

Original Research Article

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## Pesticidal Compatibility against Yellow Stem Borer and Sheath Blight in *kharif* and *Rabi* Rice

Chirasree Gangopadhyay and Sitesh Chatterjee\*

Rice Research Station, Government of West Bengal, Chinsurah (R.S.),  
Hooghly, West Bengal, India

\*Corresponding author

### ABSTRACT

#### Keywords

Rice, Pesticide compatibility, Flubendiamide + buprofezin, Hexaconazole, Yellow stem borer, Sheath blight, Spider, Coccinellid

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A field experiment was carried out at Rice Research Station, Chinsurah, Hooghly during *kharif*, 2013 and *boro*, 2013-14 to evaluate the compatibility of selected insecticides with fungicides against yellow stem borer (YSB) and sheath blight (ShB). The trial included nine treatments consisting of insecticides, pre-mix flubendiamide + buprofezin and triazophos and fungicide, hexaconazole and tricyclazole which were applied alone as individual treatment and in four possible combination treatment with untreated control. The experiment was laid in RBD with three replications. The results revealed that during *kharif*, flubendiamide + buprofezin had performed best against YSB. Whereas, in *boro* the combination of flubendiamide + buprofezin with tricyclazole was the best against dead heart. Whereas, flubendiamide + buprofezin alone had shown best result against white ear head. Low ShB severity was recorded in pre-mix flubendiamide + buprofezin along with hexaconazole treatment both in *kharif* and *boro*. In both the seasons, the highest population of spiders and coccinellids was recorded in flubendiamide + buprofezin treatment. No adverse impact on the efficacy of the combination of flubendiamide + buprofezin and triazophos with tricyclazole and hexaconazole against YSB and ShB confirming the compatibility between them when used as tank mix in the field condition.

### Introduction

Rice in West Bengal is considered as the dominant food crop and is grown in all six agro-climatic zones of the state under diversified situations such as upland, rainfed shallow, semideep and deep lowland and finally irrigated conditions. The state, West Bengal ranks second in area (5,386,000 ha) and first in production (14,771,0000 tons) of rice in India (Chatterjee *et al.*, 2017). The major constrains for low productivity of rice

in India is the losses due to insect pests and diseases. Rice stem borers are the principal pests responsible for economic crop loss under field conditions (Heinrichs *et al.*, 2017). Over 90 per cent of the borer populations were occupied by the *S. incertulas* in *kharif* rice from seedling to maturity stage in new alluvial zone of West Bengal (Chatterjee *et al.*, 2017). The yield loss due to *S. incertulas* was estimated to be approximately 10-60 percent in India (Panda, *et al.*, 1976; Pasalu, *et al.*, 2005). Sheath blight, a soil-borne

fungal disease (*Rhizoctonia solani* Kuhn) causing 25% yield losses and considered important next to blast disease of rice crop. This disease is an important constraint in intensified rice production systems. A critical analysis of the gap between the potential and actual rice yields across the nation revealed several factors act as yield constraints (Chatterjee *et al.*, 2016). To combat this situation the application of combination of suitable insecticides and fungicides as tank mix is economic, time saving and feasible management practice. Therefore, it is essential to evaluate compatibility of insecticides and fungicides against insect pests and diseases of rice. The systematic efforts for evaluation of compatibility of insecticides and fungicides were done at the Directorate of Rice Research, Hyderabad (Bhatnagar, 2004; Bhuvaneshwari and Krishnam, 2013). Keeping this in view, the study was undertaken to evaluate the compatibility of one new insecticide combination (flubendiamide+buprofezin) and other groups of insecticides and fungicides based on their efficacy against rice stem borer and sheath blight diseases of rice.

### Materials and Methods

The field experiments have been conducted at Rice Research Station, Chinsurah, West Bengal in randomized block design with three replications during *kharif* 2013 and *boro* 2013-14. The plot size was  $5 \times 3 \text{ m}^2$  with spacing of  $20 \times 15 \text{ cm}^2$  and 1.0 m replication border and 0.5 m treatment border between the plots. The experimental plots were separated by raising bunds of about 15 cm height all around each plot. The rice varieties, Swarna (MTU 7029) in *kharif* and Khitish (IET 4094) in *boro* were sown for the present study. Twenty five days old seedlings in *kharif* during July last week and forty days old seedlings in *boro* during January last week were transplanted. The crops were

raised adopting a standard package of practices with fertilizer dose @  $\text{N:P}_2\text{O}_5:\text{K}_2\text{O}::80:40:40 \text{ kg ha}^{-1}$ . The treatments included two insecticides, *viz.* flubendiamide 4% + buprofezin 20% SC @  $1.75 \text{ ml l}^{-1}$  ( $35+175 \text{ g a.i. ha}^{-1}$ ) and triazophos 40 EC @  $1.5 \text{ ml l}^{-1}$  ( $300 \text{ g a.i. ha}^{-1}$ ) and two fungicides, *viz.* hexaconazole 5 SC @  $2.0 \text{ ml l}^{-1}$  ( $50 \text{ g a.i. ha}^{-1}$ ) and tricyclazole 75 WP @  $0.6 \text{ g l}^{-1}$  ( $225 \text{ g a.i. ha}^{-1}$ ) and four possible combinations of these four pesticides besides untreated control (Table 1). High volume spray @ 500 litres of water for one hectare area was considered for spraying of each treatment. Two spraying schedule of each treatment was conducted at 15 and 45 days after transplanting (DAT). The application of pesticides on 15 DAT can manage the disease and insect-pest attack at tillering stage whereas application of pesticides on 45 DAT can control the pests attack at reproductive stage. The observations were made on dead heart at maximum tillering stage on 45 DAT and before harvest for white ear damage of yellow stem borer and per cent sheath blight incidence. The stratified random sampling from ten hills was followed to record the infestation of yellow stem borer. The infestation of sheath blight was recorded from two sampling units of one square meter each fixed in each plot at random at vegetative stage at 80 DAT. The per cent severity (as per cent area of leaf affected) of sheath blight (*Rhizoctonia solani*) was calculated (IRRI, 2013). Symptoms include oval or ellipsoidal greenish-gray lesions, usually 1-3 cm long, on the leaf sheath, initially just above the soil or water level in conventionally flooded rice fields. Under favourable conditions, initial lesions multiply and expand to the upper part of the sheaths and leaves, and then spread to neighbouring tillers of different hills (transplanted rice) or plants (direct-seeded rice). Lesions on the leaves usually have irregular lesions, often with gray-white centers and brown margins as they grow

older. The infection may even reach to panicle causing grain blight) per cent of disease covered of height of each hill sampled (Manandhar *et al.*, 2016). The number of natural enemies *viz.* spiders (*Tetragnatha* sp., *Argiope* sp., *Oxyopes* sp., *Lycosa* sp., *Phidippus* sp.) and coccinellid (*Chilomenes sexmaculatus*, *Coccinella* sp., *Harmonia* sp., *Micraspis* sp.) from five hills of each plot were noticed at 45 DAT. Harvesting was done by the end of November in *kharif* and during April for *boro* crop. The grain yield per plot was converted into kg ha<sup>-1</sup>. The yield data was recorded by excluding two border rows from all sides for each plot separately. The per cent infestation of YSB and sheath blight were converted into angular transformed values and thereafter the paddy yield and infestation data were compared for significance using critical difference at 0.05 probability level.

## Results and Discussion

The dead heart infestation during *kharif* 2013 and *boro* 2013-14 varied from 0.64 to 17.60% DH and 11.51 to 21.82% DH respectively (Table 2 and 3). The results revealed that all the insecticidal treatments alone or in combination with fungicides were significantly superior to untreated control and fungicidal treatments alone. However, the treatment, pre-mix of flubendiamide + buprofezin alone was found most effective with 0.64% average dead heart infestation followed by the combination treatment of pre-mix flubendiamide + buprofezin and hexaconazole (1.34% DH), in comparison to 17.60% DH in untreated control during *kharif* 2013 (Table 2). During the season, the lowest white ear head infestation (0.84% WE) was recorded when flubendiamide + buprofezin was applied followed by tank mix application of pre-mix flubendiamide + buprofezin and tricyclazole (2.76% WE). The stem borer infestation was found highest in the untreated control plots (19.52% WE). Phytotoxicity

symptoms like scorching effect, drying of leaves and stems or in any, were not observed in any treatment when pesticides were applied in combination. The most effective treatment was the tank mix of pre-mix flubendiamide + buprofezin and hexaconazole (3.30% ShB) against sheath blight in Swarna variety during *kharif* season followed by hexaconazole (3.69% ShB) alone compared to the control plots (17.88% ShB). In *kharif*, the maximum population of spiders and coccinellids was noticed in pre-mix flubendiamide + buprofezin (0.79 spider hill<sup>-1</sup> and 0.43 coccinellid hill<sup>-1</sup>) treated plots followed by untreated control (0.77 spider hill<sup>-1</sup>) and tricyclazole treatment (0.44 coccinellid hill<sup>-1</sup>), respectively (Table 4). Highest paddy yield of Swarna variety in *kharif* was obtained from tank mix of pre-mix flubendiamide + buprofezin and hexaconazole (4670 kg ha<sup>-1</sup>) followed by pre-mix flubendiamide + buprofezin (4503 kg ha<sup>-1</sup>) in comparison to control (3613 kg ha<sup>-1</sup>) (Table 2).

During *boro* 2013-14, the results revealed that all the insecticidal treatments alone or in combination with fungicides were significantly superior to untreated control and fungicidal treatments alone. However, the most effective treatment against dead heart was observed in the combination of pre-mix flubendiamide + buprofezin and tricyclazole (11.02% DH) followed by pre-mix flubendiamide + buprofezin alone (11.51% DH) compared to the hexaconazole treated plots (21.82% DH) and untreated control (17.61% DH). Whereas in later stage, pre-mix of flubendiamide + buprofezin alone (6.90% WE) showed the best performance against white head, followed by combination of pre-mix flubendiamide + buprofezin with tricyclazole (7.14% WE) in comparison to the untreated plots (26.40% WE). No phytotoxicity symptom was observed in any treatment when pesticides were applied in combination.

**Table.1** Treatments details with pesticidal doses

Treatments	Applied pesticides (Chemical name)	Dose	
		in g a.i. ha <sup>-1</sup>	in ml or g l <sup>-1</sup>
T <sub>1</sub>	Flubendiamide 4% + buprofezin 20% SC	35+175	1.75
T <sub>2</sub>	Triazophos 40% EC	300	1.5
T <sub>3</sub>	Hexaconazole 5% SC	50	2.0
T <sub>4</sub>	Tricyclazole 75% WP	225	0.6
T <sub>5</sub>	Tank mix of T <sub>1</sub> + T <sub>3</sub>	-	1.75 + 2.0
T <sub>6</sub>	Tank mix of T <sub>1</sub> + T <sub>4</sub>	-	1.75 + 0.6
T <sub>7</sub>	Tank mix of T <sub>2</sub> + T <sub>3</sub>	-	1.5 + 2.0
T <sub>8</sub>	Tank mix of T <sub>2</sub> + T <sub>4</sub>	-	1.5 + 0.6
T <sub>9</sub>	Untreated control	-	-

**Table.2** Efficacy of different pesticides and their combinations against insect pest and disease of rice (cv. Swarna) during *kharif*, 2013

Treatments	Yellow stem borer Damage		Sheath blight%	Paddy yield (kg ha <sup>1</sup> )
	DH%	WE%		
T <sub>1</sub> = Flubendiamide 4% + buprofezin 20%	0.64 (4.59)	0.84 (5.26)	17.69 (24.84)	4503
T <sub>2</sub> = Triazophos 40%	2.48 (9.06)	4.52 (12.27)	18.41 (25.36)	4017
T <sub>3</sub> = Hexaconazole 5% SC	14.87 (22.67)	15.19 (22.93)	3.69 (11.02)	3950
T <sub>4</sub> = Tricyclazole 75%	17.14 (24.45)	9.34 (17.79)	17.37 (24.58)	3840
T <sub>5</sub> = (T <sub>1</sub> + T <sub>3</sub> )	1.34 (6.64)	2.90 (9.80)	3.30 (10.33)	4670
T <sub>6</sub> = (T <sub>1</sub> + T <sub>4</sub> )	1.68 (7.44)	2.76 (9.56)	18.05 (25.11)	4400
T <sub>7</sub> = (T <sub>2</sub> + T <sub>3</sub> )	7.41 (15.79)	7.75 (16.16)	3.81 (11.15)	4377
T <sub>8</sub> = (T <sub>2</sub> + T <sub>4</sub> )	3.97 (11.49)	7.51 (15.90)	16.63 (24.04)	4343
T <sub>9</sub> = Untreated control	17.60 (24.79)	19.52 (26.21)	17.88 (24.98)	3613
<b>SEm±</b>	1.89	1.94	1.04	79.74
<b>CD 0.05</b>	5.73	5.86	3.13	241.12

Figures in the parenthesis are angular transformed values

**Table.3** Efficacy of different pesticides and their combinations against insect pest and disease of rice (cv. Khitish) during *boro*, 2013-14

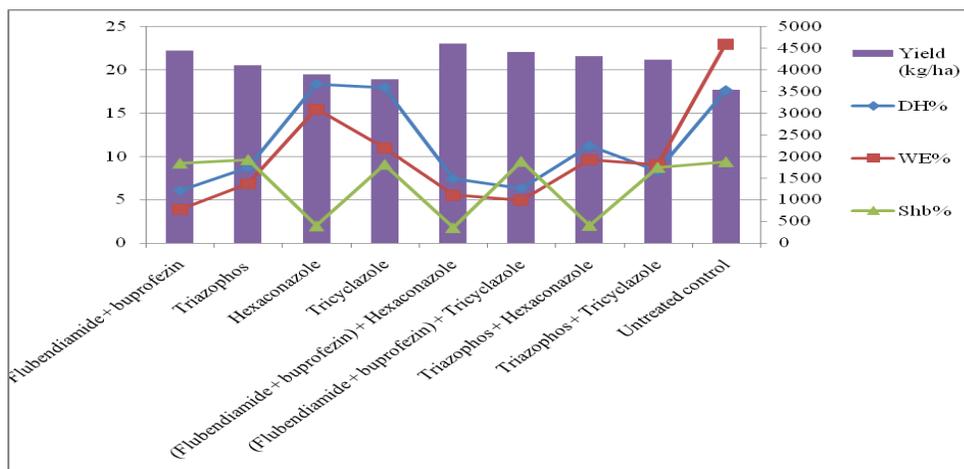
Treatments	Yellow stem borer Damage		Sheath blight%	Paddy yield (kg ha <sup>1</sup> )
	DH%	WE%		
<b>T<sub>1</sub> = Flubendiamide 4% + buprofezin 20%</b>	11.51 (19.82)	6.90 (15.22)	0.75 (4.95)	4377
<b>T<sub>2</sub> = Triazophos 40%</b>	15.01 (22.78)	9.14 (17.57)	0.86 (5.32)	4190
<b>T<sub>3</sub> = Hexaconazole 5% SC</b>	21.82 (27.82)	15.68 (23.29)	0.27 (2.96)	3810
<b>T<sub>4</sub> = Tricyclazole 75%</b>	18.80 (25.69)	12.60 (20.78)	0.79 (5.09)	3713
<b>T<sub>5</sub> = (T<sub>1</sub> + T<sub>3</sub>)</b>	13.53 (21.57)	8.15 (16.59)	0.25 (2.35)	4533
<b>T<sub>6</sub> = (T<sub>1</sub> + T<sub>4</sub>)</b>	11.02 (19.36)	7.14 (15.47)	0.82 (5.12)	4407
<b>T<sub>7</sub> = (T<sub>2</sub> + T<sub>3</sub>)</b>	15.04 (22.79)	11.43 (19.74)	0.27 (2.96)	4247
<b>T<sub>8</sub> = (T<sub>2</sub> + T<sub>4</sub>)</b>	12.73 (20.87)	10.61 (18.99)	0.86 (5.33)	4120
<b>T<sub>9</sub> = Untreated control</b>	17.61 (24.79)	26.40 (30.91)	0.89 (5.42)	3443
<b>SEm±</b>	1.50	2.30	0.42	75.27
<b>CD 0.05</b>	4.54	6.95	1.27	27.59

Figures in the parenthesis are angular transformed values

**Table.4** Efficacy of different pesticides on natural enemies of rice during *kharif*, 2013 (cv. Swarna) and *boro*, 2013-14 (cv. Khitish)

Treatments	<i>Kharif</i> 2013		<i>Boro</i> 2013-14	
	Spider hill <sup>-1</sup>	Coccinellid hill <sup>-1</sup>	Spider hill <sup>-1</sup>	Coccinellid hill <sup>-1</sup>
<b>T<sub>1</sub> = Flubendiamide 4% + buprofezin 20%</b>	0.79	0.43	0.45	0.40
<b>T<sub>2</sub> = Triazophos 40%</b>	0.14	0.11	0.07	0.05
<b>T<sub>3</sub> = Hexaconazole 5% SC</b>	0.58	0.40	0.43	0.36
<b>T<sub>4</sub> = Tricyclazole 75%</b>	0.71	0.44	0.40	0.33
<b>T<sub>5</sub> = (T<sub>1</sub> + T<sub>3</sub>)</b>	0.72	0.41	0.43	0.39
<b>T<sub>6</sub> = (T<sub>1</sub> + T<sub>4</sub>)</b>	0.75	0.36	0.36	0.40
<b>T<sub>7</sub> = (T<sub>2</sub> + T<sub>3</sub>)</b>	0.13	0.09	0.05	0.04
<b>T<sub>8</sub> = (T<sub>2</sub> + T<sub>4</sub>)</b>	0.13	0.09	0.07	0.07
<b>T<sub>9</sub> = Untreated control</b>	0.77	0.41	0.39	0.44
<b>SEm±</b>	0.06	0.04	0.05	0.04
<b>CD 0.05</b>	0.12	0.11	0.14	0.11

**Fig.1** Pesticidal efficacy against yellow stem borer and sheath blight in rice during *kharif* and *boro*



During *boro*, the combination of pre-mix flubendiamide + buprofezin and hexaconazole (0.25% ShB) provided best performance against sheath blight in Kshitish variety followed by both the treatments of hexaconazole alone and the combination of triazophos with hexaconazole (0.27% ShB). Highest population of spiders and coccinellids was recorded in pre-mix flubendiamide + buprofezin treatment (0.45 spider hills<sup>-1</sup>) and control plots (0.44 coccinellid hill<sup>-1</sup>), respectively followed by hexaconazole alone (0.43 spider hill<sup>-1</sup>) and both the treatments of pre-mix flubendiamide + buprofezin and tank mix of pre-mix flubendiamide + buprofezin and triacyclazole (0.40 coccinellid hill<sup>-1</sup>), respectively (Table 4). Highest paddy yield of Kshitish variety in *boro* was obtained from combined insecticidal treatment of pre-mix flubendiamide + buprofezin with hexaconazole (4533 kg ha<sup>-1</sup>) followed by tank mix of pre-mix flubendiamide + buprofezin and triacyclazole (4407 kg ha<sup>-1</sup>) in comparison to control (3443 kg ha<sup>-1</sup>) (Table 3).

The mean values of both the seasons that the lowest dead heart was observed in pre-mix of flubendiamide + buprofezin (6.08% DH) followed by tank mix of pre-mix flubendiamide + buprofezin and triacyclazole

combination (6.35% DH) and in the later stage the minimum white head damage was recorded in pre-mix flubendiamide + buprofezin (3.87% WE) followed by pre-mix flubendiamide + buprofezin and hexaconazole combination (5.53% WE) (Fig. 1). In case of sheath blight, tank mix of flubendiamide + buprofezin and hexaconazole (1.18% ShB) treatment was found best followed by hexaconazole alone (1.98% ShB). Highest yield was obtained from the plots treated with combination of pre-mix flubendiamide + buprofezin and hexaconazole (4602 kg ha<sup>-1</sup>) followed by pre-mix flubendiamide + buprofezin (4440 kg ha<sup>-1</sup>).

The results of this experiment have close proximity with the findings of Prasad *et al.*, (2015) who found that the combination of pre-mix flubendiamide + buprofezin and triacyclazole as tank mix was most effective against stem borer with 3.22% infestation and fetched average grain yield of 30.39 q ha<sup>-1</sup>. It was closely followed by the combination pre-mix flubendiamide + buprofezin and hexaconazole with 3.16% average stem borer infestation. This study also corroborates the study of the above. Karthikeyan (2015) who elaborated that flubendiamide + buprofezin followed by combination of triazophos +

tricyclazole recorded lowest incidence of dead hearts (0.53 and 1.07%) and triazophos + tricyclazole combination also recorded lowest incidence of white ear (3.90%). Sheath blight incidence was low in triazophos + tricyclazole and tricyclazole treated plots (19.00 and 25.63%). The grain yield was highest in pre-mix of flubendiamide + buprofezin (3355 kg ha<sup>-1</sup>) treatment followed by tank mix of pre-mix flubendiamide + buprofezin with hexaconazole (3268 kg ha<sup>-1</sup>) and triazophos with hexaconazole (3143 kg ha<sup>-1</sup>), triazophos with tricyclazole (3116 kg ha<sup>-1</sup>) treated plots. This study partially agree with the results of the above for management of YSB and paddy yield, showing that throughout the period pre-mix of flubendiamide + buprofezin and its combination with hexaconazole and tricyclazole are the most effective treatments than triazophos and its combination with fungicides against YSB. The result of the present study representing hexaconazole to be the best fungicide against sheath blight differs with the results of the experiment of Karthikeyan (2015). According to Bhuvanewari and Raju (2013) the insecticide, chlorantraniliprole in combination with fungicide, hexaconazole caused less incidence of stem borer. Prased *et al.*, (2014) indicated that acephate was the best followed by the combination of pre-mix flubendiamide + buprofezin and flubendiamide with 3.50, 4.15 and 4.40 per cent of average YSB infestation; and 18.00, 16.37 and 16.27 q ha<sup>-1</sup> average grain yields, respectively, were effective against YSB on semi deep water rice. The results of this experiment differs from the above studies revealing that pre-mix of flubendiamide + buprofezin and its combination with hexaconazole and tricyclazole are the most effective treatments than that of triazophos and its combination with fungicides against YSB. Rath (2011) showed that the combination product flubendiamide + buprofezin recorded less dead heart and white ear head which also

corroborate our findings. Thus, the results reveal that there was no adverse impact on the efficacy of either the pre-mix of flubendiamide 4%+buprofezin 20% SC or triazophos 40% EC due to their combination with hexaconazole 5% SC or tricyclazole 75% WP or vice versa confirming the compatibility of chemicals when used as a tank mix in the field.

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