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Comparative efficacies of insecticides and botanicals against rice gall midge, *Orseolia oryzae* (Wood-Mason) and their effect on the parasitoid *Platygaster oryzae* in rice ecosystem of Odisha, India

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ABSTRACT: A field experiment was carried out to determine the comparative efficacy of newer insecticides with botanical insecticides, viz., Chlorantraniliprole 0.4G @ 10 kg ha^{-1}, Fipronil 5 SC @ 1500 ml ha^{-1}, Acephate 95 SG @ 750 g ha^{-1}, Lambda cyhalothrin 4.9 CS @ 550 ml ha^{-1}, Thiamethoxam 25 WG @ 150 g ha^{-1} @ Carbofuran 3 CG @ 30 kg ha^{-1}, Carbosulfan 25 EC @ 875 ml ha^{-1}, Cedarwood oil @ 1000 ml ha^{-1}, Azadirachtin 0.03 EC @ 2500 ml ha^{-1}, applied at 20 and 35 DAT, against rice gall midge, *Orseolia oryzae* (Wood-Mason) in rice during *kharif,* 2019 and 2020. All the treatments were effective for gall midge. Lambda cyhalothrin 4.9 CS @ 550 ml ha^{-1} was significantly superior (>80% reduction over control) for gall midge management and grain yield was 4.75 t ha^{-1}. Both botanical and untreated plots had more number of parasitized gall midge (40- 53.3%) than other chemical treated plots.

KEYWORDS: Gall midge, management, newer insecticides

Rice is an important cereal crop of the world and staple food crop for more than two third of the Indian population and more than 65 per cent of the world population (Mathur *et al.,* 1999). More than 90 per cent of the world's rice is grown and consumed in Asia. But, its production is affected by the infestation of various insect pests. Almost 300 species of insect pests attack the rice crop at different growth stages and among them only 23 species cause notable damage. Asian rice gall midge (GM), *Orseolia oryzae* (Wood-Mason) is one of them. Although occasional outbreaks of this insect were reported prior to the 1960s (Bennett *et al*., 2004), but the problem became extensive after the introduction and widespread cultivation of dwarf and high-yielding rice varieties. It has been prevalent in almost all the rice growing states in India except the Western Uttar Pradesh, Uttaranchal, Punjab, Haryana and Hill states of Himachal Pradesh and Jammu & Kashmir (Bennett *et al.,* 2004; Seni and Naik, 2019). In Asia it has been reported in several countries including India, Bangladesh, China, Cambodia, Indonesia, Lao PDR, Myanmar, Sri Lanka, Thailand, and Vietnam. Whereas, the African rice gall midge, *Orseolia oryzivora* Harris and Gagne (AfRGM) is reported in several African

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countries (Bennett *et al*., 2004). They attack rice from seedling to the end of tillering stage and cause an annual yield loss of 0.8% of the total production, amounting to US$80 million (Bennett *et al*., 2004). It is also observed that in some areas in Odisha, hybrid rice recorded as much as 90% crop damage with a yield loss of about 70% (Seni and Naik, 2019). The external symptom of damage caused by gall midge is the production of a silvery-white, tubular leaf sheath gall called *silver shoot* or *onion shoot*. This is due to the feeding and salivary secretion by the larvae which turn the growing shoot meristem into a gall (Bentur *et al.,* 1992). This renders the tiller sterile and do not bear panicle (Seni and Naik, 2017).

The pest occurs regularly in Hirakud command area of Sambalpur district of Odisha and is regarded as a key pest of rice. Farmers of this region apply mainly red level insecticides like carbofuran 3G, phorate 10G indiscriminately in order to manage them. However, increased use of these insecticides causes environmental pollution, mortality of natural enemies and health problems. Although previously many conventional insecticides have been evaluated against this insect, most of the chemicals have failed to provide adequate control (Misra and Sahithi, 2006; Das and Mukherjee, 2003). Application of some botanicals against gall midge showed some promising results (Seni, 2019). Use of botanicals not only reduce the use of synthetic insecticides but also reduce the cost of pest management programme as well as they are eco-friendly in nature. Therefore, an effort was made to find suitable alternative insecticides and use in a rational way. Beside this, the effect of the insecticide

Table 1. Efficacy of different insecticides and botanicals against gall midge in rice in 2019 and 2020

Treatment and dose	% SS* in 2019		Mean % SS	% SS 2020		Mean % SS
	30 DAT#	45 DAT		30 DAT	45 DAT	
Carbofuran 3 CG @ 30 kg ha^{-1}	6.34 (2.61)	4.44 (2.22)	5.39 (2.42)	8.76 (3.04)	4.66 (2.26)	6.71 (2.68)
Acephate 95 SG @ 750 g ha^{-1}	11.78 (3.50)	9.75 (3.20)	10.76 (3.36)	15.77 (4.03)	11.50 (3.46)	13.63 (3.75)
Fipronil 5 SC @ 1500 ml ha^{-1}	5.69 (2.48)	4.31 (2.19)	5.00 (2.34)	11.84 (3.49)	7.35 (2.79)	9.60 (3.16)
Carbosulfan 25 EC @ 875 ml ha^{-1}	9.59 (3.17)	6.52 (2.64)	8.05 (2.92)	15.58 (3.99)	9.49 (3.15)	12.53 (3.61)
Lambda cyhalothrin 4.9 CS @ 550 ml ha^{-1}	4.66 (2.26)	2.85 (1.82)	3.75 (2.06)	6.10 (2.57)	3.26 (1.93)	4.68 (2.27)
Azadirachtin 0.03 EC @ 2500 ml ha^{-1}	8.06 (2.92)	7.25 (2.78)	7.66 (2.85)	13.51 (3.66)	8.50 (3.00)	11.00 (3.37)
Cedar wood oil @ 1000 ml ha^{-1}	7.27 (2.78)	6.43 (2.63)	6.85 (2.71)	13.30 (3.71)	7.78 (2.87)	10.54 (3.32)
Thiamethoxam 25 WG @ 150 g ha^{-1}	9.84 (3.21)	8.11 (2.93)	8.98 (3.08)	18.19 (4.32)	13.03 (3.68)	15.61 (4.01)
Chlorantraniliprole 0.4G @ 10 kg/ha	12.55 (3.61)	11.02 (3.39)	11.79 (3.50)	15.79 (4.03)	13.22 (3.69)	14.51 (3.86)
Untreated control	17.77 (4.26)	24.36 (4.98)	21.07 (4.64)	27.15 (5.25)	30.31 (5.55)	28.73 (5.40)
S.Em	0.14	0.11	0.08	0.21	0.15	0.13
CD (5%)	0.41	0.31	0.25	0.63	0.45	0.39

Figures in parentheses are square root transformed values, SS: Silver shoot, DAT: Days after transplanting

Table 2. Efficacy of different insecticides and botanicals against gall midge, % SS reduction over control and gall midge parasitization in rice (Mean of 2019 and 2020)

Treatment and dose	SS (%)	SS reduction (%)	Parasitization (%)	yield (t/ha^{-1})
Carbofuran 3 CG @ 30 kg ha^{-1}	6.05 (2.56)	76	0.00	4.47
Acephate 95 SG @ 750 g ha^{-1}	12.20 (3.56)	51	13.33	4.31
Fipronil 5 SC @ 1500 ml ha^{-1}	7.30 (2.79)	71	13.33	4.57
Carbosulfan 25 EC @ 875 ml ha^{-1}	10.29 (3.28)	59	6.67	4.32
Lambda cyhalothrin 4.9 CS @ 550 ml ha^{-1}	4.22 (2.17)	83	20.00	4.75
Azadirachtin 0.03 EC@ 2500 ml ha^{-1}	9.33 (3.12)	62	40.00	4.34
Cedar wood oil @ 1000 ml ha^{-1}	8.69 (3.03)	65	46.67	4.28
Thiamethoxam 25 WG @ 150 g ha^{-1}	12.29 (3.58)	50	13.33	4.28
Chlorantraniliprole 0.4G @ 10 kg/ha	13.15 (3.69)	47	33.33	4.82
Untreated control	24.90 (5.04)	-	53.33	3.27
SEm	0.08			0.05
CD	0.24			0.14

Figures in parentheses are square root transformed values, SS: Silver shoot, DAT: Days after transplanting

on egg-larval parasitoid *Platygaster oryzae* was also studied.

The experiment was conducted in the experimental farm of Regional Research and Technology Transfer Station (OUAT), Chiplima, Sambalpur, Odisha, during *kharif,* 2019 and 2020 in Randomized Block Design (RBD), having 9 treatments which were replicated thrice in a net experimental area of 5 m x 4 m each. The Station is situated at 20^{0}21' N latitude and 80^{0}55'E longitude in Dhankauda block of Sambalpur district at an altitude of 178.8 m above MSL. The climate of the area is warm/sub humid. Nursery of rice variety MTU-7029 (Swarna) was sown in the July and transplanting was done after 25 days of sowing at 20 cm x 15 cm hill spacing. All the agronomic practices were followed during crop growth period. The treatments (Table 1- 2) were applied at 20 and 35 days after transplanting (DAT) except untreated control. Gall midge incidence as silver shoot was recorded from 10 randomly selected hills per plot from each replication at 30 and 45 DAT and then percentage of silver shoot was worked out. To observe the effect of insecticides on natural enemies of gall midge, silver shoots were collected at 45 and 60 DAT from the treated plot and were kept in test tubes and waited for the emergence of natural enemies if any parasitization occurred there. The mean value of data obtained from field experiments were transformed into square root values and analyzed statistically by ANOVA. The grain yield was recorded in plot basis and expressed in ton per hectare.

Among different treatments, lambda cyhalothrin 4.9 CS @ 550 ml ha^{-1} was recorded to be significantly superior (>80% reduction over control) in efficacy against gall midge in both seasons. Next best treatment was carbofuran 3 CG (76% reduction over control) followed by fipronil 5 SC (71% reduction over control). thiamethoxam 25 WG, acephate 95 SG and chlorantraniliprole 0.4G treatments were at par with each other in gall midge management. From the experimental results, it was also observed that all the tested products minimized the infestation of gall midge and reducing the formation of silver shoots as compared to the untreated control. It was also observed that infestation of gall midge in terms of silver shoot was higher in *kharif* 2020 in comparison to *kharif* 2019. In the treated plots, in 2019 the gall midge infestation recorded as silver shoot ranged from 3.75 to 11.79% as against 21.07% in control. Whereas, in 2020 the silver shoot ranged from 4.68 to 15.61% as against 28.73% in untreated control (Table 1). All botanical treatments also reduced gall midge (6.85-7.66% and 10.54-11% in *kharif* 2019 and 2020, respectively) and among them cedarwood oil @ 1000 ml ha^{-1} showed better efficacy than other treatments (average 8.69%).

Gall midge parasitization was more (53.33%) in untreated plots (Table 2) followed by azadirachtin 0.03 EC and cedarwood oil (40 and 46.67% respectively). Shrivastava *et al.* (1987) studied the natural enemies of gall midge at Raipur, India and found that the predominant parasitoid was *P. oryzae* and was responsible for 0- 68% parasitization of gall midge. Among insecticide treatments Carbofuran treated plots had no parasitized gall midge whereas Chlorantraniliprole treated plots had more parasitized gall midge.

Significant differences were observed in grain yield among the treatments and control in both the seasons. Based on yield, chlorantraniliprole treated plot recorded the highest mean grain yield of 4.82 t ha^{-1}, followed by lambda cyhalothrin 4.9 CS with 4.75 t ha^{-1} and were significantly at par with each other whereas in control yield was 3.27 t ha^{-1}. Among the botanicals, azadirachtin 0.03 EC treated plot recorded highest yield of 4.34 t ha^{-1} followed by cedarwood oil treated plot and which was significantly at par with each other (Table 2).

The present findings revealed that all the tested products were effective in reducing the infestation of gall midge as compared to the untreated control. But, among the different treatments, application of lambda cyhalothrin 4.9 CS @ 550 ml ha^{-1} at 20 and 35 days after transplanting was very effective for the management of rice gall midge and next best treatment was the application of carbofuran 3 CG. Our results in accordance with the findings of Misra and Parida (2004) who observed that the synthetic pyrethroid containing other combined insecticides like acephate, quinolphos, profenophos and chlorpyriphos were effective against gall midge. The present findings are in line with the findings of Mardi *et al.* (2009) and Seni and Naik (2018) who reported the effectiveness of carbofuran against gall midge. Das and Mukherjee (2003) reported that fipronil was effective against rice gall midge. Among the botanicals, both (azadirachtin 0.03 EC and cedarwood oil) had moderate effects against gall midge. It was observed that although chlorantraniliprole was not so much effective against gall midge during both the years but the yield was highest in this treatment. This may be due to its greater efficacy against various key lepidopteran pests like yellow stem borer and leaf folder in rice than other treatments. Regarding parasitization botanicals were safe against *P. oryzae* whereas carbofuran was toxic to them. Application of lambda cyhalothrin 4.9 CS @ 550 ml ha^{-1} or azadirachtin 0.03 EC @ 2500 ml ha^{-1} or cedarwood oil @ 1000 ml ha^{-1} at 20 and 35 days after transplanting can effectively manage the gall midge in rice.

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