reduction over control.

**Fig 1:** Performance of plant-based materials against dead heart incidence during *kharif* 2024.**Table 2:** Bio-efficacy of plant-based material against white ear incidence caused by yellow stem borer during *kharif* 2024.

| Average percentage of white ear head/plant |                                   |               |         |
|--------------------------------------------|-----------------------------------|---------------|---------|
| Treatment no.                              | Treatment name                    | Overall Mean  | ROC (%) |
| T <sub>1</sub>                             | Untreated control                 | 28.04 (31.95) |         |
| T <sub>2</sub>                             | Neemastra                         | 23.13 (28.74) | 17.51   |
| T <sub>3</sub>                             | Brahmastra                        | 19.05 (25.87) | 32.06   |
| T <sub>4</sub>                             | Agniastra                         | 7.97 (16.39)  | 71.57   |
| T <sub>5</sub>                             | Neemastra+ Brahmastra             | 17.56 (24.73) | 37.37   |
| T <sub>6</sub>                             | Neemastra+ Agniastra              | 15.14 (22.70) | 46.00   |
| T <sub>7</sub>                             | Brahmastra + Agniastra            | 9.54 (17.88)  | 65.97   |
| T <sub>8</sub>                             | Neemastra+ Brahmastra + Agniastra | 12.83 (19.84) | 54.24   |
| C.D.@5%                                    |                                   | 6.00          |         |
| SE(m) ±                                    |                                   | 1.96          |         |

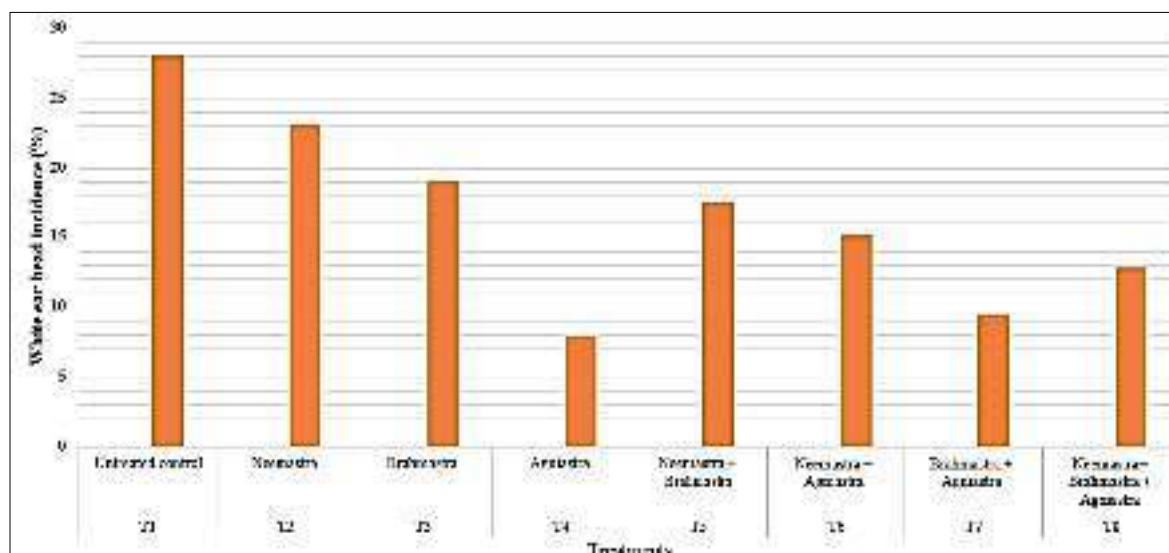


Fig 2: Performance of plant-based materials against white ear head of yellow stem borer during *kharif* 2024.

Table 3: - Bio-efficacy of plant-based materials against leaf folder damage (%) / plant during *kharif* 2024.

|                | Treatment                             | FIRST SPRAY     |                 |                 |                 | SECOND SPRAY    |                 |                 | THIRD SPRAY     |                 |                 | mean |
|----------------|---------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------|
|                |                                       | PTO             | 3 DAS           | 7 DAS           | 14 DAS          | 3 DAS           | 7 DAS           | 14 DAS          | 3 DAS           | 7 DAS           | 14 DAS          |      |
| T <sub>1</sub> | Untreated control                     | 6.05<br>(14.12) | 6.21<br>(14.18) | 6.48<br>(14.70) | 6.93<br>(15.26) | 7.01<br>(15.35) | 6.97<br>(15.30) | 6.63<br>(14.89) | 6.40<br>(14.60) | 5.80<br>(13.88) | 5.74<br>(13.86) | 6.42 |
| T <sub>2</sub> | Neemastra                             | 5.60<br>(13.58) | 5.43<br>(13.42) | 5.20<br>(13.04) | 4.96<br>(12.81) | 4.63<br>(12.39) | 4.07<br>(11.48) | 3.86<br>(11.25) | 3.27<br>(10.35) | 2.40<br>(8.80)  | 1.93<br>(7.98)  | 4.14 |
| T <sub>3</sub> | Brahmastra                            | 5.25<br>(13.11) | 2.86<br>(9.27)  | 2.53<br>(9.01)  | 2.40<br>(8.76)  | 2.07<br>(8.08)  | 1.87<br>(7.63)  | 1.60<br>(7.02)  | 1.33<br>(6.26)  | 1.07<br>(5.73)  | 0.86<br>(5.32)  | 2.18 |
| T <sub>4</sub> | Agniastra                             | 5.77<br>(13.83) | 3.67<br>(10.87) | 3.23<br>(9.97)  | 2.96<br>(9.80)  | 2.43<br>(8.83)  | 2.07<br>(8.09)  | 1.93<br>(7.78)  | 1.60<br>(6.97)  | 1.33<br>(6.62)  | 0.97<br>(5.65)  | 2.60 |
| T <sub>5</sub> | Neemastra +<br>Brahmastra             | 5.33<br>(13.23) | 4.33<br>(11.80) | 4.05<br>(11.53) | 3.87<br>(11.34) | 3.40<br>(10.55) | 3.14<br>(10.10) | 2.87<br>(9.75)  | 2.15<br>(8.28)  | 1.47<br>(6.66)  | 1.12<br>(5.58)  | 3.17 |
| T <sub>6</sub> | Neemastra +<br>Agniastra              | 6.94<br>(15.23) | 6.70<br>(14.84) | 5.80<br>(13.89) | 5.27<br>(13.22) | 5.03<br>(12.91) | 4.70<br>(12.48) | 4.23<br>(11.86) | 3.93<br>(11.36) | 3.07<br>(10.09) | 2.86<br>(9.73)  | 4.85 |
| T <sub>7</sub> | Brahmastra +<br>Agniastra             | 5.76<br>(13.87) | 5.20<br>(13.18) | 5.07<br>(12.97) | 4.40<br>(12.07) | 4.07<br>(11.63) | 3.87<br>(11.26) | 3.43<br>(10.67) | 2.93<br>(9.74)  | 2.14<br>(8.41)  | 1.63<br>(7.33)  | 3.85 |
| T <sub>8</sub> | Neemastra +<br>Brahmastra + Agniastra | 7.20<br>(15.52) | 6.86<br>(15.14) | 6.27<br>(14.46) | 5.93<br>(13.94) | 5.70<br>(13.76) | 4.70<br>(12.36) | 4.43<br>(12.14) | 3.69<br>(11.01) | 3.20<br>(10.23) | 2.76<br>(9.56)  | 5.07 |
|                | C.D.                                  | NS              | 2.58            | 2.57            | 2.93            | 2.23            | 1.77            | 2.44            | 2.9             | 2.45            | 1.92            |      |
|                | SE(m) ±                               | 0.96            | 0.84            | 0.84            | 0.96            | 0.73            | 0.58            | 0.80            | 0.95            | 0.8             | 0.63            |      |

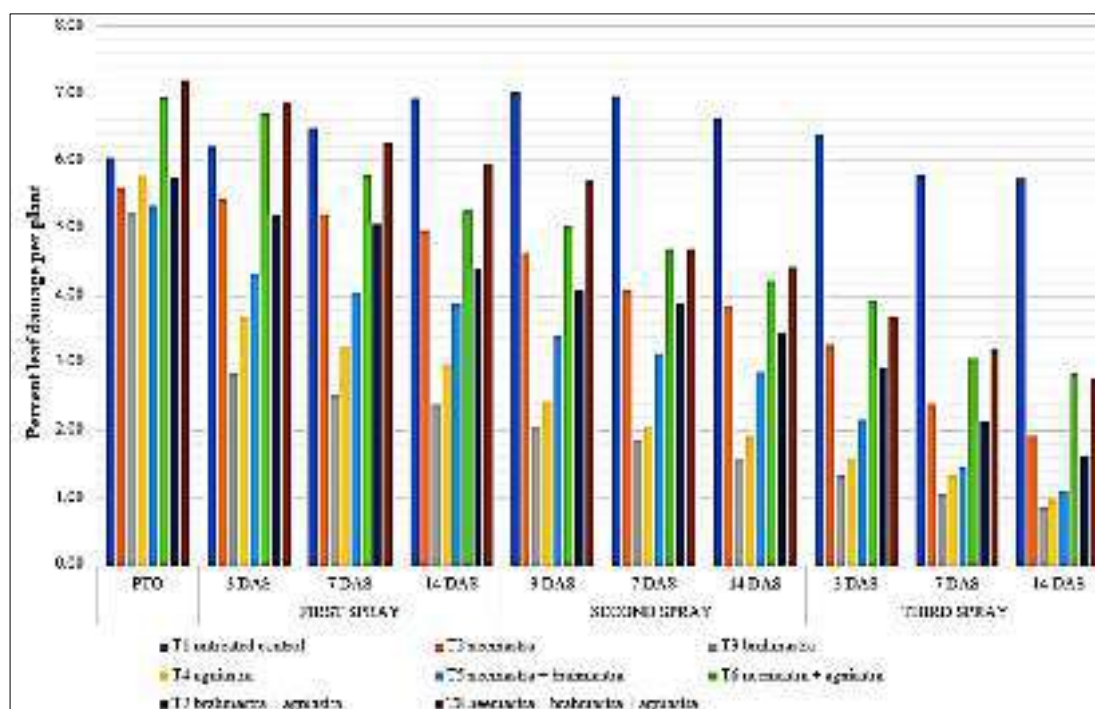
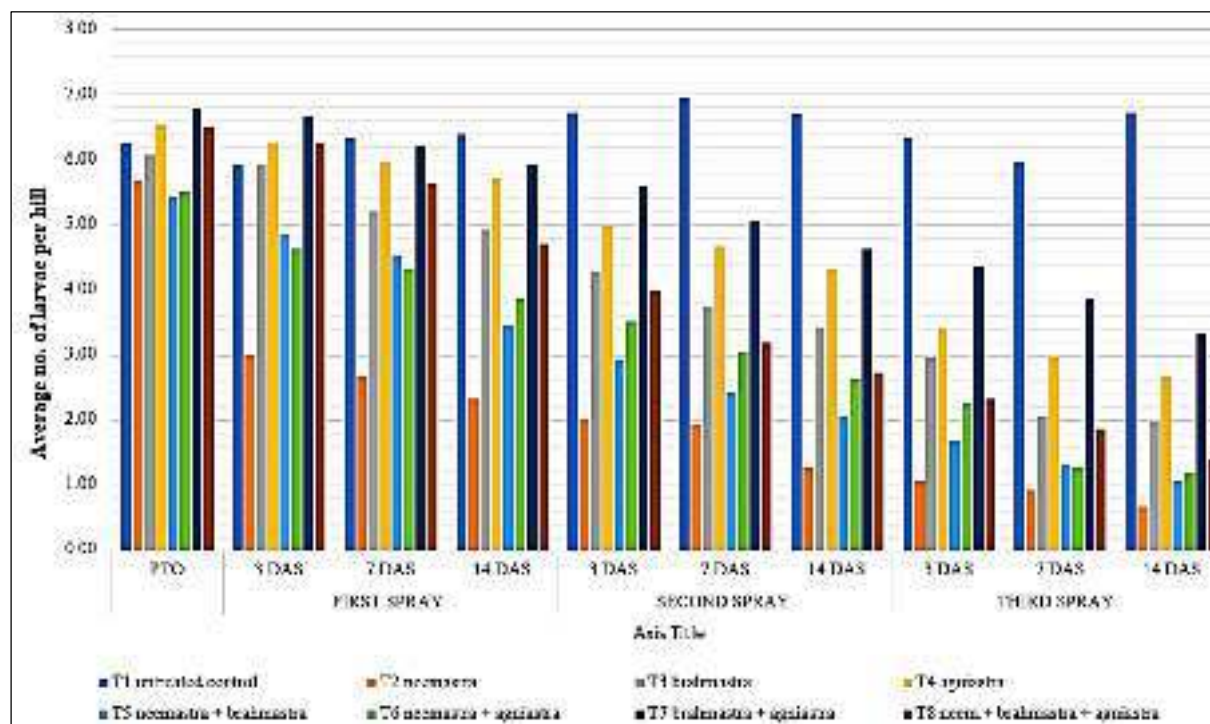


Fig 3: Performance of plant-based materials against leaf damage by leaf folder during *kharif* 2024.

**Table 4:** Bio-efficacy of plant-based materials against rice butterfly incidence during *kharif* 2024

| S. No.         | Treatment              | PTO    | First Spray |        |        | Second Spray |        |        | Third Spray |        |        | mean |
|----------------|------------------------|--------|-------------|--------|--------|--------------|--------|--------|-------------|--------|--------|------|
|                |                        |        | 3 DAS       | 7 DAS  | 14 DAS | 3 DAS        | 7 DAS  | 14 DAS | 3 DAS       | 7 DAS  | 14 DAS |      |
| T <sub>1</sub> | Untreated control      | 6.27   | 5.93        | 6.35   | 6.40   | 6.73         | 6.96   | 6.70   | 6.33        | 5.98   | 6.73   | 6.44 |
|                |                        | (2.69) | (2.62)      | (2.70) | (2.71) | (2.78)       | (2.81) | (2.77) | (2.70)      | (2.64) | (2.76) |      |
| T <sub>2</sub> | Neemastra              | 5.66   | 3.01        | 2.67   | 2.33   | 2.02         | 1.94   | 1.27   | 1.07        | 0.93   | 0.67   | 2.16 |
|                |                        | (2.56) | (1.99)      | (1.90) | (1.81) | (1.73)       | (1.67) | (1.48) | (1.43)      | (1.38) | (1.29) |      |
| T <sub>3</sub> | Brahmastra             | 6.07   | 5.93        | 5.20   | 4.93   | 4.27         | 3.73   | 3.43   | 2.96        | 2.07   | 1.96   | 4.05 |
|                |                        | (2.63) | (2.62)      | (2.48) | (2.42) | (2.29)       | (2.16) | (2.09) | (1.99)      | (1.71) | (1.67) |      |
| T <sub>4</sub> | Agniastra              | 6.56   | 6.27        | 5.97   | 5.70   | 4.98         | 4.67   | 4.33   | 3.43        | 2.96   | 2.67   | 4.75 |
|                |                        | (2.74) | (2.69)      | (2.63) | (2.58) | (2.43)       | (2.37) | (2.28) | (2.09)      | (1.99) | (1.88) |      |
| T <sub>5</sub> | Neemastra +            | 5.44   | 4.86        | 4.53   | 3.47   | 2.93         | 2.42   | 2.06   | 1.67        | 1.33   | 1.07   | 2.97 |
|                | Brahmastra             | (2.53) | (2.41)      | (2.34) | (2.11) | (1.97)       | (1.83) | (1.73) | (1.61)      | (1.52) | (1.43) |      |
| T <sub>6</sub> | Neemastra +            | 5.52   | 4.63        | 4.33   | 3.87   | 3.53         | 3.07   | 2.63   | 2.27        | 1.27   | 1.20   | 3.23 |
|                | Agniastra              | (2.55) | (2.36)      | (2.30) | (2.20) | (2.12)       | (2.00) | (1.89) | (1.79)      | (1.50) | (1.48) |      |
| T <sub>7</sub> | Brahmastra +           | 6.80   | 6.67        | 6.20   | 5.93   | 5.60         | 5.07   | 4.63   | 4.37        | 3.86   | 3.33   | 5.25 |
|                | Agniastra              | (2.79) | (2.76)      | (2.67) | (2.62) | (2.56)       | (2.45) | (2.36) | (2.31)      | (2.18) | (2.06) |      |
| T <sub>8</sub> | Neemastra +            | 6.51   | 6.27        | 5.63   | 4.70   | 3.99         | 3.20   | 2.73   | 2.33        | 1.87   | 1.40   | 3.86 |
|                | Brahmastra + Agniastra | (2.74) | (2.65)      | (2.57) | (2.38) | (2.22)       | (2.04) | (1.92) | (1.82)      | (1.67) | (1.54) |      |
| C.D.           |                        | NS     | 0.38        | 0.41   | 0.43   | 0.37         | 0.43   | 0.48   | 0.35        | 0.42   | 0.49   |      |
| SE(m) ±        |                        | 0.15   | 0.13        | 0.13   | 0.14   | 0.12         | 0.14   | 0.16   | 0.11        | 0.14   | 0.16   |      |

**Fig 4:** Performance of plant-based materials against rice butterfly during *kharif* 2024.**Grain Yield**

The highest grain yield occurred in Agniastra plot (35.35qt/ha) which was highest significant value. Agniastra

was closely followed by T<sub>7</sub> Brahmastra + Agniastra (30.72 qt/ha), where as in T<sub>1</sub> uncontrolled plot yield was lowest (17.12 qt/ha).

**Table 5:** - Effect of plant-based materials on the grain yield of rice.

| Tr. No.        | Treatment                          | Grain yield q/ha | Increase yield over control | Increase over control (%) |
|----------------|------------------------------------|------------------|-----------------------------|---------------------------|
| T <sub>1</sub> | Untreated control                  | 17.12            | 0.00                        | 0.00                      |
| T <sub>2</sub> | Neemastra                          | 20.47            | 3.35                        | 16.36                     |
| T <sub>3</sub> | Brahmastra                         | 23.72            | 6.60                        | 27.82                     |
| T <sub>4</sub> | Agniastra                          | 35.35            | 18.23                       | 51.57                     |
| T <sub>5</sub> | Neemastra + Brahmastra             | 25.18            | 8.06                        | 32.00                     |
| T <sub>6</sub> | Neemastra + Agniastra              | 26.87            | 9.75                        | 36.28                     |
| T <sub>7</sub> | Brahmastra + Agniastra             | 30.72            | 13.60                       | 44.27                     |
| T <sub>8</sub> | Neemastra + Brahmastra + Agniastra | 29.17            | 12.05                       | 41.30                     |
| C.D.           |                                    | 0.96             |                             |                           |
| SE(m)          |                                    | 0.31             |                             |                           |

## Conclusion

The bio-efficacy of various plant-based materials was evaluated against three major insect pests of rice yellow stem borer (*Scirpophaga incertulas*), rice leaf folder (*Cnaphalocrocis medinalis*), and rice butterfly (*Melanitis leda*) which were prevalent across multiple crop growth stages, ranging from vegetative to maturity.

Based on the overall mean of three sprays, Agniastra demonstrated the highest efficacy in managing yellow stem borer-induced dead heart incidence (2.79% per hill), closely followed by Brahmastra + Agniastra at 3.30%. Statistically, Agniastra was at par with Brahmastra + Agniastra, Neemastra+ Brahmastra + Agniastra, Neemastra+ Agniastra and Neemastra+ Brahmastra. Similarly, for the control of white ear head incidence, Agniastra yielded the best result (7.57% per hill), again closely followed by Brahmastra + Agniastra, and showed statistical similarity with Brahmastra + Agniastra, Neemastra+ Brahmastra + Agniastra, Neemastra + Agniastra and Neemastra+ Brahmastra.

The overall mean of three sprays indicated that Brahmastra was the most effective treatment for managing leaf folder infestation (2.18%), closely followed by Agniastra at 2.60%. Statistically, Brahmastra was at par with Agniastra, Neemastra+ Brahmastra and Brahmastra + Agniastra.

For rice butterfly larval incidence, T<sub>2</sub> Neemastra proved to be the most effective (2.16 larvae/plant) closely followed by T<sub>5</sub> i.e. Neemastra + Brahmastra with 2.97 larvae/plant. The highest population was recorded in untreated plot i.e. with 6.44 larvae/ plant.

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