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Evaluation of different botanical insecticides combinations against gall midge and yellow stem borer of rice (*Oryza sativa* L.) under field conditions

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Abstract

When used in integrated pest management programmes, rotational applications, or in conjunction with other insecticides, botanical pesticides can significantly reduce the use of conventional pesticides. This may result in a reduction in the total amount of pesticides used while potentially mitigating or delaying the emergence of pest populations with resistance. During the *Kharif* season of 2022, the experiment was carried out at Research and Instructional Farm, SGCARS Jagdalpur. In the evaluation of different botanical insecticides, three sprays of different insecticides at 25, 45 and 60 DAT were applied and the results revealed that T_1 (Combination of Neemazal 1% EC @ 2 ml L^{-1}, Eucalyptus oil @ 2 ml L^{-1} and Cartap hydrochloride 50% SC @ 2 g L^{-1}) was most effective combination with 45.75% and 48.54% ROC respectively for gall midge and stem borer infestation. This treatment was superior to T_2 (Neemazal 1% EC @ 2 ml L^{-1}, Neemoil @ 10 ml L^{-1} and Triflumezopyrim 10% SC @ 0.48 ml L^{-1}) having 33.57% and 36.12% ROC and T_3 (Neem baan (Azadirachtin 10000 ppm) @ 2 ml L^{-1}, Karanj oil @ 10 ml L^{-1} and Fipronil 0.3 GR @ 2.5 g/m^2) with 29.44% and 30.93% ROC respectively for gall midge and stem borer infestation. The least effective combination was T_4 (Neemazal 1% EC @ 2 ml L^{-1}, Eucalyptus oil @ 2 ml L^{-1} and Neemoil @ 10 ml L^{-1}) with 29.44% and 30.93% ROC for gall midge and stem borer, respectively but it was superior to T_6 (untreated control). The check treatment T_5 (Chlorantraniliprole 0.4G @ 1 g/m^2, Cartap hydrochloride 50% SC @ 2 g L^{-1} and Triflumezopyrim 10% SC @ 0.48 ml L^{-1}) had the highest ROC of 69.65% and 72.56% ROC for gall midge and stem borer, respectively.

Keywords: Rice, botanical insecticides, gall midge, yellow stem borer, reduction percentage over control (ROC)

Introduction

Rice (*Oryza sativa* L.) is monocotyledonous crop, belongs to family Poaceae and genus *Oryza* with 22 wild species and two cultivated species, namely *Oryza sativa* and *Oryza glaberrima*. However, *O. sativa* is grown all over the world, but *O. glaberrima* is primarily grown in west Africa. South-East Asia was thought to be the origin of rice. It is primarily a meal with a lot of calories. (Anonymous, 2004) [1]. Rice (Oryza sativa L.), the primary food source for more than half of the world's population, is grown in more than 95 nations worldwide. In the developing world, one of the most important cereal crops is rice. (Pandit *et al.*, 2020). It comprises 80% carbohydrates, 8% protein, 3% fat, and 3% fibre. (Chaudhari *et al*., 2018). The overall area of rice cultivation worldwide is 165.22 million hectares with the production of 509.29 million metric tonnes and productivity of 4620 kg ha^{-1} during *Kharif* 2020-21. (Anonymous, 2021) [2].

"Global grain" is a term used to describe rice. 90% of the rice consumed and produced worldwide is in Asia. Asia's rice output is so essential for ensuring global food security. India produces approximately 20% of global rice production and is both a producer and consumer of rice. During the years 2021-22, rice was grown in India over an area of 45.07 million hectares, with a production volume of 127.93 million tonnes and a productivity of approximately 2713 kg ha^{-1}. It was 11.49 million tonnes more than the 116.44 million tonnes average production over the previous five years. (Anonymous, 2022) [3].

Insect pests are among the most damaging biotic factors, causing 21- 40 percent losses in rice yield. (Prakash and Rao, 2003) [15]. In order to reduce the usage of synthetic pesticides, it is now necessary to look for alternate pest management methods. Because they have a variety of qualities, such as being toxic to pests, repellent, antifeedant, and regulating insect growth, botanical pesticides are crucial options to reduce or replace the usage of synthetic pesticides. It is possible to reduce pesticide resistance and pest resurgence issues while using safe and environmentally friendly botanicals with various mechanisms of action. (Nathan *et al.*, 2005) [13].

Modern insecticides affect the environment, consumers, and the health of farm workers, because of their inherent toxicity. Negative effects on human health led to a resurgence in interest in botanical insecticides because of their minimal costs and ecological side effects. Botanicals are preferable to traditional broad-spectrum insecticides. They are effective in very little quantities, only affect the targeted pest and closely related organisms, degrade quickly, and offer residue-free food and a secure environment to live. Botanical pesticides can significantly reduce the use of modern pesticides when used in integrated pest management programmes, or when used in conjunction with other insecticides or in rotation, it may be possible to use less pesticide overall while also preventing or postponing the emergence of pest populations that are resistant to it. Plant-based pesticides prevent pests and/or repel them in addition to causing acute toxicity to them, which may help them be more effective overall against some pests that lead to significant financial losses during the preharvest and postharvest stages of crop production and spread diseases to both animals and people. For pest control, botanical pesticides are preferable than synthetic chemical insecticides. They are most effective when used in the production of organic foods in industrialized nations, but they have far more potential as a new category of environmentally friendly pest control treatments in developing nations. (Khater, 2012) [10].

This experiment was performed to evaluate different botanical insecticides combination against two rice insect pests *i.e*., gall midge *(Orseolia oryzae* W.) and yellow stem borer (*Scirpophaga incertulas* W.).

Materials and Methods

The experiment was conducted in research cum instructional farm of Shaheed Gundadhoor College of Agriculture and Research Station, Jagdalpur, Bastar (C.G.) during *Kharif*, 2022. Field experiment was conducted on Swarna variety of rice crop to evaluate the botanical insecticides against gall midge and yellow stem borer. The crop was transplanted in randomized block design in plot size of 20 m^2 in four replications (Fig. 1). The row to row and plant to plat spacing was 20 x 15 cm. During the period while the crop was growing, all agronomic procedures were followed. The complete details of different treatments are provided in Table 1.

Mode of spray of insecticides

Three applications of the test insecticides were applied on need basis.

Schedules of insecticide application

1st application: field application at 25 DAT
2nd application: field application at 45 DAT
3rd application: field application at 60 DAT

Incidence of gall midge as silver shoot (SS %) and stem borer as dead heart (DH %) were recorded on 3, 7 and 15 days after every spray and then damage percentages were worked out. In the observation of data, healthy and damaged tillers were recorded for the percent infestation of insect pests. Ten randomly selected hills from every plot were observed for the infestation of insect pests *viz*., gall midge and stem borer. Percent infestation of insect-pests were calculated by given formula:

$$\text{Per cent silver shoot (SS\%)} = \frac{\text{Number of silver shoots}}{\text{Total numbers of tillers}} \times 100$$

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

Statistical analysis

The study's methodology was a random-block design. The data were statistically examined using the proper transformation. It is recommended to use $\sqrt{x + 0.5}$ rather than $\sqrt{x}$, where x is the original data, if the majority of the numbers in the data set are tiny (e.g., fewer than 10), especially if there are any zeros. This transformed data was then analysed by the method of analysis of variance. The 'F' test was applied with a 5% level of significance. At a level of significance of 5%, critical difference (CD) values were examined. (Gomez and Gomez, 1984; Draper and Smith, 1998) [7, 6].

CD= SE_d (Standard error of deviation) x Table t-value at 5% of significance.

Results and Discussion

At SGCARS, Jagdalpur, Bastar, various botanicals and pesticide combinations were assessed against the gall midge and yellow stem borer of rice for the management of insect pests of rice. Three sprays were applied at 25 DAT, 45 DAT and 60 DAT. The botanicals and chemical insecticide molecules, Neemazal 1% EC @ 2 ml L^{-1}, Eucalyptus oil @ 2 ml L^{-1}, Neemoil @ 10 ml L^{-1}, Neem baan (Azadirachtin 10000 ppm) @ 2 ml L^{-1}, Karanj oil @ 10 ml L^{-1}, Cartap hydrochloride 50% SC @ 2 g L^{-1}, Triflumezopyrim 10% SC @ 0.48 ml L^{-1}, Fipronil 0.3 GR @ 2.5 g m^{-2}, Chlorantraniliprole 0.4 G @ 1 g m^{-2} with different combinations (like all botanicals, botanicals with chemicals and all chemicals) and untreated control were evaluated for their efficacy against two insect pests of rice. These insect pests are: gall midge, *Orseolia oryzae* W. and yellow stem borer, *Scirpophaga incertulas* Walk. Observations were recorded at 3, 7 and 15 days after every spray, the mean of three observations and their statistical analysis was worked out.

1. Efficacy of insecticides against gall midge (*Orseolia oryzae* W.)

According to the data presented (Table 2 and Fig. 2), In comparison to the untreated control, the effectiveness of botanical and insecticidal treatments was substantially greater. The 1st spray was applied at 25 Days after transplanting (DAT) and the observation was recorded at 3, 7 and 15 days after spray, The treatment T_1 - Neemazal 1% EC @ 2 ml L^{-1} was observed with best results (8.64 SS %) and T_2 - Neemazal 1% EC @ 2 ml L^{-1} with T_4 - Neemazal 1% EC @ 2 ml L^{-1} were at par with T_1 having 8.90 SS % and 10.10 SS % respectively, followed by T_3 - Neem baan (Azadirachtin 10000 ppm) @ 2 ml L^{-1} (13.05 SS%). The highest incidence of silver shoot was received in case of untreated plot T_6 (14.46 SS %). Treatment T_5 - Chlorantraniliprole 0.4 G @ 1 g m^{-2} depicted minimum incidence of silver shoot (4.72 SS %), which was a check.

The 2nd spray was applied at 45 DAT and the observation was recorded at 3, 7 and 15 days after spray, all the botanicals and insecticidal treatments were significantly superior to the untreated control. Better reduction of silver shoot incidence was observed in T_1 - Eucalyptus oil @ 2 ml L^{-1} (17.13 SS %) and T_4 - Eucalyptus oil @ 2 ml L^{-1} (18.15 SS %), T_4 was at par with T_1, followed by T_3 - Karanj oil @ 10 ml L^{-1} (23.12 SS %) and T_2 - Neemoil @ 10 ml L^{-1} (24.21 SS %). Best results were recorded when applied T_5 - Cartap hydrochloride 50% SC @ 2 g L^{-1} with 9.22 SS %, which was a check. The highest incidence of silver shoot (30.62 SS %) was observed in case of untreated plot (T_6).

The 3rd spray was applied at 60 DAT and the observation was recorded at 3, 7 and 15 days after spray, all the botanicals and insecticidal treatments continued to perform significantly superior to the untreated control. Treatment T_1 - Cartap hydrochloride 50% SC @ 2 g L^{-1} (15.63 SS%) showed best results, T_2 - Triflumezopyrim 10% SC @ 0.48 ml L^{-1} (17.59 SS%) and T_3 - Fipronil 0.3 GR @ 2.5 g m^{-2} (17.67 SS%) both were at par with T_1, followed by T_4 - Neemoil @ 10 ml L^{-1} (25.82 SS%). Plots treated with the check treatment T_5 - Triflumezopyrim 10% SC @ 0.48 ml L^{-1} showed the minimum incidence of silver shoot (9.21 SS %). The maximum incidence of silver shoot was recorded in case of untreated control (T_6) with 31.24 percent.

Table 2 and Fig. 2 exhibit the combined data on the effectiveness of botanicals and insecticides against rice gall midge, which demonstrate that all treatments significantly outperformed the untreated control and decreased the percentage of silver shoots. Among treatments, the best result was shown by treatment T_1 (13.80 SS %), which was combination of Neemazal 1% EC @ 2 ml L^{-1}, Eucalyptus oil @ 2 ml L^{-1} and Cartap hydrochloride 50% SC @ 2 g L^{-1} applied at 25, 45 and 60 DAT respectively, with 45.75 percent reduction over control (ROC) followed by T_2 (16.90 SS%) with 33.57% ROC, which was combination of Neemazal 1% EC @ 2 ml L^{-1}, Neemoil @ 10 ml L^{-1} and Triflumezopyrim 10% SC @ 0.48 ml L^{-1}, T_3 (17.95 SS %) with 29.44% ROC, which was combination of Neem baan (Azadirachtin 10000 ppm) @ 2 ml L^{-1}, Karanj oil @ 10 ml L^{-1} and Fipronil 0.3 GR @ 2.5 g m^{-2}, T_4 (18.02 SS%) with 29.17% ROC, which was combination of Neemazal 1% EC @ 2 ml L^{-1}, Eucalyptus oil @ 2 ml L^{-1} and Neemoil @ 10 ml L^{-1} applied at 25, 45 and 60 DAT respectively. Check treatment was T_5 (7.72 SS%) with 69.65 percent reduction over control (ROC), which was combination of different chemicals *viz*., Chlorantraniliprole 0.4G @ 1 g m^{-2}, Cartap hydrochloride 50% SC @ 2 g L^{-1} and Triflumezopyrim 10% SC @ 0.48 ml L^{-1} applied at 25, 45 and 60 DAT respectively.

Earlier, Mohapatra (2018) [12] observed that Handi Ausadha (pot mixture of 5 L fermented cow urine + 1 kg fresh cow dung + 1 kg Karanj + 1 kg Neem + 1 kg Calotropis + 50 g Gur) @ 20 mlL-1 was substantially more effective in eliminating gall midge. (61.93% SS). Seni (2019) also reported that cedar wood oil at 1000 ml ha^{-1} proved successful in lowering gall midge occurrence.

Similarly, Cholantraniliprole was shown to be the most efficient insecticide against the gall midge, according to Karthikeyan and Swathy (2020) [9] with 1.82% silver shoot, while Neemazal treated plots had decreased gall midge with 5.38% silver shoot. Kumari and Prasad (2020) [11] also demonstrated that the effectiveness of botanical insecticidal treatments in reducing silver shoots affected by gall midges was significantly greater than control in Neem Baan (Aza. 1.0% EC) @ 1000 ml ha^{-1} with 4.71% SS.

2. Efficacy of insecticides against yellow stem borer (*S. incertulas* Walker)

From the data presented (Table 3 and Fig. 3), the efficacy of botanicals and insecticidal treatments were significantly superior to the untreated control. The 1st spray was applied at 25 DAT and the observation was recorded at 3, 7 and 15 days after spray. The treatment T_1 - Neemazal 1% EC @ 2 ml L^{-1} was observed with best results (2.25% DH) and T_2 - Neemazal 1% EC @ 2 ml L^{-1} with T_4 - Neemazal 1% EC @ 2 ml L^{-1} were at par with T_1 having 2.26% DH and 2.32% DH respectively, followed by T_3 - Neem baan (Azadirachtin 10000 ppm) @ 2 ml L^{-1} (4.16% DH). Treatment T_5 - Chlorantraniliprole 0.4 G @ 1 g m^{-2} depicted minimum incidence of stem borer (0.95% DH), which was a check. The highest incidence of dead heart was received in case of untreated plot T_6 (4.36% DH).

The 2nd spray was applied at 45 DAT and the observation was recorded at 3, 7 and 15 days after spray. compared to the untreated control, all botanical and insecticidal treatments were far more effective. T_1 - Eucalyptus oil @ 2 ml L^{-1} (11.26% DH) showed a better reduction in stem borer incidence. and T_4 - Eucalyptus oil @ 2 ml L^{-1} (11.36% DH) and T_3 - Karanj oil @ 10 ml L^{-1} (15.16% DH). T_4 and T_3 were at par with T_1, followed by T_2 - Neemoil @ 10 ml L^{-1} (15.74% DH). Best results were recorded in check treatment T_5 - Cartap hydrochloride 50% SC @ 2 g L^{-1} with 6.88% DH. The untreated plot (T6) exhibited the highest prevalence of stem borer (18.39% DH).

The 3rd spray was applied at 60 DAT and the observation was recorded at 3, 7 and 15 days after spray, all the botanicals and insecticidal treatments continued to perform significantly superior to the untreated control. Treatment T_1 - Cartap hydrochloride 50% SC @ 2 g L^{-1} (5.52% DH) showed best results, T_2 - Triflumezopyrim 10% SC @ 0.48 ml L^{-1} (5.61% DH) and T_3 - Fipronil 0.3 GR @ 2.5 g m^{-2} (6.19% DH) both were at par with T_1, followed by T_4 - Neemoil @ 10 ml L^{-1} (12.23% DH). Plots treated with the check treatment T_5 - Triflumezopyrim 10% SC @ 0.48 ml L^{-1} showed the minimum incidence of dead heart (2.38% DH), the maximum incidence of stem borer (DH) was received in case of untreated control (T_6) with 14.22 percent.

The data pertaining to the efficacy of botanicals and insecticides against rice yellow stem borer has been collaborated and presented in Table 3 and Fig. 3, showing that all the treatments were significantly superior over untreated control and they were reducing dead heart percentage. Among treatments, the best result was shown by treatment T_1 (6.34% DH), which was combination of Neemazal 1% EC @ 2 ml L^{-1}, Eucalyptus oil @ 2 ml L^{-1} and Cartap hydrochloride 50% SC @ 2 g L^{-1} applied at 25, 45 and 60 DAT respectively, with 48.54 percent reduction over control (ROC), T_2 (7.87% DH) with 36.12% ROC, which was combination of Neemazal 1% EC @ 2 ml L^{-1}, Neemoil @ 10 ml L^{-1} and Triflumezopyrim 10% SC @ 0.48 ml L^{-1}, was at par with T_1, followed by T_3 (8.51% DH) with 30.93% ROC, which was combination of Neem baan (Azadirachtin 10000 ppm) @ 2 ml L^{-1}, Karanj oil @ 10 ml L^{-1} and Fipronil 0.3 GR @ 2.5 g m^{-2}, T_4 (8.63% DH) with 29.95% ROC, which was combination of Neemazal 1% EC @ 2 ml L^{-1}, Eucalyptus oil @ 2 ml L^{-1} and Neemoil @ 10 ml L^{-1} applied at 25, 45 and 60 DAT respectively. Check treatment was T_5 (3.38% DH) with 72.56 percent reduction over control (ROC), which was combination of different chemicals *viz*., Chlorantraniliprole 0.4G @ 1 g m^{-2}, Cartap hydrochloride 50% SC @ 2 g L^{-1} and Triflumezopyrim 10% SC @ 0.48 ml L^{-1} applied at 25, 45 and 60 DAT respectively.

Former researcher, Dhaliwal *et al*. (2002) [5] evaluated four high potency azadirachtin-based neem formulations, including Rakshak 1%, Neemazal 1% and 5%, and Nimbecidine 0.03% against the yellow stem borer, monocrotophos had the lowest incidence of YSB and was on par with Neemazal at 5% @ 0.50 mL^{-1}. Islam *et al.* (2013) [8] also reported that white head and dead heart were both reduced by 58.08% and 38.38%, respectively, when botanical extracts, namely Tobacco, Neem, and Karanja extracts at a concentration of 15 ml L^{-1} each, as well as two insecticides, Acephate 75 SP at a concentration of 2 g L^{-1} and Fipronil (Nema 50 SC) at a concentration of 2 ml L^{-1}, were included in the treatment's concentrations against the yellow stem borer, *Scirpophaga incertulas*.

In addition, Rajpoot *et al*. (2021) [16] noted that the white ear mean damage recorded by all chemical's treatment modules was 1.3% as opposed to 28.8% for the untreated control. Among alternative treatments, the combination of Neemazal, Eucalyptus oil, and Cartap hydrochloride showed the lowest mean infestation of 4.1% DH.

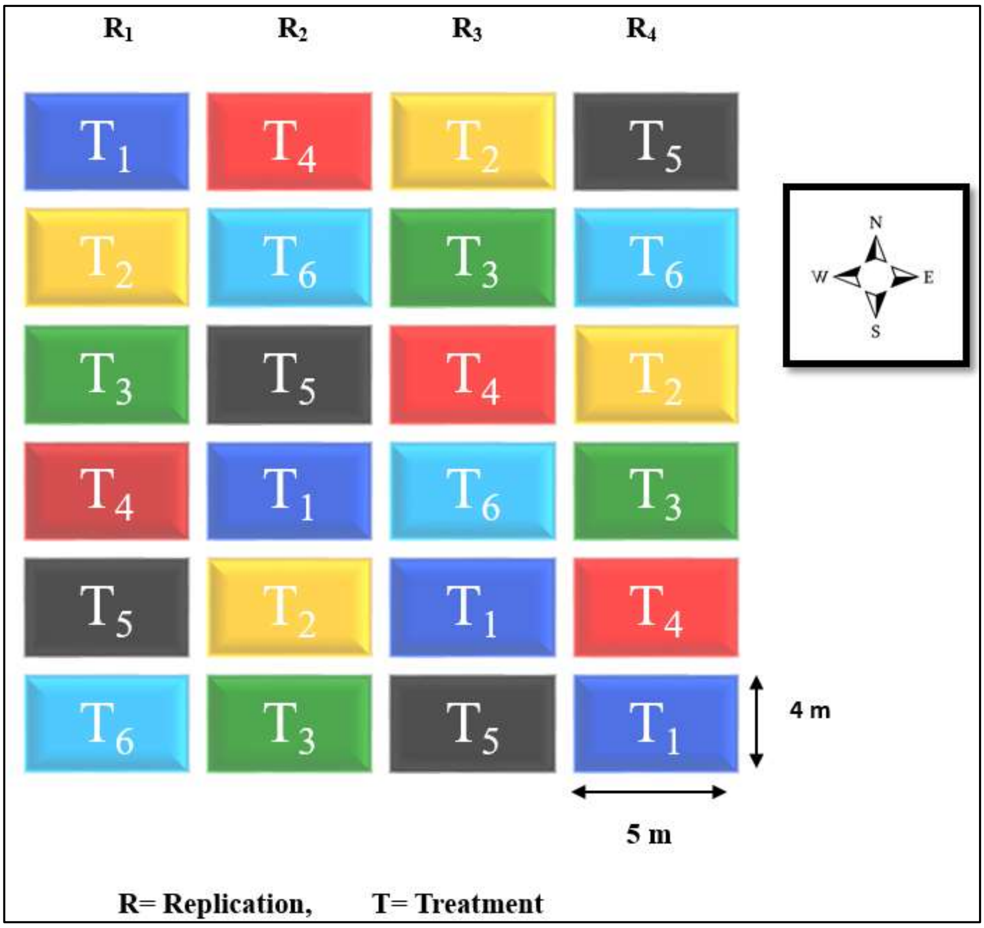

Fig 1: Layout plan and randomization

Table 1: Details about the insecticidal treatments: The experiment was conducted in a randomized block design with 4 replications. The experiment consists of 6 different treatments.

Treatment	Trt no.	Insecticide	Dosage
Botanicals+ insecticides	T_1	Neemazal 1% EC (25 DAT)	2 ml L^{-1}
		Eucalyptus oil (45 DAT)	2 ml L^{-1}
		Cartap hydrochloride 50% SC (60 DAT)	2 g m^{-2}
Botanicals+ Insecticides	T_2	Neemazal 1% EC (25 DAT)	2 ml L^{-1}
		Neemoil (45 DAT)	10 ml L^{-1}
		Triflumezopyrim 10% SC (60 DAT)	0.48 ml L^{-1}
Botanicals+ Insecticides	T_3	Neem Baan (Azadirachtin 10000 ppm) (25 DAT)	2 ml L^{-1}
		Karanj oil (45 DAT)	10 ml L^{-1}
		Fipronil 0.3 GR (60 DAT)	2.5 g m^{-2}
All Botanicals	T_4	Neemazal 1% EC (25 DAT)	2 ml L^{-1}
		Eucalyptus oil (45 DAT)	2 ml L^{-1}
		Neem oil (60 DAT)	10 ml L^{-1}
All insecticide	T_5	Chlorantraniliprole 0.4G (25 DAT)	1.0 g m^{-2}
		Cartap hydrochloride 50% SC (45 DAT)	2 g m^{-2}
		Triflumezopyrim 10% SC (60 DAT)	0.48 ml L^{-1}
Untreated control	T_6	Untreated control	

Table 2: Effect of the botanical insecticides against gall midge at different growth stages of rice crop

Treatments		Dosage	Silver shoots (%)				Reduction percent over control (%)
			40 DAT	60 DAT	75 DAT	Overall mean	
T1	Neemazal 1% EC (25 DAT)	2 ml L^{-1}	8.64 (3.09)	17.13 (4.24)	15.63 (4.07)	13.80 (3.85)	45.75
	Eucalyptus oil (45 DAT)	2 ml L^{-1}					
	Cartap hydrochloride 50% SC (60 DAT)	2 g m^{-2}					
T2	Neemazal 1% EC (25 DAT)	2 ml L^{-1}	8.90 (3.14)	24.21 (5.01)	17.59 (4.30)	16.90 (4.23)	33.57
	Neemoil (45 DAT)	10 ml L^{-1}					
	Triflumezopyrim 10% SC (60 DAT)	0.48 ml L^{-1}					
T3	Neem Baan (Azadirachtin 10000 ppm) (25 DAT)	2 ml L^{-1}	13.05 (3.71)	23.12 (4.88)	17.67 (4.31)	17.95 (4.35)	29.44
	Karanj oil (45 DAT)	10 ml L^{-1}					
	Fipronil 0.3 GR (60 DAT)	2.5 g m^{-2}					
T4	Neemazal 1% EC (25 DAT)	2 ml L^{-1}	10.10 (3.31)	18.15 (4.36)	25.82 (5.18)	18.02 (4.36)	29.17
	Eucalyptus oil (45 DAT)	2 ml L^{-1}					
	Neem oil (60 DAT)	10 ml L^{-1}					
T5	Chlorantraniliprole 0.4G (25 DAT)	1.0 g m^{-2}	4.72 (2.38)	9.22 (3.18)	9.21 (3.19)	7.72 (2.95)	69.65
	Cartap hydrochloride 50% SC (45 DAT)	2 g m^{-2}					
	Triflumezopyrim 10% SC (60 DAT)	0.48 ml L^{-1}					
T6	Untreated control		14.46 (3.92)	30.62 (5.53)	31.24 (5.66)	25.44 (5.12)	0.00
	SE(m)±		0.15	0.20	0.15	0.09	
	C.D. at 5%		0.47	0.61	0.47	0.28	

*Figures in parenthesis are square root transformed values ($\sqrt{x+0.5}$) * Mean of three observations *i.e.*, 3, 7 and 15 days after spray

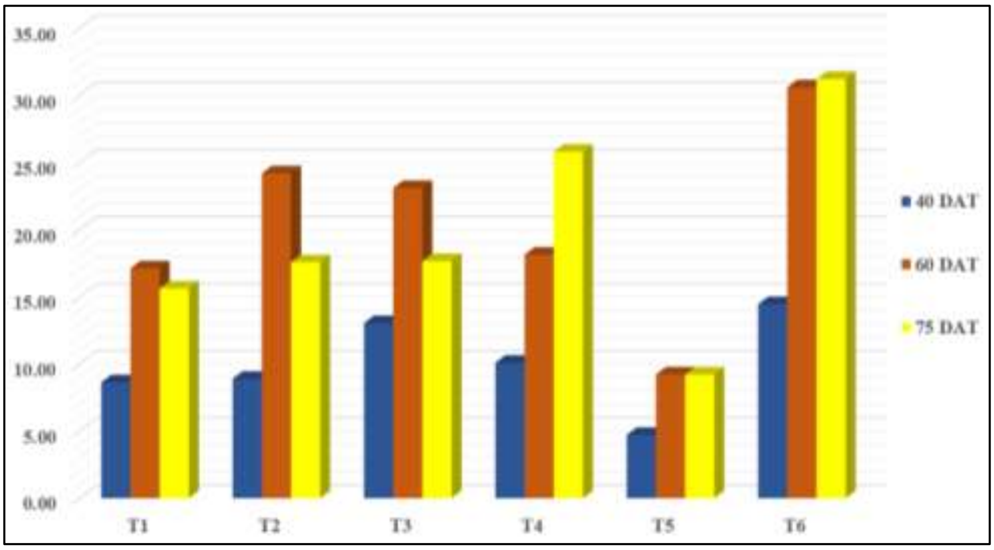

Fig 2: Effect of the botanical insecticides against gall midge at different growth stages of rice crop during *Kharif* 2022

Table 3: Effect of the botanical insecticides against stem borer at different growth stages of rice crop

Treatments		Dosage	Dead heart (%)				Reduction percent over control (%)
			40 DAT	60 DAT	75 DAT	Overall mean	
T1	Neemazal 1% EC (25 DAT)	2 ml L^{-1}	2.25 (1.79)	11.26 (3.48)	5.52 (2.53)	6.34 (2.70)	48.54
	Eucalyptus oil (45 DAT)	2 ml L^{-1}					
	Cartap hydrochloride 50% SC (60 DAT)	2 g m^{-2}					
T2	Neemazal 1% EC (25 DAT)	2 ml L^{-1}	2.26 (1.80)	15.74 (4.08)	5.61 (2.56)	7.87 (2.97)	36.12
	Neemoil (45 DAT)	10 ml L^{-1}					
	Triflumezopyrim 10% SC (60 DAT)	0.48 ml L^{-1}					
T3	Neem Baan (Azadirachtin 10000 ppm) (25 DAT)	2 ml L^{-1}	4.16 (2.26)	15.16 (4.01)	6.19 (2.68)	8.51 (3.08)	30.93
	Karanj oil (45 DAT)	10 ml L^{-1}					
	Fipronil 0.3 GR (60 DAT)	2.5 g m^{-2}					
T4	Neemazal 1% EC (25 DAT)	2 ml L^{-1}	2.32 (1.81)	11.36 (3.50)	12.23 (3.63)	8.63 (3.10)	29.95
	Eucalyptus oil (45 DAT)	2 ml L^{-1}					
	Neem oil (60 DAT)	10 ml L^{-1}					
T5	Chlorantraniliprole 0.4G (25 DAT)	1.0 g m^{-2}	0.95 (1.39)	6.81 (2.79)	2.38 (1.83)	3.38 (2.09)	72.56
	Cartap hydrochloride 50% SC (45 DAT)	2 g m^{-2}					
	Triflumezopyrim 10% SC (60 DAT)	0.48 ml L^{-1}					
T6	Untreated control		4.36 (2.30)	18.39 (4.39)	14.22 (3.89)	12.32 (3.65)	0.00
	SE(m)±		0.12	0.19	0.16	0.11	
	C.D. at 5%		0.37	0.59	0.48	0.35	

*Figures in parenthesis are square root transformed values ($\sqrt{x+0.5}$) * Mean of three observations *i.e.*, 3, 7 and 15 days after spray

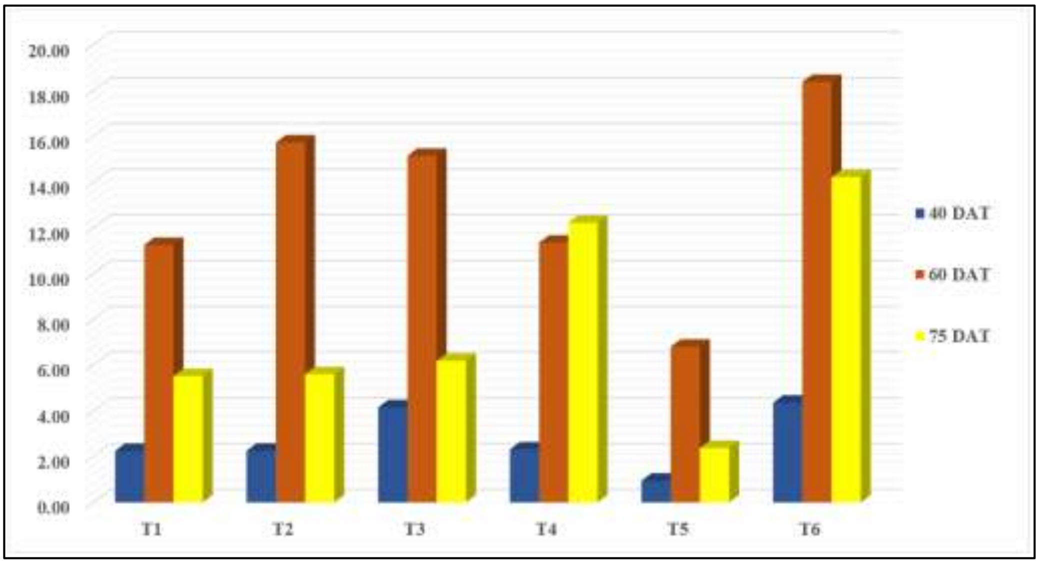

Fig 3: Effect of the botanical insecticides against stem borer at different growth stages of rice crop during *Kharif* 2022

Conclusion

In the evaluation of botanical insecticides, Among the treatments, significantly superior results were recorded in check treatment T_5 (containing combination of Chlorantraniliprole 0.4G, Cartap hydrochloride 50% SC and Triflumezopyrim 10% SC) for both insect pests with 69.65% ROC and 72.56% ROC in gall midge and stem borer, respectively.

Among the treatments, T_1 (combination of Neemazal 1% EC, Eucalyptus oil and Cartap hydrochloride 50% SC) performed best (45.75% ROC) against gall midge, followed by T_2, T_3 and T_4 and against stem borer, T_1 (combination of Neemazal 1% EC, Eucalyptus oil and Cartap hydrochloride 50% SC) performed best (48.54% ROC), T_2 (combination of Neemazal 1% EC, Neemoil and Triflumezopyrim 10% SC) having 36.12% ROC was at par with T_1, followed by T_3 and T_4.

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Layout for allocation of different treatments

Four replications for the experiment were done in a randomized block design. The experiment's design, which depicts how the modules were distributed, is shown in fig. 1. Six treatments, including an untreated control, were distributed at random to various plots with four replications.

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