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Studies on Compatibility of Insecticides and Fungicides against Brown Plant Hopper and Blast in Rice

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Abstract

Field experiments conducted for evaluation of compatibility of insecticides and fungicides against brown planthopper and blast in rice revealed that pymetrozine in combination with tricyclazole and isoprothiolane and triflumezopyrim in combination with tricyclazole and isoprothiolane were found effective against brown plant hopper and blast and recorded higher grain yields (4872 kg/ha, 4873 kg/ha, 5014 kg/ha and 5088 kg/ha) compared to untreated control (3036 kg/ha). Neither insecticides nor fungicides lost their efficacy against target pest/disease when used as tank mixtures. Insecticides, pymetrozine and triflumezopyrim are compatible with tricyclazole and isoprothiolane fungicides with nil phytotoxicity and can be safely used as tank mixtures for simultaneous management of BPH and blast in rice.

Key words: Brown Plant Hopper, Blast, Insecticides, Fungicides, Compatibility, Rice.

Introduction

Rice (*Oryza sativa* L.) is an important staple food crop for more than half of the world population and accounts for more than 50 per cent of the daily calorie intake (Khush, 2005). Rice is prone to attack by several insect pests and diseases irrespective of its method of cultivation. Among the insect pests, Brown Plant Hopper (BPH), *Nilaparvata lugens* (Stal.) are considered as the major yield limiting biological constraints in all rice growing countries both in tropics and temperate regions (Krishnaiah, 2014). Both nymphs and adults of the BPH suck plant sap from phloem cells cause "hopper burn" symptoms, resulting in 10% yield loss in general, and losses exceed even up to 90% in case of severity (Seni and Naik, 2017). Rice blast caused by *Pyricularia oryzae* is the most destructive disease of rice worldwide causing significant yield losses (Kunova *et al*., 2013) and in tropical region, especially in India the disease is a serious threat to rice crop (Sireesha, 2013).

Though the incidence of BPH and blast are noticed throughout the crop growth stages, their simultaneous occurrence after primordial initiation, especially in *rabi* season necessitates application of recommended insecticides and fungicides at a time. Labour shortage coupled with increased spraying costs force the farmers to apply insecticides and fungicides as tank mixtures without any first-hand information on their compatibility, which often results improper pest control besides pest resistance and resurgence. Information on compatibility of newly recommended fungicides and insecticides as tank mix application in rice is limited. Such information is vital to achieve effective control of both BPH and Blast simultaneously.

Materials and Methods

Field experiments were conducted to assess the physical compatibility, phytotoxicity and efficacy of insecticide and fungicide mixtures against BPH and blast at Regional Agricultural Research Station, Maruteru. The study area lies in between 16° 37' 48" N Latitude and 81° 44' 47" E Longitude at an altitude of 10 meters above sea level with humid to sub humid climate. Rice is an indispensable crop and grown throughout the year in two major seasons *kharif* (June-November) and *rabi* (December-March) in alluvial clay soils. Rice crop is grown under assured canal irrigation during *rabi* season.

Incidence of BPH and blast are a major concern during *rabi* season and compatibility studies were conducted for two consecutive years 2020 and 2021. Rice variety RDR-763, highly susceptible to BPH and blast was chosen for the present investigation in a randomized block design (RBD) with nine treatments replicated thrice. Transplanting and other crop husbandry operations as recommended in the package of practices of Acharya N. G. Ranga Agricultural University, Andhra Pradesh were adopted for raising the crop. Insecticidies recommended for control of BPH *viz*., Pymetrozine 50 WG @ 0.60 g/l (T_1); Triflumezopyrim 10SC @ 0.48 ml/l (T_2) and fungicides recommended for containing blast *viz*., Tricyclazole 75WP @ 0.60 g/l (T_3), Isoprothiolane 40 EC @ 1.5 ml/l (T_4) were tested alone and in combination for physical compatibility, bio-efficacy and phyto toxicity.

Physical compatibility studies:

Insecticide (Pymetrozine and Triflumezopyrim) and fungicide (Tricyclazole and Isoprothiolane) combinations were evaluated with jar compatibility test, where 500 ml of standard hard water (0.304 g calcium chloride and 0.139 g of magnesium chloride hexahydrate in one litre of double distilled water) was taken in a one litre jar to which one insecticide and fungicide are added in the order of Wettable powder (WP) followed by Dry flowables (DF), Flowables (F), Emulsifiable concentrates (EC) and finally Solubles designated as either soluble (S), soluble liquid (SL) or soluble concentrates (SC). Later, the volume of insecticide and fungicide mixture was made to one litre with hard water, agitated by shaking the jar and left undisturbed for 30 minutes to observe foaming and sedimentation. p^H of insecticides and fungicides alone and in combinations were also recorded and designated according to Bickelhaupt (2012) **(Table 1)**.

Table 1: Rating chart for reaction based on the value of p^H

Reaction	P^H
Extremely acidic	< 4.5
Very strongly acidic	4.5 - 5.0
Strongly acidic	5.1 - 5.5
Moderately acidic	5.6 - 6.0
Slightly acidic	6.1 - 6.5
Neutral	6.6 - 7.3
Slightly alkaline	7.4 - 7.8
Moderately alkaline	7.9 - 8.4
Strongly alkaline	1.5- 9.0
Very strongly alkaline	> 9.1

Phytotoxicity studies: Specific symptoms like injury to leaf tips, surface injury, necrosis, wilting, vein clearing, hyponasty and epipnasty at 1, 5 and 10 days after spray using phytotoxicity scale as prescribed by Central Insecticide Board and Registration Committee (C.I.B.R.C) were observed and per cent injury was arrived using the formula **(Table 2)**.

$$= \frac{\text{Total grade points}}{\text{Max. Grade x No. of leaves observed}} \text{ x } 100$$

Table 2: Phytotoxicity scale of CIBRC

Scale	Phytotoxicity (%)
0	No phytotoxicity
1	1-10
2	11-20
3	21-30
4	31-40
5	41-50
6	51-60
7	61-70
8	71-80
9	81-90
10	91-100

Bio-efficacy studies: The treatments were imposed at 60 DAT, when the population of BPH and blast disease crossed their economic threshold level. A spray fluid of 500 l/ha was used to ensure thorough coverage of the crop canopy with battery operated hand sprayer. Observations on nymphs and adults of BPH were taken directly on ten randomly selected hills per plot at one day before spray (Pre-treatment) and ten days after spray (Post-treatment). The incidence of blast was also recorded on 10 randomly selected hills one day before and ten days after treatment by using 0-9 scale of SES for Rice (IRRI, 2013) and the severity of the blast was calculated as per cent disease index (PDI) or % severity index (SI) using the formula.

$$= \frac{\text{Sum of all disease ratings}}{\text{Total number of leaves observed x maximum disease grade}} \times 100$$

SES Scale for leaf blast	
Score	**Description**
0	No lesions
1	Small brown specks of pinhead size without sporulating centre
2	Small roundish to slightly elongated, necrotic grey spots, about 1-2 mm in diameter with a distinct brown margin and lesions are mostly found on the lower leaves
3	Lesion type is the same as in scale 2' but significant number of lesions are on the upper leaves.
4	Typical sporulating blast lesions, 3 mm or longer, infecting less than 2% of the leaf area
5	Typical blast lesions infecting 2-10% of the leaf area
6	Blast lesions infecting 11-25% leaf area
7	Blast lesions infecting 26-50% leaf area
8	Blast lesions infecting 51-75% leaf area
9	More than 75% leaf area affected.

Grain yield was recorded per plot leaving two border rows on all sides and expressed as kg/ha. Data on BPH population and per cent disease severity were square root and angular transformed, respectively and analyzed using ANOVA (Gomez and Gomez, 1984). The treatment means were compared by least significant difference (LSD) method.

Results and Discussion

Physical compatibility: None of the test insecticide and fungicide mixture formed precipitation or sedimentation at 30 or 60 minutes after mixing, hence, they are physically compatible with each other. Similar observations are also made by Chander *et al*., (2020), who reported the physical compatibility of triflumezopyrim insecticide with tricyclazole and hexaconazole fungicides. The quality of water in term of pH also plays an important role in determining the efficacy of a spray fluid against target pest. All the test combinations of insecticides with fungicides recorded neutral reaction in the present study **(Table 3)**.

Table 3: P^{H} range of insecticides, fungicides and after their physical mixing

S. No.	Reaction	P^{H} range	Pesticides
1	Neutral	6.6 - 7.3	Pymetrozine @ 0.60 g/l (6.70) Triflumezopyrim @ 0.48 ml/l (6.91) Tricyclazole @ 0.60 g/l (6.57) Isoprothiolane @ 1.5 ml/l (6.80) Pymetrozine + Tricyclazole @ 0.60 g + 0.60 g (6.91) Pymetrozine + Isoprothiolane@ 0.60 g+ 1.5 ml/l (6.98) Triflumezopyrim + Tricyclazole@ 0.48 ml + 0.60 g /l (7.06) Triflumezopyrim + Isoprothiolane@ 0.48 ml + 1.5 ml/l (6.96)

Phytotoxicity: None of the pesticide spays alone or in combination exerted phytotoxicity symptoms like injury to leaf tip, yellowing, wilting, vein clearing, necrosis, epinasty and hyponasty at 1, 5 and 10 days after spraying on rice crop.

Bio-efficacy of pesticides: Data presented in **(Table 4)** revealed that BPH population ranged from 125.17 to 142.33 per 10 hills before imposition of treatments and found non-significant. At ten days after spray, BPH population ranged from 24.67 to 236.33 per 10 hills among the treatments, which is statistically significant. Pymetrozine 50 WG @ 0.60 g/l, triflumezopyrim 10 SC @ 0.48 ml/l alone and their combinations with fungicides (T_5, T_6, T_7 and T_8) recorded the lower population of BPH which were at par with each other and superior to untreated check. On the other hand, treatments comprising only fungicides *viz*., tricyclazole 75 WP @ 0.60 g/l and isoprothiolane 40 EC @1.5 ml/l and untreated control registered higher BPH population. Based on per cent reduction in BPH population over control, triflumezopyrim 10 SC @ 0.48 ml/l, pymetrozine 50 WG + isoprothiolane 40 EC @ 0.60 g/l + 1.5 ml/l and triflumezopyrim 10 SC + isoprothiolane 40 EC @ 0.48 ml + 1.5 ml/l stood first, second and third best treatments by registering 89.56%, 88.65% and 87.59% reduction in BPH population over control. It was followed by triflumezopyrim 10 SC + tricyclazole 75 WP @ 0.48 ml + 0.6 g/l, pymetrozine 50 WG @ 0.60 g/l alone, pymetrozine 50 WG + tricyclazole 75 WP @ 0.60 g + 0.6 g/l with 86.11%, 85.05% and 81.95 reduction over control, respectively.

Table 4: Efficacy of insecticide and fungicide combinations (tank mixtures) against BPH and blast in rice during *rabi* 2019-20 and *rabi* 2020-21 (Pooled)

Tr. No.	Treatment	Dose (g or ml/l)	BPH (No./10 hills)*		Reduction over control (%)	Blast severity (%)**		Reduction over control (%)
			PTC	10 DAS		PTC	10 DAS	
T_1	Pymetrozine 50 WG	0.60 g/l	134.83 (11.57)	35.33 (5.89)[a]	85.05	11.85 (20.03)	16.59 (24.04)[b]	3.67
T_2	Triflumezopyrim 10 SC	0.48 ml/l	129.17 (11.33)	24.67 (4.96)[a]	89.56	12.59 (20.73)	16.87 (24.20)[b]	2.04
T_3	Tricyclazole 75 WP	0.60 g/l	126.00 (11.02)	233.00 (15.26)[b]	1.41	11.85 (20.13)	5.19 (13.15)[a]	69.90
T_4	Isoprothiolane 40 EC	1.5 ml/l	139.67 (11.80)	231.33 (15.16)[b]	2.12	10.74 (19.07)	5.19 (13.10)[a]	69.90
T_5	Pymetrozine + Tricyclazole	0.60 g + 0.60 g/l	128.00 (11.21)	42.67 (6.45)[a]	81.95	11.48 (19.63)	5.56 (13.59)[a]	67.75
T_6	Pymetrozine + Isoprothiolane	0.60 g+ 1.5 ml/l	142.33 (11.87)	26.83 (5.13)[a]	88.65	11.11 (19.44)	5.37 (13.31)[a]	68.82
T_7	Triflumezopyrim + Tricyclazole	0.48 ml + 0.60 g/l	125.17 (11.09)	32.83 (5.72)[a]	86.11	11.85 (20.10)	5.93 (13.98)[a]	65.59
T_8	Triflumezopyrim +Isoprothiolane	0.48 ml + 1.5 ml/l	125.33 (11.19)	29.33 (5.41)[a]	87.59	11.67 (19.96)	5.00 (12.88)[a]	70.97
T_9	Untreated control (water spray)	-	137.83 (11.69)	236.33 (15.37)[b]		14.26 (22.17)	17.22 (24.51)[b]	
F test			**NS**	**Sig.**		**NS**	**Sig.**	
CD (0.05)			**-**	**1.57**		**-**	**2.85**	
CV (%)			**10.70**	**10.27**		**8.63**	**9.71**	

*Values in the parentheses are square root transformed values; **Values in the parentheses are arc sine values; PTC- Pre-treatment count, DAS-Days after spray; NS-Non-significant; Sig.-Significant; Means followed by same letter are not significantly different by LSD method (p=0.05%).

From the above results, it is evident that the bio-efficacy of pymetrozine 50 WG and triflumezopyrim 10 SC insecticides against BPH did not adversely affect the fungicides, tricyclazole 75 WP and isoprothiolane 40 EC, as their combination treatments *i.e.*, T_5, T_6, T_7 and T_8 are equally effective as T_1 (Pymetrozine 50 WG) and T_2 (Triflumezopyrim 10 SC) against BPH. Similar observations were made by Adhikari *et al*., (2019) and Rehman *et al*., (2020), who reported the supremacy of pymetrozine 50 WG in controlling the BPH and WBPH populations in rice. Sarao and Jhansilakshmi (2019) reported triflumezopyrim 10 SC was most effective against BPH. Chander *et al*., (2020) also reported that mixing of tricyclazole 75 WP with triflumezopyrim 10 SC did not show any negative effect on efficacy of triflumezopyrim against brown plant hopper.

Similarly, fungicides controlling blast have not lost their efficacy when mixed with insecticides. Among the treatments, tricyclazole 75 WP @ 0.60 g/l (T_3) and isoprothiolane 40 EC @ 1.5 ml/l (T_4) and their combinations with insecticides (T_5, T_6, T_7 and T_8) recorded lower blast severity (5.00% to 5.93%) and significantly superior compared to control (17.22%) at ten days after spray, respectively. Based on per cent reduction in blast severity over control, triflumezopyrim 10 SC + isoprothiolane 40 EC @ 0.48 ml + 1.5 ml/l recorded highest per cent reduction (70.97%) in blast severity over control. It was followed by tricyclazole 75 WP @ 0.60 g/l, isoprothiolane 40 EC @ 1.5 ml/l, pymetrozine 50 WG + isoprothiolane 40 EC @ 0.60 g + 1.5 ml/l, pymetrozine 50 WG + tricyclazole 75 WP @ 0.60 g + 0.6 g/l, triflumezopyrim 10 SC + tricyclazole 75 WP @ 0.48 ml + 0.60 g/l with 69.90%, 69.90%, 68.82%, 67.75% and 65.59% reduction over control, respectively. These results are in agreement with the reports of earlier workers. The efficacy of isoprothiolane 40 EC (Raji and Louis, 2007) and tricyclazole 75 WP (Dar and Murtaza, 2021) in controlling the leaf and neck blast severity in rice was well documented.

The pooled data on the grain yield of two seasons, *rabi* 2019-20 and 2020-21 **(Table 5)** revealed that triflumezopyrim 10 SC + isoprothiolane 40 EC @ 0.48 ml + 1.5 ml/l recorded the highest grain yield of 5088 kg/ha with 67.59% yield increase over untreated control. It was followed by triflumezopyrim 10 SC + tricyclazole 75 WP @ 0.48 ml + 0.60 g/l (5014 kg/ha), pymetrozine 50 WG + isoprothiolane 40 EC @ 0.60 g + 1.5 ml/l (4873 kg/ha), pymetrozine 50 WG + tricyclazole 75 WP @ 0.60 g + 0.60 g/l (4872 kg/ha) with 65.14%, 60.49% and 60.48% increase in grain yield over untreated check, respectively.

Table 5: Efficacy of insecticide and fungicide combinations (tank mixtures) on grain yield in rice

Tr. No.	Treatment	Dose (g or ml/l)	Grain yield (kg/ha)		Pooled	Increase over control (%)
			***Rabi* 2019-20**	***Rabi* 2020-21**		
T_1	Pymetrozine 50 WG	0.60 g/l	5211^{ab}	3946^{b}	4578^{c}	50.79
T_2	Triflumezopyrim 10 SC	0.48 ml/l	5223^{ab}	3999^{b}	4611^{bc}	51.88
T_3	Tricyclazole 75 WP	0.60 g/l	4660^{b}	2689^{c}	3675^{d}	21.03
T_4	Isoprothiolane 40 EC	1.5 ml/l	4719^{b}	2614^{c}	3667^{d}	20.78
T_5	Pymetrozine + Tricyclazole	0.60 g + 0.60 g/l	5358^{a}	4386^{ab}	4872^{abc}	60.48
T_6	Pymetrozine + Isoprothiolane	0.60 g + 1.5 ml/l	5339^{a}	4406^{ab}	4873^{abc}	60.49
T_7	Triflumezopyrim + Tricyclazole	0.48 ml + 0.60 g/l	5377^{a}	4649^{a}	5014^{ab}	65.14
T_8	Triflumezopyrim + Isoprothiolane	0.48 ml + 1.5 ml/l	5614^{a}	4660^{a}	5088^{a}	67.59
T_9	Untreated control (water spray)	-	3580^{c}	2493 c	3036^{e}	
F test			Sig.	Sig.	Sig.	
CD (0.05)			592.11	608.25	426.01	
CV (%)			6.83	9.35	5.62	

Sig.-Significant; Means followed by same letter are not significantly different by LSD method (p=0.05%).

Present studies proved that the tank mixing of insecticides (pymetrozine 50 WG and triflumezopyrim 10 SC) with fungicides (tricyclazole 75 WP and isoprothiolane 40 EC) did not cause any deleterious effect in their bio-efficacy against target pest/disease. Further, they are physically compatible and did not exert any phytotoxicty on rice. Thus, the above insecticides and fungicides can be applied as tank mixtures when BPH and blast occur simultaneously in rice.

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