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Effect of chemical insecticides on the incidence of gall midge (*Orseolia oryzae* Wood mason) in terms of silver shoots (SS %)

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Abstract
Gall midge (*Orseolia oryzae* Wood mason) is one of the major insect pests of rice in India. An experiment was conducted at Rice Research farm, RAC, B.A.U, Kanke, Ranchi to evaluate the bio-efficacy of newer molecules of different chemical insecticides against gall midge. Among the nine insecticides, application of Spinetoram 6SC +Methoxyfenozide 30SC @400ml/ha was found to be most effective against gall midge. The highest infestation of Gall midge was recorded in the untreated control plots throughout the experimental periods. Peak duration of occurrence of gall midge was observed almost from 40DAT and onward period during both years of experimentations.

Keywords: *Orseolia oryzae*, newer molecule of insecticides, gall midge, bio-efficacy

Introduction
Rice is the most important food crop cultivated in India accounts for 81 million tons of total food grain production in the country. India is the largest rice growing country in the world with 40 million hectares under this crop, but unfortunately the yield of rice per hectare is much less as compared to other countries. The insect pest plays a significant role and accounts for appreciable reduction in the yield. It has been estimated that about 31.5% of the production of rice crop in Asia is reduced by insect pests [1]. Rice gall midge belongs from family Cecidomyiidae (Diptera) and it causes great damage to the rice crop. The pest of rice, widely distributed in South-East and West Asian countries. The pest occurs regularly in part of the plateau region of Chhotanagpur and is recorded as the key pest of rice. The gall midge attacks rice from nursery to the end of tillering stage. The larvae of the gall midge fly cause heavy damages to the rice crop. Early infestation results in gall formation from the tillers which consequently do not bear panicles. The gall midge remains inactive as a prepupa in wild rice or weeds during the dry season. The galls formed by gall midge are also known as onion tubes or silver shoots at the onset of the monsoons, it becomes active and completes one or two generations in grasses before it moves to the rice crop [2]. Seasonal incidence of gall midge commenced in late August, reaching a peak in October and declined in December [3]. The most important egg-larval parasite widely present during the rice season is *Platygaster oryzae* which has recorded high parasitization [4]. Subsequent studies by Kulshrestha *et al.* (1978) [5] also indicated similar trend in parasitisation which increased in from 20% in July, despite the prevalence of favourable environment for the pest. Parasitism increased with the increase in midge infestation and it suppressed the midge population late in the season. In the past one decade, insecticides use in rice has increased tremendously in this region, as the farmers started growing high yielding rice varieties with greater yield and better profit margin. However, increased use of insecticides does not commensurate with grain production. Nevertheless, insecticides are the only tool available at present to the farmer to suppress the insect population during epidemics. In view of this, chemical insecticide will remain as a most dependable weapon at present and in future too. Farmers of the plateau region apply insecticides indiscriminately in order to obtain maximum profit. Studies on chemical control of rice gall midge have been undertaken by many workers, but no systematic work seems to have been done in Chhotanagpur region. Therefore in today's time, there is a need for a pesticide that can reduce pest population while minimizing the environmental damage. Therefore, present studies are needed for the safe and ecologically management of rice gall midge.

Hence, efforts were made to assess the relative field efficacy of different chemical insecticides against rice gall midge.

Methods and Materials

The experiment was carried out to study the efficacy of nine different formulation insecticides for the control of rice gall midge. In order to evaluate field bio-efficacy of newer molecules of different insecticides against gall midge of rice, a field trial was conducted at Rice research farm, RAC, B.A.U, Kanke, Ranchi, Jharkhand during *kharif*, 2016 and 2017.

Treatment application: Periodical and need based application of the respective test insecticidal treatments were applied based on the ETL of the pest species at the different stages of the crop. Observations on rice gall midge incidence were to be recorded at 4th, 7th, & 10th days after insecticidal application (DAA) in terms of silver shoot formation.

Table 1: Details of experiment conducted

Design Insecticidal treatments :	RBD (Randomized block design) 10
Replications	3
Spacing (plant to plant)	15 cm
Spacing (row to row)	20 cm
Plot size	5 x 4 m
N:P:K	80:40:20 ka/ha (As per local recommendation)
Date of sowing	3rd July
Date of transplanting	22th July
Date of insecticide application	40 DAT
Date of harvesting	7th November
Crop variety	Naveen

Table 2: Treatment details of field bio-efficacy of some selected commercial formulations of newer molecules of chemical insecticide against gall midge of rice

Treatments	Trade name	Common Name	% a.i. in formulations	Dose of the formulated product (ml or g /ha)	Dose ml or g/l of water
T 1	Spinetoram 6 SC + methoxyfenozide 30 SC	Spinetoram 6 SC + methoxyfenozide 30 SC	36 SC	375 ml	0.75 ml
T 2	Spinetoram 6 SC + methoxyfenozide 30 SC	Spinetoram 6 SC + methoxyfenozide 30 SC	36 SC	400 ml	0.80ml
T 3	DPX-RAB55	Triflumezopyrim	106 SC	238 ml	0.475 ml
T 4	Fame	Flubendiamide 480 SC	48 SC	50 ml	0.10 ml
T 5	Coragen	Rynaxypyr	20 SC	150 ml	0.30 ml
T 6	Hunk	Acephate	95 SG	526 g	1.053
T 7	Osheen	Dinotefurain	20 SG	200g	0.40 g
T 8	Hostathion	Triazophos	36 SL	1500 ml	3 ml
T 9	Furadan + Hostathion (in form of alternate use)	Carbofuran + triazophos (in form of alternate use)	3G+40EC	30kg+1500ml	30kg+ 3 ml
T 10	Untreated control	-	--	-	-

Result and discussion

The data Table-3 depicted that the observations on incidence of gall midge in terms of silver shoot (SS) were recorded at 4, 7 & 10 days after application (DAA) of insecticidal treatment during *kharif* season 2016 & 2017. In general, all the treatments proved superior over untreated control, almost throughout the cropping season in suppressing the incidence of silver shoot, caused by gall midge. Peak duration of occurrence of gall midge (bio-type-3) was observed almost from 40 DAT and onward period during both years of the experimentations.

1. Incidence of silver shoots (SS) recorded at 4 days after application (4 DAA)

i. Incidence of SS recorded at 4 DAA, during 2016

At 4 DAA, the data resulted from the test of insecticides against gall midge in terms of silver shoot (SS) were found to be statistically significant. The minimum damage was found in terms of incidence of silver shoot (0.25% SS) in the treatment comprising of ready mix combination of Spinetoram 6 SC + methoxyfenozide 30 SC @ 400 ml/ha, which was superior to almost all the test insecticides, but it was at par with spinetoram 6 SC + methoxyfenozide 30 SC @ 375 ml/ha (0.35% SS) and flubendiamide 48 SC @ 50 ml/ha (0.48% SS). The highest silver shoot damage of 5.64 per cent was observed in case of the unprotected crop of rice (var. Naveen).

ii. Incidence of SS recorded at 4 DAA, during 2017

At 4 DAA, the data resulted from the test of insecticides used against gall midge in terms of silver shoot (SS) gave rise to the significant results. The minimum damage was found in terms of silver shoot in the treatments comprising of ready mix combination of Spinetoram 6 SC + methoxyfenozide 30 SC @ 400 ml/ha recorded the lowest incidence of silver shoot (0.44% SS), which was superior among all insecticides, but was at par with that of the lower dose of the same product, i.e. spinetoram 6 SC + methoxyfenozide 30 SC @ 375 ml/ha (0.57% SS) and flubendiamide 48 SC @ 50 ml/ha (0.66% SS). The highest incidence silver shoot damage of 5.87 per cent was observed in case of untreated control plot.

iii. Pooled mean incidence of SS recorded at 4 DAA, during 2016 and 2017

The pooled data the impact of insecticides used against gall midge in terms of silver shoot (SS) recorded significant results. The minimum damage were found in terms of silver shoot in the treatments comprising of the new combination of

Spinetoram 6 SC + methoxyfenozide 30 SC @ 400 ml/ha recorded the lowest incidence of silver shoot (0.35% SS), which it was superior among all the test insecticides, but was at par with spinetoram 6 SC + methoxyfenozide 30 SC @ 375 ml/ha (0.46% SS). The highest silver shoot damage of 5.75 percent was observed in case of untreated control plot.

2. Incidence of silver shoots (SS) recorded at 7 days after application (7 DAA)

i. Incidence of SS recorded at 7 DAA, during 2016

At 7 DAA, the data on the effect of insecticides used against gall midge in terms of silver shoot (SS) gave rise to the significant results. The minimum damage in terms of silver shoot was found in the treatments comprising of ready mix combination of Spinetoram 6 SC + methoxyfenozide 30 SC @ 400 ml/ha with (0.68%), which was superior to almost all the test insecticides, but it was at par with spinetoram 6 SC+ methoxyfenozide 30 SC @ 375 ml/ha (0.85% SS) and flubendiamide 48 SC @ 50 ml/ha (1.01% SS). The highest silver shoot damage of 6.08 per cent was observed in untreated control plot.

ii. Incidence of SS recorded at 7 DAA, during 2017

At 7 DAA, the data on the effect of insecticides used against gall midge in terms of silver shoot (SS) gave rise to the significant results. The minimum damage (1.00% SS) was found in terms of silver shoot was found in case of in the treatment comprising of new combination of Spinetoram 6 SC + methoxyfenozide 30 SC @ 400 ml/ha, which was superior among all the test insecticides, but it was at par with spinetoram 6 SC + methoxyfenozide 30 SC @ 375 ml/ha (1.17% SS), flubendiamide 48 SC @ 50 ml/ha (1.34% SS) and carbofuran 3 G @ 30 kg/ha followed by need based foliar spray with triazophos 40 EC @ 1500 ml/ha (1.47% SS). The highest silver shoot damage of 6.74 per cent was observed in untreated control plot.

iii. Pooled mean of the incidence of SS recorded at 7 DAA, during 2016 and 2017

The pooled data of the impact of the test insecticides used against gall midge in terms of silver shoot (SS) reflected the significant results. The minimum damage were found in terms of silver shoot in the treatment comprising of the new combination of spinetoram 6 SC + methoxyfenozide 30 SC @ 400 ml/ha recorded the lowest incidence of silver shoot (0.84% SS), which it was superior among all insecticides, but it was at par with spinetoram 6SC plus methoxyfenozide 30 SC @ 375 ml/ha (1.01% SS). The highest silver shoot damage of 6.41 percent was observed in case of untreated control plot.

3. Incidence of silver shoots (SS) recorded at 10 days after application (10 DAA)

i. Incidence of SS recorded at 10 DAA, during 2016

At 10 DAA, the data of insecticides used against gall midge in terms of silver shoot (SS) gave rise to the significant results. The minimum damage were found in terms of silver shoot in the treatment comprising of ready mix combination of Spinetoram 6 SC + methoxyfenozide 30 SC @ 400 ml/ha recorded the lowest incidence of silver shoot (1.19% SS), which was superior to almost all the test insecticides, but it was at par with spinetoram 6 SC+ methoxyfenozide 30SC @ 375 ml/ha (1.34% SS), flubendiamide 48 SC @ 50 ml/ha (1.55% SS), carbofuran 3 G @ 30 kg/ha followed by need based foliar spray with triazophos 40 EC @ 1500 ml/ha (1.80% SS) and acephate 95 SG @ 526g/ha (1.92% SS). The highest silver shoot damage of 7.26 per cent was observed in case of untreated control plot.

ii. Incidence of SS recorded at 10 DAA, during 2017

At 10 DAA, data on the impact of insecticides used against gall midge in terms of silver shoot (SS) gave rise to the significant results. The minimum damage was found in terms of silver shoot in the treatment comprising of new combination of Spinetoram 6 SC + methoxyfenozide 30 SC @ 400 ml/ha recorded the lowest incidence of silver shoot (1.66% SS), which was superior among all the test insecticides, but it was at par with spinetoram 6SC plus methoxyfenozide 30 SC @ 375 ml/ha (1.81% SS), flubendiamide 48 SC @ 50 ml/ha (2.02% SS), carbofuran 3G @ 30 kg/ha followed by need based foliar spray with triazophos 40 EC @ 1500 ml/ha (2.28% SS) and acephate 95 SG @ 526g/ha (2.39% SS). The highest silver shoot damage of 7.73 per cent was observed in untreated control plot.

iii. Pooled mean incidence of SS recorded at 10 DAA, during 2016 and 2017

The pooled data of impact of insecticides used against gall midge in terms of silver shoot (SS) recorded significant results. The minimum damage was found in terms of silver shoot in the treatment comprising of the new combination of Spinetoram 6 SC + methoxyfenozide 30 SC @ 400 ml/ha recorded the lowest incidence of silver shoot (1.43% SS), which was superior among all the test insecticides, but was at par with Spinetoram 6 SC + methoxyfenozide 30 SC @ 375 ml/ha (1.58% SS) and flubendiamide 48 SC @ 50 ml/ha (1.79% SS). The highest silver shoot damage of 7.50 per cent was observed in unprotected control plot.

4. Overall mean of silver shoot (SS) recorded at 4, 7 and 10 DAA (days after application)

i. Mean of SS recorded at 4, 7 and 10 DAA, during 2016

Overall mean of three dates of observations (4, 7 & 10 DAA), the data of insecticides used against gall midge in terms of silver shoot (SS) were recorded significant results. The minimum damage was found in terms of silver shoot in the treatment comprising of ready mix combination of Spinetoram 6 SC + methoxyfenozide 30 SC @ 400 ml/ha recorded the lowest incidence of silver shoot (0.71% SS), which was superior among all the test insecticides, but it was at par with Spinetoram 6 SC + methoxyfenozide 30 SC @ 375 ml/ha (0.85% SS). The highest silver shoot damage of 6.33 per cent was observed in case of untreated control plot.

ii. Mean of SS recorded at 4, 7 and 10 DAA, during 2017

Overall mean values of SS of three dates observations (4, 7 & 10 DAA), in terms of silver shoot (SS) caused by gall midge recorded significant results. The minimum damage was found in terms of silver shoot in the treatment of the new combination product of Spinetoram 6 SC + methoxyfenozide 30 SC @ 400 ml/ha recorded the lowest incidence of silver shoot (1.04% SS), which was superior among all the test insecticides, but was at par with the lower dose of same insecticide, Spinetoram 6 SC + methoxyfenozide 30 SC @ 375 ml/ha (1.18% SS). The highest silver shoot damage of 6.77 per cent was observed in case of untreated control plot.

iii. Pooled mean of SS recorded at 4, 7 and 10 DAA, during 2016 and 2017

Overall pooled mean values of SS of three dates observations (4, 7 & 10 DAA), caused by gall midge in terms of silver shoot (SS) recorded significant results. The minimum damage was found in terms of silver shoot in the treatment comprising

of the new combination of Spinetoram 6 SC + methoxyfenozide 30 SC @ 400 ml/ha recorded the lowest incidence of silver shoot (0.87% SS), which was superior among all insecticides, but was at par with the lower dose of the same insecticide combination product i.e., Spinetoram 6 SC + methoxyfenozide 30 SC @ 375 ml/ha (1.01% SS). The highest silver shoot damage of 6.55 per cent was observed in the untreated control plot.

Earlier, various scientists evaluated the bio-efficacy of different chemical insecticide against gall midge in rice at different locations. Rao (2003) [6] conducted an experiment in the agro-climate conditions of Andhra Pradesh, India, for two consecutive years (years not given) for evaluation of efficacy of triazophos, carbofuran and chlorphyriphos etc. against *Orseolia oryzae*. The results showed that 0.5 and 0.75 kg (a.i) triazophos @ 1500 ml/ha proved to be most effective in reducing the incidence of *Orseolia oryzae* followed by chlorpyriphos and carbofuran. These findings are almost in agreement with the results of the present experiment. Prasad and Prasad (2011) [7] also obtained the similar results there are almost in the line of the findings of the present results indicating the combination products of certain insecticides *viz*. (imidacloprid 40% + ethiprole 40%) 80 WG @ 125g per hectare or sole use of either of bifenthrin 10EC @ 500 mlit./ha or imidacloprid 200 SL@ 100 mlit./ha could be successfully used as foliar spray on the standing crop on need based basis for optimized management of gall midge to reduce the crop-loss and to enhance grains yield of rice. Panda *et al.* (1988) [8] reported that granular Carbofuran at 0.5 kg ai/ha 25 days after transplanting followed by spray of Quinalphos at 0.5 kg ai/ha at 40 days after transplanting was quite effective in controlling *O. oryzae* during the wet season and gave a mean yield of 2.25 t/ha, 79% higher than that in untreated control.

Conclusion

It may be concluded that the minimum infestation of gall midge insect in case of application of spinetoram 6 % SC + methoxyfenozide 30 % SC @ 400 ml/ha which was found to be most superior in less toxic level as compare to other treatments (insecticides) showed the highest minimize the population of gall midge and infestation with lowest pest incidence. Thus by using this new type of chemical insecticide we can increase the production of rice significantly and get rid of the problem of environmental pollution, pest outbreak and pest resistance to a great extent.

Table 3: Effect of chemical insecticides on the incidence of gall midge (*Orseolia oryzae* Wood mason) in terms of silver shoot

				Silver shoot (SS) caused by gall midge, recorded after spray at											
				4 DAA			7 DAA			10 DAA			Overall Mean		
S.N	Treatment	Formulations (a.i.)	Dose (ml or g /ha)	2016	2017	Pooled Mean	2016	2017	Pooled Mean	2016	2017	Pooled Mean	2016	2017	Pooled Mean
T1	Spinetoram 6 SC+ methoxyfenozide 30 SC	36 SC	375 ml	0.35 (3.32)	0.57 (4.16)	0.46 (3.74)	0.85 (5.19)	1.17 (6.14)	1.01 (5.66)	1.34 (6.49)	1.81 (7.63	1.58 (7.06)	0.85 (5.18)	1.18 (6.15)	1.01 (5.67)
T2	Spinetoram 6 SC+ methoxyfenozide 30 SC	36 SC	400 ml	0.25 (2.80)	0.44 (3.76)	0.35 (3.28)	0.68 (4.54)	1.00 (5.63)	0.84 (5.08)	1.19 (6.09)	1.66 (7.30)	1.43 (6.69)	0.71 (4.68)	1.04 (5.76)	0.87 (5.22)
T3	Triflumezopyrim	106 SC	238 ml	1.14 (5.88)	1.36 (6.43)	1.25 (6.16)	1.58 (7.03)	1.91 (7.78)	1.75 (7.41)	2.35 (8.61)	2.82 (9.51)	2.58 (9.06)	1.69 (7.26)	2.02 (8.01)	1.86 (7.63)
T4	Flubendiamide	48SC	50 ml	0.48 (3.95)	0.66 (4.70)	0.57 (4.33)	1.01 (5.47)	1.34 (6.44)	1.18 (5.95)	1.55 (6.97)	2.02 (8.05)	1.79 (7.51)	1.02 (5.62)	1.35 (6.55)	1.18 (6.08)
T5	Rynaxypyr	20SC	150 ml	1.23 (6.13)	1.44 (6.64)	1.33 (6.38)	1.75 (7.37)	2.08 (8.09)	1.92 (7.73)	2.45 (8.76)	2.92 (9.65)	2.69 (9.20)	1.81 (7.51)	2.14 (8.23)	1.98 (7.87)
T6	Acephate	95SG	526 g	0.88 (5.20)	1.10 (5.82)	0.99 (5.51)	1.23 (6.10)	1.55 (6.97)	1.39 (6.54)	1.92 (7.74)	2.39 (8.74)	2.16 (8.24)	1.34 (6.44)	1.68 (7.27)	1.51 (6.86)
T7	Dinotefurain	20 SG	200 g	1.36 (6.49)	1.55 (6.96)	1.46 (6.72)	1.92 (7.68)	2.25 (8.38)	(2.09 (8.03)	2.70 (9.25)	3.18 (10.09)	2.94 (9.67)	1.99 (7.90)	2.33 (8.58)	2.16 (8.24)
T8	Triazophos	40 EC	1500 ml	1.08 (5.70)	1.26 (6.28)	1.17 (5.99)	1.39 (6.54)	1.72 (7.35)	1.56 (6.95)	2.15 (8.28)	2.62 (9.20)	2.39 (8.74)	1.54 (6.93)	1.87 (7.71)	1.71 (7.32)
T9	Carbofuran followed by triazophos	3G & 40 EC	30 kg & 1500 ml	0.63 (4.42)	0.84 (5.12)	0.73 (4.77)	1.15 (5.95)	1.47 (6.82)	1.31 (6.38)	1.80 (7.60)	2.28 (8.59)	2.04 (8.09)	1.20 (6.13)	1.53 (6.99)	1.36 (6.56)
T10	Untreated control	Water spray	500 lit.	5.64 (13.66)	5.87 (13.90)	5.75 (13.78)	6.08 (14.16)	6.74 (14.87)	6.41 (14.51)	7.26 (15.47)	7.73 (16.01)	7.50 (15.74)	6.33 (14.53)	6.77 (15.03)	6.55 (14.78)
SEm±				(0.46)	(0.42)	(0.28)	(0.44)	(0.44)	(0.28)	(0.58)	(0.57)	(0.37)	(0.26)	(0.25)	(0.17)
CD 5%				(1.36)	(1.25)	(0.80)	(1.31)	(1.30)	(0.80)	(1.72)	(1.70)	(1.04)	(0.79)	(0.73)	(0.47)
CV %				(13.80)	(11.43)	(12.57)	(10.93)	(9.67)	(10.27)	(11.78)	(10.47)	(11.09)	(6.36)	(5.29)	(5.80)

Figures under the parenthesis are angular transformed values. SS- Silver shoot caused by gall midge
DAT-Days after transplanting; DAA-Days after application of insecticidal treatment
Foliar spray of the insecticidal treatments was applied at 40 DAT.

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