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Vijay Kumar
Department of Entomology, RMD College of Agriculture and Research Station, Ambikapur, Chhattisgarh, India

KL Painkra
Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

GP Painkra
Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

PK Bhagat
Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Corresponding Author:
Vijay Kumar
Department of Entomology, RMD College of Agriculture and Research Station, Ambikapur, Chhattisgarh, India

Efficacy of newer insecticides for management of rice gall midge (*Orseolia oryzae* Wood-Mason) in rice crop

Vijay Kumar, KL Painkra, GP Painkra and PK Bhagat

Abstract
The field experiment was carried out to evaluate the efficacy of six newer insecticides *viz*., emamectin benzoate + thiamethoxam 3.0% + 12.0% WG, emamectin benzoate 5% SG, chlorantraniliprole 18.5% SC, novaluran + indoxacarb 5.25% + 4.5% SC, flubendiamide 39.35% SC and spinosad 45% SC along with untreated control against the rice gall midge during *Kharif* 2019.Among the various treatments, Spinosad 45 SC was found to be most effective against rice gall midge, with least of2.41% shoot damage/plant, highest grain yield (45.2 q/ha) and Benefit-Cost (BC) ratio 1:5.63, and maximum Net Profit amount (₹. 20191.00/ha). Flubendiamide 39.35% SC was next best treatment with 3.31shoot/plant, grain yield 43.1 q/ha, Net Profit amount (₹. 16290.00/ha) and Benefit-Cost ratio (1:4.43) as compared to rest of the treatments.

Keywords: gall midge, *Orseolia oryzae*, management, rice

Introduction
Rice (*Oryza sativa* L.) is a staple food for more than half of the world's population and it has occupied an area of 161.1 million hectares with a total production of 488.6 million tonnes in 2017-18. Its cultivation supports livelihood for more than 2 billion people. Rice is the major crop in India and occupies the largest cropped area of 43.19 million hectares with annual production of 110.15 million tonnes and productivity of 2.55 tonnes/ha (Anonymous, 2017) [1]. Among the rice growing countries, India has the largest area under rice crop and ranks second in production next to China. It occupies about 23.3 per cent of gross cropped area of the country and plays a vital role in the national food grain supply. Rice alone contributes 43 per cent of total food-grain production and 46 per cent of total cereal production of the country.
The rice crops in the field are subjected to attack by more than 800 insect species (Grist and Lever, 1969) [3] and 20 of them can cause economic loss (Pathak, 1977) [4]. Together, they infest all parts of the plant at all growth stages and a few transmit viral diseases (Pathak and Dhaliwal, 1981) [5]. The losses due to insect pests during vegetative phase (50 per cent) contribute more to yield reduction than the reproductive phase (30 per cent) or ripening phase (20 per cent) as reported by Gupta and Raghuraman (2003) [2]. In Chhattisgarh, crop losses up to the 60 per cent have been reported by Mishra and Sarawgi (1997) [6]. Among the insect-pests, the rice gall midge *Orseolia oryzae* Wood-Mason (Diptera; Cecidomyiidae) is one of the key pests of rice in Chhattisgarh. It is locally called "gangai" in Chhattisgarhi. Its incidence was observed in all rice grown areas except some plain region in Chhattisgarh state.
Many conventional insecticides though have been evaluated against the pest, yet, most of the chemicals have failed to provide adequate control. Hence, new molecules are being added for their evaluation with an aim to minimize disruption of environmental quality as much as possible. For this, the present study was carried out to find the efficacy of certain new molecules against gall midge of rice. Keeping this in view, the present investigation was carried out during *Kharif* season 2019.

Materials and Methods
A field experiment was laid out to evaluate the most effective newer insecticides against rice gall midge. It was laid in randomized block design (RBD) with seven treatments including untreated control and replicated thrice. The crop was sown on 19th July, 2019 and transplanted on 8th August 2019 with plot size of 3x4m and 25x20cm spacing. The treatment details are following:

Table 1: Treatment details

S. No.	Treatments	Available concentration	Dose/ha.
T_1	Emamectin benzoate + Thiamethoxam	3.0%+12.0%WG	150 g
T_2	Emamectin Benzoate	5%SG	200 g
T_3	Chlorantraniliprole	18.5% SC	150 ml
T_4	Novaluron + Indoxacarb	5.25% + 4.5% SC	875 ml
T_5	Flubendiamide	39.35% SC	150 ml
T_6	Spinosad	45% SC	150 ml
T_7	Control	-	-

The required quantity of spray solutions were calibrated and foliar spraying done by knapsack sprayer. The first sprays of insecticides were applied the initiation of pest infestation and second spray was done at 15 days after first spray.

Pre-treatment observations were recorded from randomly selected 10 hills under each treatment and the total number of tillers and affected tillers (silver shoot) were counted. Post-treatment observations were recorded at 15th day after each spray. The percentage of tiller infestation percentage was recorded on number basis.

$$\text{Tiller infestations (\%)} = \frac{\text{No. of infested tillers}}{\text{Total number of tillers}} \times 100$$

Results and Discussion

The efficacy of six newer insecticides *viz.*, emamectin benzoate + thiamethoxam 3.0% + 12.0% WG, emamectin benzoate 5% SG, chlorantraniliprole 18.5% SC, novaluran + indoxacarb 5.25% + 4.5% SC, flubendiamide 39.35% SC and spinosad 45% SC along with untreated control were evaluated against the rice gall midge during *Kharif* 2019 (Showed in Table 2).

Pretreatment observation

Pre-treatment observation was recorded for assessing whether the shoot damage by the pest was uniformly distributed over all the treatments. The silver shoot damage percentage ranged from 7.77 to 9.42.

15th days after first spray

The observation on the pest infestation 15th days after first spray revealed that all the treatments registered significant low infestation per cent as compared to untreated control. The spinosad 45% SC was proved to be the best treatment with lowest of 3.18 per cent infestation of silver shoot. The next effective treatment was flubendiamide 39.35% SC with 4.31 per cent silver shoot damage followed by emamectin benzoate + thiamethoxam 3.0% + 12.0% WG, emamectin benzoate 5% SG, chlorantraniliprole 18.5% SC and novaluran + indoxacarb 5.25% + 4.5% SC with 6.73, 7.12, 7.31 and 7.45 per cent silver shoot damage, respectively. However, the infestation per cent was recorded highest (9.31) in the untreated control plot.

15th days after second spray

On 15th days after second spray, the shoot infestation per cent reached to minimum as compared with the first spray. All the treatments proved their superiority over untreated control in recording low infestation level. Spinosad 45% SC was found most effective treatment in recording the least infestation (1.64 per cent) of silver shoot. The next effective treatment was flubendiamide 39.35% SC (2.32 per cent) followed by emamectin benzoate + thiamethoxam 3.0% + 12.0% WG (3.30 per cent), novaluran + indoxacarb 5.25% + 4.5% SC (3.59 per cent), emamectin benzoate 5% SG (3.95 per cent) and chlorantraniliprole 18.5% SC (4.74 per cent) which were at par with each other. The highest infestation (11.65 per cent) was recorded in the untreated control.

Overall efficacy after first and second spray

The overall mean infestation percentage after first and second sprays showed that all the treatments were significantly superior to untreated control. The infestation level ranged from 2.41 to 10.48 per cent. The minimum infestation 2.41 per cent was recorded in spinosad 45% SC treatment and was superior over rest of the treatments which are as follows flubendiamide 39.35% SC (3.31 per cent) followed by emamectin benzoate + thiamethoxam 3.0% + 12.0% WG (5.01 per cent), novaluran + indoxacarb 5.25% + 4.5% SC (5.52 per cent), emamectin benzoate 5% SG (5.53 per cent) and chlorantraniliprole 18.5% SC (6.02 per cent). The maximum (10.48 per cent) infestation was recorded in untreated control plot.

Table 2: Efficacy of newer insecticides against rice gall midge (*Orseolia oryzae* Wood-Mason) on rice during *Kharif*2019

S. No.	Treatments	Available concentration	Dose/ha	Average infestation of gall midge as a silver shoot (%)			Overall mean
				Pre treatment	15th day after 1st spray	15th day after 2nd spray	
T_1	Emamectin benzoate + Thiamethoxam	3.0% + 12.0% WG	150 g	8.87 (17.01)	6.73 (14.91)	3.30 (10.42)	5.01 (12.66)
T_2	Emamectin benzoate	5% SG	200 g	8.54 (16.94)	7.12 (15.41)	3.95 (11.43)	5.53 (13.42)
T_3	Chlorantraniliprole	18.5% SC	150 g	9.42 (17.76)	7.31 (15.64)	4.74 (12.41)	6.02 (14.02)
T_4	Novaluran + Indoxacarb	5.25% + 4.5% SC	875 ml	8.79 (17.23)	7.45 (15.80)	3.59 (10.88)	5.52 (13.34)
T_5	Flubendiamide	39.35% SC	150 ml	7.77 (16.12)	4.31 (11.96)	2.32 (8.74)	3.31 (10.35)
T_6	Spinosad	45% SC	150 ml	8.82 (17.09)	3.18 (10.25)	1.64 (7.35)	2.41 (8.8)
T_7	Control	-	-	7.96 (16.29)	9.31 (17.72)	11.65 (19.87)	10.48 (18.79)
SEm (±)				1.153	0.925	0.887	0.910
CD (P=0.05)				N/A	2.881	2.765	2.820
CV (%)				11.806	11.026	13.270	12.150

Figures under the parentheses are angular transformed value

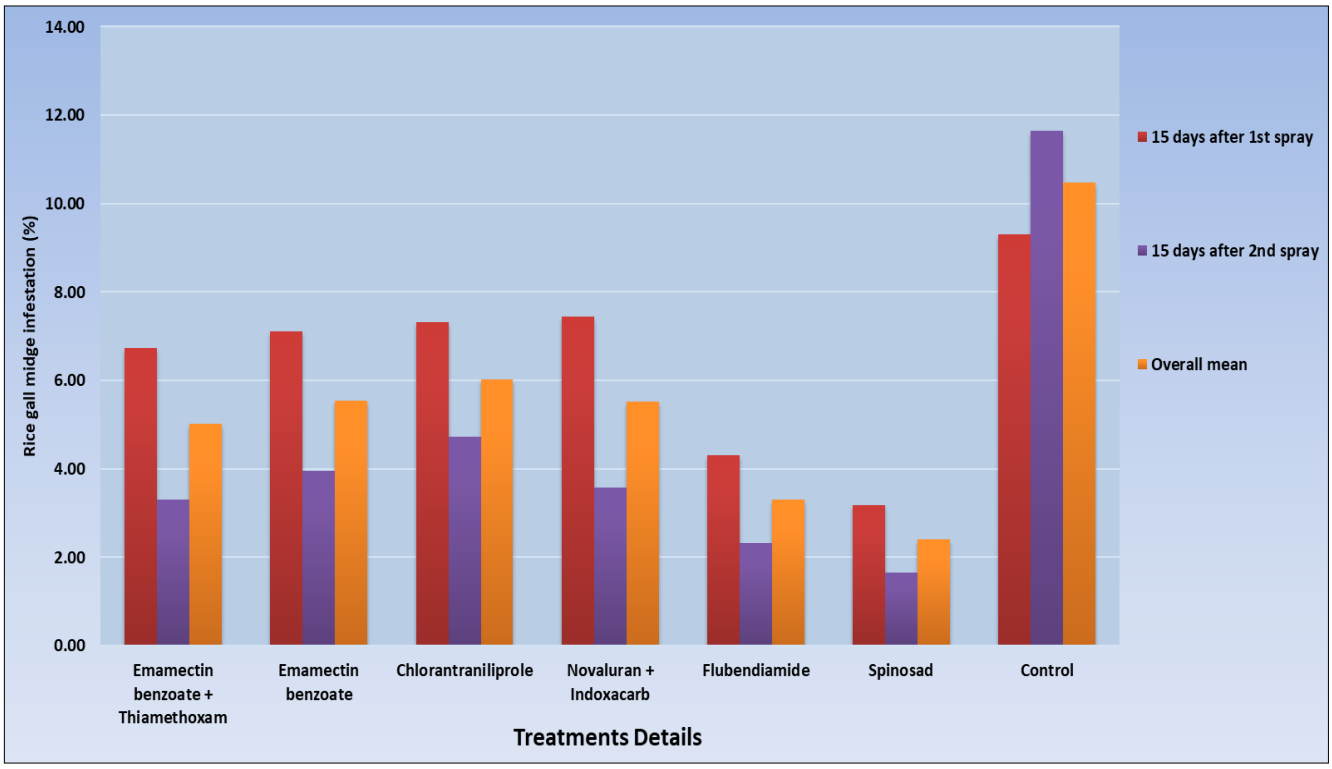

Fig 1: Efficacy of newer insecticides against rice gall midge (*Orseolia oryzae* Wood-Mason) on rice during *Kharif*2019

Table 3: Cost assessment ratio among various treatments against rice gall midge on rice during *Kharif* 2019

S. No.	Treatments	Dose/ha	Yield (q/ha)	Increase in yield over untreated control (q/ha)	Value of additional yield (₹/ha)	Cost of treatment including labour charge (₹/ha)	Net return (₹/ha)	Benefit-Cost Ratio
T_1	Emamectin benzoate + Thiamethoxam 3.0%+12.0% WG	150 g	42.5	10.40	18876.00	2550.00	16326.00	1:6.40
T_2	Emamectin benzoate 5% SG	200 g	41.2	9.10	16516.50	3024.00	13492.50	1:4.46
T_3	Chlorantraniliprole 18.5% SC	150 ml	39.5	7.40	13431.00	4080.00	9351.00	1:2.29
T_4	Novaluran + Indoxacarb 5.25% + 4.5% SC	875 ml	40.3	8.20	14883.00	4087.50	10796.50	1:2.64
T_5	Flubendiamide 39.35% SC	150 ml	43.1	11.00	19965.00	3675.00	16290.00	1:4.43
T_6	Spinosad 45% SC	150 ml	45.2	13.10	23776.50	3585.00	20191.00	1:5.63
T_7	Control	-	32.1	-	-	-	-	-

Labour rate per day = ₹. 300/labourer (2 labourers required for spraying in one hectare per day), Price of paddy ₹. 1815/quintal

Cost assessment of different treatments against gall midge on rice during *Kharif* 2019

A perusal of results represented in Table 3 revealed that all the treatments recorded higher grain yield of rice over untreated control (32.1 q/ha). The highest yield (45.2 q/ha) was obtained from spinosad 45% SC followed by flubendiamide 39.35% SC (43.1 q/ha), emamectin benzoate + thiamethoxam 3.0% + 12.0% WG (42.5 q/ha), emamectin benzoate 5% SG (41.2 q/ha), novaluran + indoxacarb 5.25% + 4.5% SC (40.3 q/ha) and chlorantraniliprole 18.5% SC (39.5 q/ha).

The Net Profit amount of different insecticidal treatments applied for the management of gall midge also showed that the highest was obtained in spinosad 45% SC (₹. 20191.00/ha) followed by emamectin benzoate + thiamethoxam 3.0% + 12.0% WG (₹. 16326.00/ha), flubendiamide 39.35% SC (₹. 16290.00/ha), emamectin benzoate 5% SG (₹. 13492.50/ha), novaluran + indoxacarb 5.25% + 4.5% SC (₹. 10796.50/ha), whereas the minimum net profit (₹. 9351.00/ha) was recorded in chlorantraniliprole 18.5% SC.

Likewise, emamectin benzoate + thiamethoxam 3.0% + 12.0% WG was high with Benefit-Cost Ratio of (1:6.40) followed by spinosad 45% SC (1:5.63), emamectin benzoate 5% SG (1:4.46), flubendiamide 39.35% SC (1:4.43) and novaluran + indoxacarb 5.25% + 4.5% SC (1:2.64), while chlorantraniliprole 18.5% SC was recorded with least Benefit-Cost Ratio (1:2.29).

The current findings partially supported with the work of Prasad *et al.* (2018) [7] who reported dinotefuran 20% SG @ 200 g/ha and rynaxypyr 20% SC @150 ml/ha remained superior over the neem-based insecticides in terms of suppression of the gall midge and realization of grain yield of rice too. Similarly, the foliar application of monocrotophos 36 SL and chlorpyriphos 20 EC at 10 DAT had resulted in 56.05, 62.47 and 46.14, 59.14 mean per cent silver shoots reduction over control during Kharif and Rabi, 2017-18 respectively as reported by Sudharani and Venkatesh (2018) [8]. Yadav *et al.* (2018) [9] reported spinotorom + methoxyfenozide 36 EC @400 ml/ha was most effective against almost all the prevailing major insect pests of rice including gall midge, which in turn, was found to be at par with rynaxypyr 20 SC @150 ml/ha and flubendiamide 480 SC @50 ml/ha against yellow stem borer, leaf folder and gall midge infesting rice. But the current finding exhibited superiority in spinosad 45% SC and flubendiamide 39.35% SC that it recorded the

minimum incidence of silver shoot (2.42% and 3.31%, respectively) as well as maximum yield of rice over rest of the treatments at foliar applications.

Conclusion

Spinosad 45% SC recorded minimum shoot infestation percent against gall midge among all other treatments. The highest net return (₹. 20191.00) was obtained in spinosad treatment whereas emamectin benzoate + thiamethoxam 3.0% + 12.0% WG was recorded highest benefit-cost ratio (1:6.4).

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