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A novel insecticide seed treatment formulation (Chlorantraniliprole 625 g/L FS) for yellow stem borer and leaf folder management in rice

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ABSTRACT

The potential yield loss of 15-25% rice production is noticed due to different pest infestation in South Asian countries. This is due to the favorable climatic conditions for pests. It compels farmers to use a major chunk of pesticides to prevent/recover from pest attack. Hence, the field experiments were carried out to test the insecticide, Chlorantraniliprole 625 g/L FS as seed treatment formulation. It is evident from the studies undertaken during rabi 2018-19 and kharif 2018, that Chlorantraniliprole provided excellent control over yellow stem borer and leaf folder in conventional variety of rice (CR Dhan 304) and hybrid rice (28P67). Among the different doses, Chlorantraniliprole @ 75.0 g a.i/ha recorded significantly better control registering least dead heart of 5.41, 4.77, 3.43, 2.98% and 2.47% at 14, 21, 28, 35 and 42 days after transplanting, respectively. Similarly for Hybrid (28P67) trial the treatment recorded the least count of leaf folder with 0.57, 0.68, 0.74, 0.81 and 0.89 larvae/hill during the intervals of 14, 21, 28, 35 and 42 days after transplanting, respectively and the highest yield (5.46 t/ha) was registered in treatment which was significantly superior over the other entire dose rates of Chlorantraniliprole and the market standard. Thus, from this study, Chlorantraniliprole @ 75 g a.i /ha can be recommended for controlling stem borer and leaf folder in paddy (both for conventional variety and hybrid).

Key words: *Seed treatment, yellow stem borer, leaf folder, paddy, Chlorantraniliprole 625 g/L FS*

INTRODUCTION

Rice pests are major bottlenecks in escalating the productivity of rice under all ecosystems in the tropics. Pest population changes both spatially and temporally over a period of time in rice. There are more than 100 insect species feeding on rice but few of these are considered to be the major pests. The number of major pests is increasing day by day. About one third of major problems in rice cultivations are related to rice pests (Herdt, 1991). At present number of major insect pests are 20 and major diseases are 10 based on the information generated from All India Coordinated Project on Rice between 1965 to 2017 (Jena et al., 2018). The major concern of the farmers is frequent occurrence of pests with increased severity in recent years. The mean yield reduction in rice had been estimated to vary between 21-51 per cent and out of which 10-15% yield reduction occurred due to the infestation of insect pests. Among the different insect pests, stem borer, plant hoppers, gall midge, leaf folder accounted for 30, 20, 15, 10% of the crop losses, respectively at national level (Krishnaiah and Varma, 2014).

Among the major insect pests, yellow stem borer (YSB), *Scirpophaga incertulas* (Walker) a monophagous pest is known to be most damaging pest in different rice ecosystems since it attack at seedling stage causing dead hearts & white ear-head symptoms during reproductive stage. Similarly rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) has recently emerged as an important major pest status in Asian countries. As there is no holistic approach to get rid of these two pests either through a resistant variety or through certain biological agents. Hence, the use of

insecticides becomes unavoidable to control these pests. In India, Central Insecticide Board and Registration Committee has recommended more than 90 pesticides or combination product to tackle wide range of pest problems, but not even a single insecticide seed treatment formulation is recommended against rice insect pests. Always there exists a thrust to search for a viable and cost-effective alternative strategy to manage the insect pests, paving way for reduced use of insecticides without compromising the natural enemies' suppression. One such management tactic is the seed treatment which is very much successful in managing rice water weevil, *Lissorhoptrus oryzophilus* at Louisiana State of USA (Lanka et al., 2013 and Hummel et al., 2014). Even though we selected good quality seeds for sowing, it is always advised to go for seed treatment for better germination and further to prevent crop from seed and soil borne diseases and insect pests. Seed treatment enhances the seed viability and vigor which are the two most important factors in plant health management.

In western countries to achieve early season defense of corn from feeding damage by wireworms, cutworms, armyworm (*Mythimna unipuncta*) and seed corn maggot. Chlorantraniliprole (Lumivia), as seed treatment is used in approximately 80% of the rice-producing area in Southwest Louisiana (Wilson et al., 2019). Chlorantraniliprole persists in the plant long enough to affect late season pests. In fact, a greenhouse study conducted by Sidhu et al. (2014) reported that 70-80% mortality on sugarcane borer larvae in chlorantraniliprole treated rice plants at the mid-tillering stage of development. The tested product Chlorantraniliprole 625 g/L FS for seed treatment is proved to have positive effect on rice yellow stem borer and rice leaf folder under multi-location trials. In this context, the present work was conducted to explore the possible utilization of the product for the management of yellow stem borer (*S. incertulas*) and leaf folder (*C. medinalis*) in paddy.

MATERIAL AND METHODS

The field experiments were carried out during *kharif* 2018 and *rabi* 2018-19 seasons in a RBD design with 4 replications at the Crop Protection Division fields (K & L Block), of ICAR-National Rice Research Institute (NRRI), Cuttack (Odisha). Cuttack is located in East and Southern Coastal plain of Odisha state at 20° 46'25'N, latitude and 85°88'30''E, longitude at an altitude of 36 m above mean sea level. This place is considered to have hot and humid climate with mean annual rain fall of 1577 mm, average maximum summer temperature of 39°C and average minimum winter temperature of 11.5°C. The soil is diverse ranging from saline, lateritic, alluvial, red, mixed red and black.

Seed treatment with Chlorantraniliprole 625 g/L FS

Seed treatment was done to test the bio-efficacy of test insecticide on Variety (CR Dhan 304) and Hybrid (28P67) as per the standard protocol. Details of the treatments imposed for the bio-efficacy trials on variety (CR Dhan 304) and hybrid (28P67) experiments during *rabi* 2018-19 are mentioned hereunder in Table 1. The required quantity of Chlorantraniliprole 625 g/L FS was calculated for different treatments and mixed with water to make 25 ml slurry which was sufficient to treat 1 kg seed. Then slurry was applied onto seeds and thoroughly mixed to ensure uniform coating on the seeds. The treated seeds were spread under shade (12 hours) for proper drying and seeds were used for sowing in nursery. After germination crop management was done as per standard practice including the control of non-target insect and diseases though foliar sprays or other standard practices.

Observations recorded

For YSB, after transplanting, randomly selected 20 hills from each plot, number of dead-hearts and healthy tillers count was made at 14, 21, 28, 35 and 42 days after transplanting. The percent dead-hearts for each

Table 1. Treatment details.

Treatment number	Treatment detail	Dose (g a.i. / ha)	Dose of formula-tion* (ml/ kg seed)
T1	Chlorantraniliprole 625 g/L FS	52.50	2.80
T2	Chlorantraniliprole 625 g/L FS	60.00	3.20
T3	Chlorantraniliprole 625 g/L FS	67.50	3.60
T4	Chlorantraniliprole 625 g/L FS	75.00	4.00
T5	Cartap hydrochloride 4% GR	750.00	18750g/ ha.
T6	Untreated Check	NA	NA

*Seed rate of 30 kg/ha for conventional variety (CR Dhan 304) and 15 kg/ha for hybrid (28P67).

plot was calculated. Similarly, for leaf folder, we randomly selected 20 hills from each plot and observed for number of leaf folder larvae per hill and estimated the approximate damage done by leaf folder on randomly selected hills at 14, 21, 28, 35 and 42 days after transplanting. Finally, plot wise grain yield was recorded at the time of harvest and represented as yield in terms of tonnes/ha after proper drying and threshing.

Data analysis

The data was showed as mean ± standard error (SE). For analysis of data Microsoft excel and SAS, software was used. The significance of observed difference was assessed by analysis of variance (ANOVA).

RESULTS AND DISCUSSION

YSB and leaf folder infestation

During *kharif* 2018 trial, for CR Dhan 304 variety, at different time intervals of 14, 21, 28, 35 and 42 days after transplanting, all the treatments recorded superior results in terms of dead-heart control in comparison to the untreated check and even the lowest dose of Chlorantraniliprole 625 g/L FS was found superior over the standard check (T5). Among the different dose rates of Chlorantraniliprole treatments, Chlorantraniliprole @ 75.0 g a.i/ha was recorded significantly best control with a least dead-heart per cent of 5.41, 4.77, 3.43, 2.98 and 2.47 at 14, 21, 28, 35 and 42 days after transplanting, respectively. Similarly, for hybrid (28P67) trial, among the different dose rates of treatments Chlorantraniliprole @ 75.0 g a.i/ha recorded significantly best control with a least dead-heart per cent of 4.77, 3.43, 2.81, 2.37 and 2.02 at 14, 21, 28, 35 and 42 days after transplanting, respectively. The similar trend was observed during *rabi* 2018-19 trials (Table 2 and Table 3).

Similarly, during *kharif* 2018 trial, for CR Dhan 304 variety, at different time intervals of 14, 21, 28, 35 and 42 days after transplanting, untreated check recorded the highest incidence of leaf folder with 4.45, 4.55, 4.77, 4.92 and 5.02 larvae/hill, respectively. Whereas, treatment Chlorantraniliprole @ 75.0 g a.i/ha registered the least count of leaf folder recording 0.87, 0.68, 0.78, 0.53 and 0.61 larvae/hill, respectively. Similarly, for Hybrid (28P67) trial the treatment Chlorantraniliprole @ 75.0 g a.i/ha recorded the least count of leaf folder with 0.57, 0.68, 0.74, 0.81 and 0.89 larvae/hill during the intervals of 14, 21, 28, 35 and 42 days after transplanting, respectively. The similar trend was observed during *rabi* 2018-19 trials (Table 4 and Table 5).

The seed treatment of paddy with

Table 2. Yellow stem borer infestation during *kharif* 2018 field experiment trial.

Sl. no.	Treatments	Variety trial					Hybrid trial				
		Dead heart (%)					Dead heart (%)				
		14 DAT	21 DAT	28 DAT	35 DAT	42 DAT	14 DAT	21 DAT	28 DAT	35 DAT	42 DAT
1	Chlorantraniliprole 625 g/L FS @ 52.5 g a.i./ ha	4.06 (11.62)*	3.02 (10.01)	2.50 (9.10)	2.24 (8.61)	2.08 (8.29)	3.02 (10.01)*	2.53 (9.15)	2.26 (8.65)	2.03 (8.19)	1.87 (7.86)
2	Chlorantraniliprole 625 g/L FS @ 60.0 g a.i./ ha	3.10 (10.14)	2.21 (8.55)	1.42 (6.84)	1.17 (6.21)	1.26 (6.44)	2.21 (8.55)	1.71 (7.52)	1.24 (6.38)	1.13 (6.11)	1.26 (6.44)
3	Chlorantraniliprole 625 g/L FS @ 67.5 g a.i./ ha	2.77 (9.58)	1.24 (6.38)	1.15 (6.15)	0.90 (5.44)	1.15 (6.15)	1.24 (6.38)	1.15 (6.15)	1.03 (5.83)	0.96 (5.62)	1.14 (6.13)
4	Chlorantraniliprole 625 g/L FS@ 75.0 g a.i./ ha	0.89 (5.41)	0.69 (4.77)	0.36 (3.43)	0.27 (2.98)	0.19 (2.47)	0.69 (4.77)	0.36 (3.43)	0.24 (2.81)	0.17 (2.37)	0.12 (2.02)
5	Cartap hydrochloride 4% GR @ 750 g a.i./ ha (Standard check)	5.26 (13.26)	6.53 (14.81)	6.83 (15.15)	8.82 (17.28)	9.51 (17.97)	5.60 (13.69)	6.75 (15.06)	7.07 (15.42)	10.12 (18.55)	11.07 (19.44)
6	Untreated Check	9.86 (18.30)	10.25 (18.68)	13.97 (21.95)	15.05 (22.83)	17.33 (24.60)	9.86 (18.30)	11.03 (19.40)	13.50 (21.56)	14.90 (22.71)	16.50 (23.97)
	SEm±	0.38	0.37	0.29	0.22	0.25	0.29	0.34	0.30	0.25	0.24
	CD (5%)	1.15	1.11	0.88	0.67	0.67	0.88	1.02	0.90	0.75	0.72
	CV	7.44	7.31	5.77	4.23	4.58	5.14	6.44	5.71	4.72	4.36

DAT- Days after transplanting. * Figures in the parenthesis are Arcsine transformed values.

Table 3. Yellow stem borer infestation during *rabi* 2018-19 field experiment trial.

Sl no	Treatments	Variety trial					Hybrid trial				
		Dead heart (%)					Dead heart (%)				
		14 DAT	21 DAT	28 DAT	35 DAT	42 DAT	14 DAT	21 DAT	28 DAT	35 DAT	42 DAT
1	Chlorantraniliprole 625 g/L FS @ 52.5 g a.i./ ha	3.42 (10.66)*	4.25 (11.90)	4.06 (11.62)	3.02 (10.01)	2.50 (9.10)	7.71 (16.12)*	7.20 (15.57)	5.70 (13.81)	4.08 (11.65)	3.32 (10.49)
2	Chlorantraniliprole 625 g/L FS @ 60.0 g a.i./ ha	2.81 (9.64)	3.33 (10.51)	3.17 (10.26)	2.21 (8.55)	1.26 (6.44)	6.14 (14.34)	6.26 (14.49)	4.81 (12.67)	2.81 (9.65)	2.09 (8.31)
3	Chlorantraniliprole 625 g/L FS @ 67.5 g a.i./ ha	2.49 (9.07)	2.89 (9.79)	2.53 (9.15)	1.24 (6.38)	1.15 (6.15)	4.22 (11.86)	5.37 (13.40)	3.45 (10.71)	1.72 (7.54)	1.51 (7.05)
4	Chlorantraniliprole 625 g/L FS@ 75.0 g a.i./ ha	1.01 (5.77)	1.85 (7.83)	1.36 (6.71)	0.69 (4.77)	0.36 (3.43)	2.51 (9.12)	2.63 (9.34)	1.71 (7.52)	0.84 (5.25)	0.34 (3.35)
5	Cartap hydrochloride 4% GR @ 750 g a.i./ ha (Standard check)	10.80 (19.18)	19.60 (26.28)	16.84 (24.23)	11.75 (20.04)	9.97 (18.41)	16.27 (23.79)	17.71 (24.89)	16.96 (24.32)	15.24 (22.98)	14.30 (22.22)
6	Untreated Check	13.07 (21.19)	27.98 (31.93)	28.70 (32.39)	16.29 (23.80)	16.50 (23.97)	22.77 (28.50)	30.27 (33.38)	27.71 (31.76)	17.81 (24.96)	15.87 (23.48)
	SEm±	0.44	0.45	0.66	0.40	0.34	0.89	0.81	0.58	0.48	0.49
	CD (5%)	1.32	1.30	1.98	1.20	1.01	2.67	2.44	1.73	1.45	1.49
	CV	6.95	5.36	8.39	6.50	5.98	10.28	8.79	6.86	7.05	7.93

DAT- Days after transplanting. * Figures in the parenthesis are Arcsine transformed values.

Chlorantraniliprole is widely recommended in locations where high incidence of leaf folder and stem borer incidence is anticipated (Wilson et al., 2019). The study revealed that Chlorantraniliprole 625 g/L FS seed treatment can effectively manage the key pests of rice. Present study is in line with studies by Lanka et al. (2013) and Hummel et al. (2014) who reported the reduction in rice root weevil densities in chlorantraniliprole treated plots. Similarly, Thrash et al. (2013) reported reduced survivorship of fall armyworm

Table 4. Leaf folder infestation during *kharif* 2018 field experiment trial.

Sl. no.	Treatments	Variety trial					Hybrid trial				
		Leaf folder larvae per hill					Leaf folder larvae per hill				
		14 DAT	21 DAT	28 DAT	35 DAT	42 DAT	14 DAT	21 DAT	28 DAT	35 DAT	42 DAT
1	Chlorantraniliprole 625 g/L FS @ 52.5 g a.i./ ha	1.64 (1.78)*	1.75 (1.82)	1.83 (1.85)	1.89 (1.87)	1.96 (1.90)	1.92 (1.89)	1.96 (1.90)	2.04 (1.93)	2.17 (1.97)	2.26 (2.00)
2	Chlorantraniliprole 625 g/L FS @ 60.0 g a.i./ ha	1.49 (1.72)	1.58 (1.75)	1.62 (1.77)	1.74 (1.82)	1.88 (1.87)	1.57 (1.75)	1.68 (1.79)	1.94 (1.89)	2.06 (1.94)	2.13 (1.96)
3	Chlorantraniliprole 625 g/L FS @ 67.5 g a.i./ ha	1.23 (1.61)	1.42 (1.69)	1.48 (1.71)	1.67 (1.79)	1.13 (1.56)	1.41 (1.69)	1.53 (1.74)	1.67 (1.79)	1.73 (1.82)	1.84 (1.86)
4	Chlorantraniliprole 625 g/L FS@ 75.0 g a.i./ ha	0.87 (1.43)	0.68 (1.32)	0.78 (1.38)	0.53 (1.23)	0.61 (1.28)	0.57 (1.25)	0.68 (1.32)	0.74 (1.36)	0.81 (1.40)	0.89 (1.44)
5	Cartap hydrochloride 4% GR @ 750 g a.i./ ha (Standard check)	3.14 (2.27)	3.24 (2.30)	3.57 (2.39)	3.84 (2.46)	3.94 (2.49)	2.94 (2.21)	3.01 (2.23)	3.19 (2.29)	3.27 (2.31)	3.35 (2.33)
6	Untreated Check	4.45 (2.61)	4.55 (2.63)	4.77 (2.68)	4.92 (2.72)	5.02 (2.74)	5.18 (2.77)	5.25 (2.79)	5.34 (2.81)	5.50 (2.85)	5.62 (2.87)
	SEm±	0.03	0.03	0.02	0.02	0.03	0.02	0.03	0.02	0.02	0.02
	CD (5%)	0.10	0.08	0.07	0.07	0.09	0.06	0.09	0.07	0.07	0.07
	CV	3.37	2.94	2.44	2.39	3.08	1.97	2.89	2.36	2.42	2.33

DAT- Days after transplanting. * Figures in the parenthesis are square root transformed values.

Table 5. Leaf folder infestation during *rabi* 2018-19 field experiment trial.

Sl. no.	Treatments	Variety trial					Hybrid trial				
		Leaf folder larvae per hill					Leaf folder larvae per hill				
		14 DAT	21 DAT	28 DAT	35 DAT	42 DAT	14 DAT	21 DAT	28 DAT	35 DAT	42 DAT
1	Chlorantraniliprole 625 g/L FS @ 52.5 g a.i./ ha	1.20 (1.60)*	1.13 (1.56)	1.16 (1.58)	1.15 (1.57)	1.14 (1.57)	1.05 (1.52)	1.11 (1.55)	1.13 (1.56)	1.15 (1.57)	1.19 (1.59)
2	Chlorantraniliprole 625 g/L FS @ 60.0 g a.i./ ha	1.14 (1.57)	1.16 (1.58)	1.12 (1.56)	1.12 (1.56)	1.13 (1.56)	1.03 (1.52)	1.13 (1.56)	1.14 (1.57)	1.17 (1.58)	1.11 (1.55)
3	Chlorantraniliprole 625 g/L FS @ 67.5 g a.i./ ha	1.11 (1.55)	1.11 (1.55)	1.14 (1.57)	1.00 (1.50)	0.80 (1.39)	1.15 (1.57)	1.14 (1.57)	1.11 (1.55)	1.14 (1.57)	1.15 (1.57)
4	Chlorantraniliprole 625 g/L FS@ 75.0 g a.i./ ha	0.17 (0.91)	0.44 (1.16)	0.35 (1.09)	0.28 (1.03)	0.38 (1.11)	0.24 (0.99)	0.42 (1.14)	1.06 (1.53)	0.68 (1.32)	0.55 (1.24)
5	Cartap hydrochloride 4% GR @ 750 g a.i./ ha (Standard check)	3.20 (2.29)	2.70 (2.14)	2.90 (2.20)	3.10 (2.26)	3.25 (2.30)	2.50 (2.08)	2.75 (2.16)	2.85 (2.19)	3.00 (2.23)	2.85 (2.19)
6	Untreated Check	5.40 (2.82)	4.90 (2.71)	5.20 (2.78)	5.30 (2.80)	4.40 (2.60)	4.25 (2.56)	4.50 (2.62)	4.00 (2.50)	3.75 (2.44)	4.15 (2.54)
	SEm±	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.03	0.03
	CD (5%)	0.08	0.08	0.09	0.08	0.08	0.08	0.06	0.07	0.09	0.08
	CV	3.00	2.84	3.15	3.20	3.20	2.99	2.16	2.61	3.43	2.93

DAT- Days after transplanting. * Figures in the parenthesis are square root transformed values.

larvae at both vegetative as well as reproductive stages of soybean plants due to treatment of seeds with chlorantraniliprole. The above results corroborate with work of Singh et al. (2004) who reported that, imidacloprid 600 FS @ 10 ml/ kg seed is the most effective in pearl millet against termites. Sundria and Acharya (2012) also reported imidacloprid 70 WS @ 10 gm/ kg seed as highly effective on wheat. Panigrahi (2010) found that imidacloprid 10 ml/ kg seed was superior. Choudhary and Dashad (2002) proved that seed treatment with chlorpyriphos @ 7 ml/ kg seed has significantly proved to be effective in chickpea resulting in minimum termite damage and maximum grain yield of chickpea.

Yield determined under Chlorantraniliprole 625 g/L FS treated plots

During *kharif* 2018 trial, for CR Dhan 304 variety the highest yield (5.46 t/ha) was recorded in treatment Chlorantraniliprole @ 75.0 g a.i/ha (T4) which was significantly superior over the other doses of Chlorantraniliprole and the check treatment (Table 6). Similarly in hybrid (28P67) trial also, all the dose rates of Chlorantraniliprole and the check treatment recorded superior yield in comparison to the untreated check. The highest yield (6.85 t/ha) was recorded in treatment Chlorantraniliprole @ 75.0 g a.i/ha (T4) which was significantly superior over the other doses of Chlorantraniliprole and the check treatment. The similar trend was observed for yield parameters during *rabi* 2018-19 trials.

Due to the high efficacy of chlorantraniliprole seed treatment in suppression of leaf folder and stem borers population under field conditions significantly increase in yield under chlorantraniliprole treated plots were recorded in both seasons (*Kharif* and *Rabi*) and in both variety and hybrid trials. Mazzanti et al. (2012) evaluated the efficacy of thiamethoxam seed treatment on paddy water weevil control in conventional and hybrid rice and showed that the hybrid paddy had significantly more tiller number and dry weight when compared with the conventional variety hence, shown significantly higher larval density of paddy water weevil. Similarly, Parsai et al. (2014) achieved maximum grain yield of chickpea with seed treatment of thiamethoxam 30% FS @ 2.5 ml/ kg seed. Mishra et al. (2007) observed maximum plant stand with maximum grain yield in wheat due to seed treatment against termite. Hence, seed treatment with Chlorantraniliprole 625 g/ L FS (seed treatment formulation) can be recommended for managing stem borer and leaf folder pests in paddy.

CONCLUSION

It is apparent from the studies undertaken during *kharif* 2018 and *rabi* 2018-19, that Chlorantraniliprole 625 g/ L FS (seed treatment formulation) provided an excellent

Table 6. Yield data observed during Chlorantraniliprole 625 g/L FS field experiment trial.

Sl no	Treatments	*Kharif* 2018		*Rabi* 2018-19	
		Yield (t/ha)		Yield (t/ha)	
		Variety (CR Dhan 304)	Hybrid (28P67)	Variety (CR Dhan 304)	Hybrid (28P67)
1	Chlorantraniliprole 625 g/L FS @ 52.5 g a.i./ ha	4.64	5.86	4.55	5.78
2	Chlorantraniliprole 625 g/L FS @ 60.0 g a.i./ ha	4.72	5.98	4.61	5.85
3	Chlorantraniliprole 625 g/L FS @ 67.5 g a.i./ ha	4.87	6.03	4.73	5.91
4	Chlorantraniliprole 625 g/L FS@ 75.0 g a.i./ ha	5.46	6.85	5.34	6.49
5	Cartap hydrochloride 4% GR @ 750 g a.i./ ha (Standard check)	4.05	5.15	4.18	5.13
6	Untreated Check	3.70	4.43	3.39	4.41
	SEm±	0.14	0.17	0.10	0.15
	CD (5%)	0.41	0.51	0.30	0.44
	CV	5.91	5.84	4.37	5.23

control of stem borer and leaf folder in conventional variety of rice (CR Dhan 304) and hybrid rice (28P67). Similarly, treatment of Chlorantraniliprole @ 75 g ai/ha recorded highest yield (both in variety and hybrid rice). Hence, seed treatment with Chlorantraniliprole @ 75 g ai/ha can be recommended for managing stem borer and leaf folder pests in paddy.

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CONFLICTS OF INTEREST

Individual authors declare no conflict of interest with regards to this publication.

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