

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; 9(12): 964-969
www.biochemjournal.com
Received: 01-10-2025
Accepted: 05-11-2025

Kanhaiya Prasad Sai
Department of Entomology,
Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

NC Mandawi
Department of Entomology,
Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Geeta Songer
Department of Entomology,
Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Manish Kumar
Department of Entomology,
Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Vinita Darro
Department of Entomology,
Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Corresponding Author:
Kanhaiya Prasad Sai
Department of Entomology,
Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Efficacy of chemical insecticides against rice gall midge, *Orseolia oryzae* (Wood-Mason) at Bastar region

Kanhaiya Prasad Sai, NC Mandawi, Geeta Songer, Manish Kumar and Vinita Darro

DOI: <https://www.doi.org/10.33545/26174693.2025.v9.i12l.6697>

Abstract

A field experimental trial was conducted during the *Kharif* season 2022 to evaluate the comparative efficacy of some insecticides against the gall midge of rice. The results clearly indicated that, after insecticidal application, silver shoots varied from 5.44-31.34 per cent over the *Kharif* season. T₈-Fipronil 0.3 GR + Chlorantraniliprole 0.4 GR @ 2.5 + 10 kg ha⁻¹ and T₉-Fipronil 0.3 GR + Cartap hydrochloride 4% GR @ 2.5 + 19 kg ha⁻¹ with averages of 5.44 and 6.44 per cent silver shoots respectively. T₂-Fipronil 0.3 GR @ 2.5 kg ha⁻¹ showed the least effective when applied in the nursery. Regarding the insecticide cost benefit ratio (ICBR), combine of nursery treatment and main field treatment of T₂-Fipronil 0.3 GR @ 2.5 kg ha⁻¹ and T₆-Chlorantraniliprole 0.4 G @ 10 kg ha⁻¹ was more efficient with an average yield (54.50 q ha⁻¹) and all other insecticidal treatments showed significant superiority over untreated control (42.60 q ha⁻¹).

Keywords: Chemical insecticides, *Orseolia oryzae* W., rice

Introduction

Rice (*Oryza sativa* L.) is the world's single most important crop, belonging to the family Poaceae. It is one of the most important cereals and a staple diet for more than 2 billion people. With a yield of roughly 118.43 million tonnes and an average productivity of 2.75 tonnes ha⁻¹, rice was produced on approximately 43 million hectares in India. (Anonymous, 2020 a) [1]. About 82% of the people living in the state of Chhattisgarh, which is referred to as the "rice bowl of India," depend on agriculture for their livelihood. With a yield of 6.5 million tonnes and a productivity of 1.77 tonnes ha⁻¹, there were 3.6 million hectares of rice growing land in total. (Anonymous, 2020 b) [2]. Total production of rice during 2021-22 was recorded at 127.93 million tonnes. It was higher by 11.49 million tonnes than the last five years average production of 116.44 million tonnes (Anonymous, 2022) [3]. In previous decades, Ridley (1881) [19] initially reported an unknown insect pest on rice in the Monghyr area of Bihar, India; Wood-Mason later identified the pest as *Cecidomyia oryzae* (Cotes, 1889) [6].

The Asian rice gall midge *Orseolia oryzae* (Wood-Mason) (Diptera: Cecidomyiidae) is a serious pest of rice (*Oryza sativa* L.) in India, causing an average annual yield loss of about US \$80 million (Bentur *et al.*, 2003) [4]. According to estimations for yield loss, silver shoot damage caused by 1% gall midge caused a 3.5% loss (Muralidharan and Pasalu, 2005) [14]. *Orseolia oryzae* and *Orseolia oryzivora*'s mature flies have wings that are 3.0-3.5 mm for males and 3.5-4 mm for females, making them roughly the size of mosquitoes. They are phototropic and nocturnal. The males' abdomens are darker in colour, while the females are bright red and stout. The female-to-male ratio in *Orseolia oryzae* field populations is typically 4:1, but it is 1:1 in *Orseolia oryzivora*. The adults have a lifespan of 2 to 5 days and feed on dewdrops. Soon after emergence, copulation often occurs and lasts for about five minutes. A few hours later, there is oviposition. Unmated females deposit infertile eggs, and the females only mate once. No parthenogenesis has been seen. A single female is capable of depositing anywhere between 100 and 200 eggs, either single or in clusters of three to four near the base of the plants, on the ligules or nearby, on the leaf blade, or on the leaf sheath. Regular tillers are damaged when they change into tubular galls that dry up without producing panicles.

The pest begins by infesting the seedbed plants and keeps doing so up until the booting stage. The larvae cannot live on a crop past the vegetative stage since they can only develop on developing primordia (Pathak and Khan, 1994) [16].

The rice gall midge produces monogenous progeny, where in all off springs of a single females are of one sex only (Sain and Kalode, 1988) [20]. The occurrence of a female-biased sex ratio in a population, with male-producing females and female-producing females in the ratio of 1:1.32, is an interesting characteristic of the gall midge life cycle. (Panda and Mohanty, 1970) [15]. The young larvae of the gall midge, which take around two to three weeks to develop, do more damage. An active first instar larva at the meristem promotes the creation of a gall and inhibits the growth of the growth cone, causing the developing tips to be distorted into the shape of a gall and transform into "onion tips" or "silver shoots." A molecular "signal," or "cecidogen," is produced by the salivary glands of feeding larvae (Chiu, 1980) [5]. Significant yield losses result from the damaged tillers' failure to produce panicles. When rice is damaged, the quantity of unproductive tillers rises while the quantity of productive spikes falls (Tan *et al.*, 1996) [25]. Gall midge incidence was reported to be higher in late-sown crops and negatively correlated with yield (Kulkarni *et al.*, 1989) [9]. Early sowing and transplanting to avoid gall midge attack has been practised successfully (Hegdekatti, 1927) [8].

The gall midge attacks rice from the nursery to the end of the tillering stage. The larvae of the gall midge fly cause heavy damage to the rice crop. The gall midge fly's larvae severely harm the rice crop. Early infection causes the tillers to produce gall, which prevents them from producing panicles. During the dry season, the gall midge is dormant as a prepupa in weeds or wild rice. It starts active at the beginning of the monsoon season and completes one or two generations in grasses before switching to the rice crop (Reddy, 1967) [18]. The seasonal occurrence of gall midges began in late August, peaked in October, and then started to drop in December (Sain and Kalode, 1992) [21]. The Asian Rice Gall Midge (*Orseolia oryzae* W. Both single and group egg laying occurred parallel to the midrib. Until they reached an apical or lateral bud's growth point, newly born maggots moved between leaf sheaths. The newly emerged maggots had a pointed anterior end and were grey in colour. The plant produces distinctive galls, which turn ordinary tillers into tubular galls that dry up without yielding panicles. The gall is produced by the maggots as they eat within the developing bud and harm the growth points. An onion shoots or silver shoot is one way that damage manifests itself. The pest begins by infesting the seedlings and might carry on doing so until they are ready to boot. From September through October, they are active. Additionally, several areas of Kerala, Orissa, Andhra Pradesh, Madhya Pradesh, Jharkhand, and Bihar are negatively affected. In north eastern UP, the loss caused by this pest is very low but in Jharkhand, Prasad, (2011) [17] estimated 20-70% loss due to infestation of rice gall midge.

Materials and Methods

The experiment was conducted at Research cum Instructional farm of Shaheed Gundadhoor College of Agriculture and Research Station, Jagdalpur, Bastar (C.G.) 494001 during *Kharif* 2022 with Randomized Block Design (RBD). Rice variety "Swarna" evaluated against gall midge

pests of rice with chemical insecticides. Nursery treatment was done with chemicals, *i.e.*, carbofuran 3% GR, fipronil 0.3 GR and chlorantraniliprole 0.4 GR, one week before transplanting. The experimental field was divided into 3 replications, with 10 plots in each replication. The plot size was 20 m² and 20 x 15 cm spacing (R x P). The data observations were taken from 10 hills, which were selected randomly from each plot. The observation of gall midges infesting rice were recorded at 35, 50 and 65 DAT. The observation was recorded by counting damage done by rice gall midges, *i.e.*, silver shoots (SS) on the basis of total numbers of tillers and gall midge damaged tillers (silver shoots) at the vegetative stage. According to Singh and Singh, 2017, the per cent damage was calculated by using the formula:

$$\text{Percent silver shoot (\%)} = \frac{\text{Number of silver shoots}}{\text{Total number of tillers}} \times 100$$

Results and Discussion

Different insecticides were evaluated against gall midge of rice at SGCARS Farm, Kumhrawand, Jagdalpur, Bastar. The insecticides were applied in the nursery treatment and main field on rice crop. The insecticide molecules, Carbofuran 3% GR (Check) @ 3.3 g/m², Fipronil 0.3 GR @ 2.5 g/m², Chlorantraniliprole 0.4 GR @ 1.0 g/m², Cartap hydrochloride 4% GR @ 1.9 g/m² and untreated control were evaluated for their efficacy against rice gall midge, *Orseolia oryzae* W.

Perusal of data presented (Table 2) on efficacy of chemical insecticides against rice gall midge in field condition, observed that the insecticidal treatments were significantly superior to the untreated control. First observation was taken at 35 DAT (days after transplanting) in which T₈-combine of nursery treatment and main field treatment of fipronil 0.3 GR @ 2.5 g/m² + chlorantraniliprole 0.4 GR @ 1.0 g/m² (T₂ + T₆) depicted minimum incidence of silver shoots (4.94 SS%) and the use of insecticides statistically at par with T₉. combine of nursery treatment and main field treatment of fipronil 0.3 GR @ 2.5 g/m² + cartap hydrochloride 4% GR @ 1.9 g/m² (T₂ + T₇) with 5.87 SS%, followed by T₄-carbofuran 3% GR (Check 2) @ 3.3 g/m² with 8.02 SS%, T₆-chlorantraniliprole 0.4 GR @ 1.0 g/m² (9.73 SS%), T₇-cartap hydrochloride 4% GR @ 1.9 g/m² (11.55 SS%), T₅-fipronil 0.3 GR @ 2.5 g/m² (12.31 SS%), T₁-carbofuran 3% GR (Check 1) @ 3.3 g/m² (12.34 SS%), T₃-chlorantraniliprole 0.4 GR @ 1.0 g/m² (12.57 SS%) and T₂-fipronil 0.3 GR @ 2.5 g/m² (13.22 SS%). The highest incidence of silver shoot (23.76 SS%) was received in case of untreated plot.

At 50 DAT (days after transplanting) all the insecticidal treatments were found to be significantly superior to the untreated control. Higher reduction per cent of silver shoots incidence were recorded from T₈-combine of nursery treatment and main field treatment of fipronil 0.3 GR @ 2.5 g/m² + chlorantraniliprole 0.4 GR @ 1.0 g/m² (T₂ + T₆) depicted minimum incidence of silver shoots (6.09 SS%) and the use of insecticides statistically at par with T₉-combine of nursery treatment and main field treatment of fipronil 0.3 GR @ 2.5 g/m² + cartap hydrochloride 4% GR @ 1.9 g/m² (T₂ + T₇) with 6.71 SS%, followed by T₄-carbofuran 3% GR (Check 2) @ 3.3 g/m² (10.24 SS%), T₆-chlorantraniliprole 0.4 GR @ 1.0 g/m² (11.16 SS%), T₅-fipronil 0.3 GR @ 2.5 g/m² (13.24 SS%), T₇-cartap

hydrochloride 4% GR @ 1.9 g/m² (14.10 SS%), T₁-carbofuran 3% GR (Check 1) @ 3.3 g/m² (15.89 SS%), T₃-chlorantraniliprole 0.4 GR @ 1.0 g/m² (17.04 SS%) and T₂-fipronil 0.3 GR @ 2.5 g/m² (18.09 SS%). The highest incidence of silver shoot (37.23 SS%) was received from T₁₀-untreated plot.

At 65 DAT (days after transplanting), the observations were recorded, the lowest incidence of silver shoots (5.28 SS%) showed in T₈-combine of nursery treatment and main field treatment of fipronil 0.3 GR @ 2.5 g/m² + chlorantraniliprole 0.4 GR @ 1.0 g/m² (T₂ + T₆) which was at par with T₉-combine of nursery treatment and main field treatment of fipronil 0.3 GR @ 2.5 g/m² + cartap hydrochloride 4% GR @ 1.9 g/m² (T₂ + T₇) with 6.75 SS%, followed by T₇-cartap hydrochloride 4% GR @ 1.9 g/m² (11.67 SS%), T₄-carbofuran 3% GR (Check 2) @ 3.3 g/m² with 13.14 SS%, T₆-chlorantraniliprole 0.4 GR @ 1.0 g/m² (13.52 SS%), T₅-fipronil 0.3 GR @ 2.5 g/m² (15.96 SS%), T₁-carbofuran 3% GR (Check 1) @ 3.3 g/m² (21.15 SS%), T₃-chlorantraniliprole 0.4 GR @ 1.0 g/m² (21.54 SS%) and T₂-fipronil 0.3 GR @ 2.5 g/m² (22.03 SS%). The maximum incidence of silver shoot (33.02 SS%) was received from T₁₀-untreated control.

All of the treatments were found to be significantly superior than the untreated control and it decreased the proportion of silver shoots, according to data (overall mean) collected (Table 2), regarding the effectiveness of insecticides against rice gall midge. Among the treatments, the best result was observed in T₈-combine of nursery treatment and main field treatment in which fipronil 0.3 GR @ 2.5 g/m² + chlorantraniliprole 0.4 GR @ 1.0 g/m² (T₂ + T₆) were applied and recorded 5.44 SS% which was 82.65% reduction over control (ROC) and at par with T₉-combine of nursery treatment and main field treatment of fipronil 0.3 GR @ 2.5 g/m² + cartap hydrochloride 4% GR @ 1.9 g/m² (T₂ + T₇) with 6.44 SS% which was 79.44% ROC, followed by T₄-carbofuran 3% GR (Check 2) @ 3.3 g/m² with 10.46 SS% and 66.61% ROC, T₆-chlorantraniliprole 0.4 GR @ 1.0 g/m² (11.47 SS%) with 63.40% ROC, T₇-cartap hydrochloride 4% GR @ 1.9 g/m² (12.44 SS%) with 60.31% ROC, T₅-fipronil 0.3 GR @ 2.5 g/m² (13.84 SS%) with 55.85% ROC, T₁-carbofuran 3% GR (Check 1) @ 3.3 g/m² (16.46 SS%) with 47.48% ROC, T₃-chlorantraniliprole 0.4 GR @ 1.0 g/m² (17.05 SS%) with 45.59% ROC and T₂-fipronil 0.3 GR @ 2.5 g/m² (17.78 SS%) with 43.26% ROC. The highest percentage of silver shoot (31.34 SS%) was recorded in case of T₁₀-untreated plot.

Earlier, Dakouo and Nacro (1987) [7] recorded that one application of carbofuran were effective based on counts of silver shoots at 45, 60 and 60 days after transplantation. In treated plots compared to untreated plots, yields were 1-2 t ha⁻¹ greater. Singh *et al.* (2000) [23] evaluated the efficacy of several insecticides and observed that the percentage of silver (damaged) shoots at 60 DAT was 6.77% and 7.33% in the chlorpyrifos and carbofuran treatments in experiment 1 and all treatments were better than the monocrotophos treatment and untreated control. Seni and Naik (2017) [22] recorded the fipronil 5 SC @ 75 g a.i. ha⁻¹ were best treatment which recorded 3.03 and 2.14% silver shoot in two observations. Similarly, Misra and Sahithi (2006) [13] showed the cartap hydrochloride-treated plots had the lowest incidence of silver shoots at 15 days after spraying, with a maximum reduction of 74.1-78.7%, followed by phosphamidon (2.1-3.7%), with a 61.0-80.0% reduction

over control. Mardi *et al.* (2009) [12] observed that the carbofuran 3G was most effective against gall midge (SS%) and greater yield obtained (3032.5 kg ha⁻¹) followed by chlorpyrifos 40EC (2910.0 kg ha⁻¹) and phorate 10G (2832.5 kg ha⁻¹). Kumar *et al.* (2011) [10] recorded that the lowest gall midge infestation (4.98% silver shoot), higher grain (60.02 q ha⁻¹) with 79.73% SS reduction over control when isazophos 3G @ 0.75 kg a.i. ha⁻¹ applied in the nursery. This is followed by fipronil 0.3G @ 0.075 kg a.i. ha⁻¹ (9.07% SS) which recorded 55.77 q ha⁻¹ with 63.08% SS reduction over control and carbofuran 3G @ 1.0 kg a.i. ha⁻¹ (7.96% SS) which recorded grain yields of 55.33 q ha⁻¹ with 67.60% SS reduction over control.

Yield analysis and assessment of avoidable yield losses

The yields were obtained from different plots and all treatments had significantly superior than the untreated control. The data presented on Table 3 revealed that T₈-fipronil 0.3 GR + chlorantraniliprole 0.4 GR (T₂+ T₆) was most effective with 54.50 q ha⁻¹ yield when insecticide applied in the two times (Nursery + main field). The treatment showed 11.90 q ha⁻¹ actual increase in yield over untreated control which accounted for 27.93 per cent increase in yield due to treatment with 21.83 per cent avoidable losses. This treatment was superior to T₉-fipronil 0.3 GR + cartap hydrochloride 4% GR (T₂+ T₇) with 52.63 q ha⁻¹ yield which was 10.03 q ha⁻¹ actual increase in yield over untreated control with 19.06% avoidable losses (%) in yield, followed by T₄-carbofuran 3% GR (50.40 q ha⁻¹ yield) with 15.48% avoidable losses and T₆-chlorantraniliprole 0.4 GR (49.70 q ha⁻¹ yield) with 14.29% avoidable losses T₇-cartap hydrochloride 4% GR, (48.35 q ha⁻¹ yield) with 11.89% avoidable losses, T₅-fipronil 0.3 GR (48.13 q ha⁻¹ yield) with 11.50% avoidable losses, T₁-carbofuran 3% GR (Check 1) (44.60 q ha⁻¹ yield) with 4.48% avoidable losses and T₃-chlorantraniliprole 0.4 GR (44.00 q ha⁻¹ yield) with 3.18% avoidable losses respectively, with 10.03, 7.80, 7.10, 5.75, 5.53, 2.00 and 1.40 q ha⁻¹ actual increase in yield over control. The lowest yield (43.78 q ha⁻¹) was found in T₂-fipronil 0.3 GR) with 1.18 q ha⁻¹ actual increase in yield over untreated control and 2.70 per cent avoidable losses but it was superior to T₁₀ (untreated check) with 42.60 q ha⁻¹ yield.

The current findings partially supported with the work of Kumar *et al.* (2020) [11] recorded the 39.5 q ha⁻¹ yield which was obtained from chlorantraniliprole 18.5% SC at 15 ml ha⁻¹.

Economic analysis of management practices

Net benefit (Rs ha⁻¹)

From the data presented (Table 3) revealed that calculation of economic in different treatments was made by considering the net benefit Rs ha⁻¹ of individual components and the insecticide cost benefit ratio. The rice MSP rate was 2040 Rs q⁻¹ for 2022 at Chhattisgarh. During the experiment different insecticides were applied on rice at two times *i.e.*, nursery and main field treatment. Based on the economics of the management of gall midge of rice on different treatments, the best treatment was T₈-fipronil 0.3 GR + chlorantraniliprole 0.4 GR (T₂+ T₆) @ 2.5 + 10 kg ha⁻¹ with net benefit of 21656 Rs ha⁻¹ and the next best treatment was T₉-fipronil 0.3 GR + cartap hydrochloride 4% GR @ 2.5 + 19 kg ha⁻¹ with net benefit of 17571 Rs ha⁻¹, followed by T₆-chlorantraniliprole 0.4 GR @ 10 kg ha⁻¹ with net benefit of

12414 Rs ha⁻¹, T₄-carbofuran 3% GR @ 33 kg ha⁻¹ with net benefit of 12330 Rs ha⁻¹, T₇-cartap hydrochloride 4% GR @ 19 kg ha⁻¹ with net benefit of 9383 Rs ha⁻¹, T₅-fipronil 0.3 GR @ 25 kg ha⁻¹ with net benefit of 7588 Rs ha⁻¹, T₁-carbofuran 3% GR (Check 1) @ 3.3 kg ha⁻¹ with net benefit of 3542 Rs ha⁻¹, T₃-chlorantraniliprole 0.4 GR @ 1.0 kg ha⁻¹ with net benefit of 2469 Rs ha⁻¹ and the lowest net benefit was recorded in T₂-fipronil 0.3 GR @ 2.5 kg ha⁻¹ with net benefit of 1864 Rs ha⁻¹.

Insecticides cost benefit ratio (ICBR)

Cost benefit ratio of different insecticides when applied in the nursery and main field treatment *viz*; Carbofuran 3% GR, Fipronil 0.3 GR, Chlorantraniliprole 0.4 GR and Cartap hydrochloride 4% GR have been worked out in the context of suitability of individual insecticidal treatment which are presented in Table 3.

The maximum cost benefit ratio was found in the nursery treatment getting from T₁-carbofuran 3% GR (Check 1) with 1:6.58 ICBR, followed by T₃-chlorantraniliprole 0.4 GR with 1:6.38 ICBR and T₂-fipronil 0.3 GR with 1:3.39 ICBR. Carbofuran gave higher cost benefit ratio in the nursery because it was used in lower quantity (1/10 ha⁻¹) compared

to main field treatment. In the main field treatment, the maximum cost benefit ratio (1:6.00) was found in T₆-chlorantraniliprole 0.4 GR, followed by T₇-cartap hydrochloride 4% GR with 1:4.00 ICBR, T₄-carbofuran 3% GR (Check 2) with 1:3.44 ICBR and T₅-fipronil 0.3 GR with 1:2.05 ICBR. Both, in the nursery and main field treatment the best cost benefit ratio was found in T₈-combine of nursery treatment and main field treatment of fipronil 0.3 GR + chlorantraniliprole 0.4 GR (T₂ + T₆) which gave 1:8.27 ICBR and next best treatment was T₉-fipronil 0.3 GR + cartap hydrochloride 4% GR (T₂ + T₇) with 1:6.07 ICBR. It can be further seen that in terms of cost benefit ratio T₈-fipronil 0.3 GR + chlorantraniliprole 0.4 GR proved to be the best treatment against the rice gall midge.

Present findings are in conformity with the findings of Mardi *et al.* (2009) [12] recorded that the carbofuran which gave higher grain yield (3032.50 kg ha⁻¹) than other treatment but in terms of cost benefit ratio remained lowest (1.52) due to higher price of insecticides. Similarly, Seni and Naik (2017) [22] found that the cost benefit ratio was recorded in cartap hydrochloride 50 WP @ 375 g a.i. ha⁻¹ (1:5.55) and fipronil 5 SC @ 75 g a.i. ha⁻¹ (1:3.40).

Table 1: Treatment details

Crop Stage	Trt.	Insecticides	Dosage (formulation)
Nursery alone (15 DAS/one week before transplantation)	T ₁	Carbofuran 3% GR (Check 1)	3.3 g/m ²
	T ₂	Fipronil 0.3 GR	2.5 g/m ²
	T ₃	Chlorantraniliprole 0.4 GR	1.0 g/m ²
Main field (20 DAT)	T ₄	Carbofuran 3% GR (Check 2)	3.3 g/m ²
	T ₅	Fipronil 0.3 GR	2.5 g/m ²
	T ₆	Chlorantraniliprole 0.4 GR	1.0 g/m ²
	T ₇	Cartap hydrochloride 4% GR	1.9 g/m ²
Nursery+ Main field	T ₈	T ₂ + T ₆	-
	T ₉	T ₂ + T ₇	-
Untreated control	T ₁₀	Untreated control	-

Table 2: Efficacy of granular insecticides against rice gall midge

Crop Stage	Trt.	Insecticides	Dosage (formulation)	Silver shoot %			Overall mean	ROC (%)
				35 DAT	50 DAT	65 DAT		
Nursery alone (15 DAS/one week before transplantation)	T ₁	Carbofuran 3% GR (Check 1)	3.3 g/m ²	12.34 (3.65)	15.89 (4.11)	21.15 (4.70)	16.46 (4.18)	47.48
	T ₂	Fipronil 0.3 GR	2.5 g/m ²	13.22 (3.77)	18.09 (4.36)	22.03 (4.80)	17.78 (4.33)	43.26
	T ₃	Chlorantraniliprole 0.4 GR	1.0 g/m ²	12.57 (3.67)	17.04 (4.25)	21.54 (4.74)	17.05 (4.25)	45.59
Main field (20 DAT)	T ₄	Carbofuran 3% GR (Check 2)	3.3 g/m ²	8.02 (3.00)	10.24 (3.34)	13.14 (3.75)	10.46 (3.39)	66.61
	T ₅	Fipronil 0.3 GR	2.5 g/m ²	12.31 (3.64)	13.24 (3.77)	15.96 (4.11)	13.84 (3.85)	55.85
	T ₆	Chlorantraniliprole 0.4 GR	1.0 g/m ²	9.73 (3.26)	11.16 (3.49)	13.52 (3.81)	11.47 (3.53)	63.40
	T ₇	Cartap hydrochloride 4% GR	1.9 g/m ²	11.55 (3.53)	14.10 (3.88)	11.67 (3.54)	12.44 (3.67)	60.31
Nursery+ Main field	T ₈	T ₂ + T ₆		4.94 (2.44)	6.09 (2.66)	5.28 (2.49)	5.44 (2.53)	82.65
	T ₉	T ₂ + T ₇		5.87 (2.62)	6.71 (2.77)	6.75 (2.78)	6.44 (2.73)	79.44
	T ₁₀	Untreated control		23.76 (4.98)	37.23 (6.18)	33.02 (5.83)	31.34 (5.69)	0.00
SE(m) ±				0.15	0.15	0.17	0.08	
C.D. at 5%				0.45	0.44	0.50	0.24	

* Figures in parenthesis are square root transformed $\sqrt{x + 0.5}$

Table 3: Economics of the management of gall midge of rice on different treatments

Crop Stage	Trt.	Insecticides	Dosage (formulation)	Yield (q ha ⁻¹)	Additional gain yield over control		Avoidable loss in Yield (%)	Value of additional yield (Rs ha ⁻¹)	Cost of insecticides and labour (Rs ha ⁻¹)	Net Benefit (Rs ha ⁻¹)	Insecticide s cost benefit ratio (ICBR)
					q ha ⁻¹	(%)					
Nursery alone (15 DAS/one week before transplantation)	T ₁	Carbofuran 3% GR (Check 1)	3.3 g/m ²	44.60	2.00	4.69	4.48	4080	538	3542	6.58
	T ₂	Fipronil 0.3 GR	2.5 g/m ²	43.78	1.18	2.78	2.70	2414	550	1864	3.39
	T ₃	Chlorantraniliprole 0.4 GR	1.0 g/m ²	44.00	1.40	3.29	3.18	2856	387	2469	6.38
Main field (20 DAT)	T ₄	Carbofuran 3% GR (Check 2)	3.3 g/m ²	50.40	7.80	18.31	15.48	15912	3583	12330	3.44
	T ₅	Fipronil 0.3 GR	2.5 g/m ²	48.13	5.53	12.99	11.50	11288	3700	7588	2.05
	T ₆	Chlorantraniliprole 0.4 GR	1.0 g/m ²	49.70	7.10	16.67	14.29	14484	2070	12414	6.00
	T ₇	Cartap hydrochloride 4% GR	1.9 g/m ²	48.35	5.75	13.50	11.89	11730	2347	9383	4.00
Nursery+ Main field	T ₈	T ₂ + T ₆	-	54.50	11.90	27.93	21.83	24276	2620	21656	8.27
	T ₉	T ₂ + T ₇	-	52.63	10.03	23.55	19.06	20468	2897	17571	6.07
	T ₁₀	Untreated control		42.60	-	-	-	-	-	-	-

*Rice MSP as per C.G. Govt. Rs-2040 Rs q⁻¹ for 2022, Labour cost = 1 labour per day @ Rs 200.

Conclusion

The present study revealed that T₈fipronil 0.3 GR + chlorantraniliprole 0.4 GR (T₂+ T₆) was most effective against gall midges when insecticide applied two times (Nursery + main field). This treatment was superior to T₉-fipronil 0.3 GR + cartap hydrochloride 4% GR followed by T₄, T₆, T₇, T₅, T₁, T₃ and T₂ respectively. So, it was proved that the all treatments had significantly superior than untreated control.

Acknowledgement

Our sincere gratitude is extended to the IIRR in Hyderabad and the IGKV in Raipur, Chhattisgarh, India. For all of their help, inspiration, great advice, suggestions and recommendations, as well as their consistent enthusiasm throughout the research. I would like to express my sincere gratitude to my research adviser, Dr. N.C. Mandawi, for his continuous encouragement and to Shaheed Gundadhoor College of Agriculture and Research Station in Jagdalpur, Bastar (C.G.), which supplied the resources required to conduct this investigation.

References

- Anonymous. Annual report 2020. ICAR-National Rice Research Institute, Cuttack (Odisha), India; 2020a. p. 1-8.
- Anonymous. Agriculture statistics report of the Department of Agriculture and Welfare and Directorate of Economics and Statistics. Government of India; 2020b. p. 1.
- Anonymous. Ministry of Agriculture & Farmers Welfare. Press Information Bureau. Government of India, New Delhi; 2022 Feb. p. 1-1.
- Bentur JS, Pasalu IC, Sarma NP, Rao UP, Mishra B. Gall midge resistance in rice. DRR Research Paper Series No. 01/2003. Directorate of Rice Research, Hyderabad, India; 2003. p. 1.
- Chiu SF. Gall midge life-cycle and plant injury in South China. Int Rice Res Newsl. 1980;5(4):22-22.
- Cotes EC. Indian insects. Indian Museum Notes. 1889;1:103-103.
- Dakouo D, Nacro S. Chemical control of rice gall midge (*Orseolia oryzivora*). Int Rice Res Newsl. 1987;12(3):38-38.
- Hegdekatti RM. The rice gall midge in North Kanara. Indian J Agric Sci. 1927;2:461-463.
- Kulkarni N, Reddy PP, Rao KS, Gangaram A, Reddy NS. Evaluation of early duration rice cultures for normal and late sowing in certain Telangana districts. APAU J Res. 1989;17(2):181-184.
- Kumar LV, Patil SU, Prasannakumar MK, Chakravarthy AK. Bioefficacy of insecticides in nursery against Asian rice gall midge, *Orseolia oryzae* (Wood-Mason). Curr Biotica. 2011;5(3):323-329.
- Kumar RS, Malathi S, Rao PJM. Screening of certain rice entries against Asian rice gall midge, *Orseolia oryzae* (Wood-Mason) in Warangal, Telangana. J Entomol Zool Stud. 2020;8(5):1888-1893.
- Mardi G, Pandey AC, Kumar SS. Occurrence and management of rice gall midge in transplanted rice (*Orseolia oryzae* Wood-Mason). Ecol Environ Conserv. 2009;15(2):361-365.
- Misra HP, Sahithi S. Field screening of insecticides against rice gall midge *Orseolia oryzae* Wood-Mason. Ann Plant Prot Sci. 2006;14(1):62-64.
- Muralidharan K, Pasalu IC. Crop losses in rice ecosystems due to gall midge (*Orseolia oryzae* Wood-Mason) damage. Indian J Plant Prot. 2005;33(1):11-16.
- Panda N, Mohanty M. Biological studies on the paddy gall midge, *Pachydiplosis oryzae* (Wood-Mason), in rice and its alternate hosts. OUAT J Agric. 1970;2:8-18.
- Pathak MD, Khan ZR. Insect pests of rice. 1st ed. Manila (Philippines): International Rice Research Institute; 1994. p. 1-29.
- Prasad R. Status of the rice gall midge (*Orseolia oryzae* W.M.) in the state of Jharkhand. J Rice Res. 2011;4:19-21.
- Reddy DB. The rice gall midge *Orseolia oryzae* (Wood-Mason). In: Major insect pests of the rice plant. Baltimore (MD): Johns Hopkins Press; 1967. p. 457-481.

19. Ridley CV. Insect enemies of the rice plant. Am Nat. 1881;15:149-149.
20. Sain M, Kalode MB. Traps to monitor gall midge population in rice. Curr Sci. 1988;54:876-877.
21. Sain M, Kalode MB. Seasonal dynamics of gall midge (*Orseolia oryzae* Wood-Mason) and its parasites in rice at Rajendranagar, Hyderabad, India. Indian J Plant Prot. 1992;20(2):223-225.
22. Seni A, Naik BS. Efficacy of some insecticides against major insect pests of rice, *Oryza sativa* L. J Entomol Zool Stud. 2017;5(4):1381-1385.
23. Singh KM, Singh MP, Singh TK. Bio-efficacy of nursery application, seedling root dip and post-transplanting application of certain insecticides against rice gall midge, *Orseolia oryzae*. Indian J Entomol. 2000;62(2):191-195.
24. Singh S, Singh BK. Survey and fortnightly observation to find out major insect pests of rice crop (*Oryza sativa*) in Patna district of Bihar. J Entomol Zool Stud. 2017;5(1):766-769.
25. Tan Y, Zhang Y, Huang BC, Xu Y, Zhao L, Katiyar SK, et al. Analysis of resistance genetics and mapping of resistant gene in a rice variety Duokang 1 to rice gall midge. J Plant Prot. 1996;23(4):315-320.