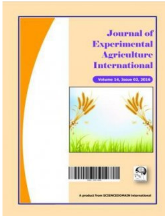

Journal of Experimental Agriculture International
14(4): XX-XX, 2016, Article no.JEAI.28893
Previously known as American Journal of Experimental Agriculture
ISSN: 2231-0606

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Bio-efficacy of a Combination Fungicide against Blast and Sheath Blight Diseases of Paddy

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Authors' contributions

This work was carried out in collaboration between all authors. Author DP designed the study, conducted the field experiments. Authors Maruti and KMM performed the statistical analysis and wrote the first draft of the manuscript. Authors K. Mallikarjun, GSG, K. Mahantashivayogayya, BGMR, SBG and BSC have reviewed the experimental design and all drafts of the manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEAI/2016/28893
Editor(s):
(1)
(2)
Reviewers:
(1)
(2)
(3)
(4)
Complete Peer review History:

Original Research Article

Received 11th August 2016
Accepted 3rd November 2016
Published 9th November 2016

ABSTRACT

A new combination fungicide Nativo 75 WG composed of Trifloxystrobin 25% (Strobilurin) and Tebuconazole 50% (Triazole) was tested against rice blast and sheath blight diseases under field condition during *Autumn* 2014 and - 2015. The combination fungicide Trifloxystrobin 25% + Tebuconazole 50% (Nativo 75 WG) @ 0.4 g/l was found effective against blast and sheath blight diseases recording least Percent Disease Index (PDI) of 17.02 and 24.7 respectively. Other combination fungicide Tricyclazole 18% + Mancozeb 62% WP @ 1.5 g/l recorded blast PDI of 26.03 which is statistically on par with Kresoxim methyl 44.3 SC @ 1.0 ml/l and Tricyclazole 75 WP @

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0.6 g/l. Other fungicides of the experiment such as Thifluzamide 24 SC @ 0.75 ml/l, Hexaconazole 4% + Zineb 68% @ 2.0 g/l and Carbendazim 12% + Mancozeb 63% WP @ 2.0 g/l are on par among themselves but stands next to the Trifloxystrobin 25% + Tebuconazole 50% (Nativo 75 WG) @ 0.4 g/l in reducing sheath blight PDI. Significant increase in the grain yield was observed in the plots treated with test chemical Nativo 75 WG @ 0.4 g/l (55.13 q/h) compared to the other fungicidal treatments which recorded the yield in the range of 40.75 to 48.12 q/h.

Keywords: Rice; blast; sheath blight; trifloxystrobin 25% + Tebuconazole 50%; PDI.

1. INTRODUCTION

Rice (*Oryza sativa* L.) is an important food crop of the world including India. Ever growing population in the world particularly in India is further demanding more rice production and continuous reduction in the availability of cultivable land demanding higher productivity. Under field condition, the productivity of rice is affected by many biotic and abiotic factors. Among the different biotic constraints, diseases caused by fungal pathogens such as blast and sheath blight are more frequent and ferocious disease in irrigated rice of both temperate and subtropical areas and which cause damage at all stages of crop growth [1].

Rice blast caused by *Pyricularia oryzae* Cavara [synonym *Pyricularia grisea* Sacc. the anamorph of *Magnaporthe grisea* (Herbert) Yaegashi and Udagawa], is one of the most destructive and wide spread disease of rice [2]. Blast epidemic causes the complete defeat of seedling [3] at the nursery and in field condition [4] and causes up to 80% of total yield reduction [5-6]. Sheath blight, caused by *Rhizoctonia solani* Kunh., is an important destructive disease of rice occurs in all rice growing areas of the world [7-10]. In India, a modest estimation of losses due to the sheath blight disease alone has been up to 54.3% [11,12]. The disease is particularly important in intensive rice production systems due to excess use of nitrogenous fertilizers [13]. Yield losses of 5-10% have been estimated for tropical lowland rice varieties such as PSBRc4, C4-137, IRW, IR74 and IR72 in Asia [9].

Fungicide based management of blast and sheath blight diseases is successful at filed level in majority of the cases [14-18]. Fungicidal control is largely practiced for blast disease in temperate or subtropical rice cultivation, primarily in Japan, China, South Korea, Taiwan and, increasingly, Vietnam [18].

For the management of blast, fungicides such as Isoprothiolane, Probenazole, Pyroquilon, Tricyclazole [19] and most of the other fungicides like Benomyl, Carbendazim, Chloroneb, Captafol, Mancozeb, Zineb, Edifenphos, Iprobenphos, Thiophanate, Carboxin, Kitazin, Flutolanil, etc. are found to be effective for blast disease management under filed conditions [20-24]. For sheath blight, most of the fungicides like benomyl, carbendazim, chloroneb, captafol, mancozeb, zineb, edifenphos, iprobenphos, thiophanate, carboxin, *etc.* have been found effective under field conditions [22-24].

Recently, many combination fungicides such as Trifloxystrobin 25% + Tebuconazole 50% 75WG, Azoxystrobin 18.2% + Difenoconazole 11.4% SC, Kasugamycin 5% + Copper Oxychloride 45% WP and Kresoxim methyl 40% + Hexaconazole 8% WG have been shown to control the blast and sheath blight disease under field condition [25,17,26].

Fungicides have been used successfully to control blast and sheath blight but, due to continuous development of fungicide tolerance in fungal population, it is inevitable to search for a new group of fungicide with different mode of action so that new information on diverse fungicides with different modes of action can be offered to farmers. In this view, the present study was undertaken to appraise the field efficacy of Trifloxystrobin 25% + Tebuconazole 50% 75WG, a combination fungicide having strobilurin (Trifloxystrobin 25%) and triazole (Tebuconazole 50%) group of fungicide against blast and sheath blight disease of paddy under field conditions.

2. MATERIALS AND METHODS

2.1 Layout, Fungicides and Crop Establishment

A randomized complete block design (RCBD) field experiment was conducted at the experimental fields of Agricultural Research Station, Gangavathi, Karnataka (5.4319° N, 76.5315° E) during 2014 & 2015 *autumn* seasons. A popular rice variety BPT5204 which is susceptible to blast and sheath blight disease was used for the study. Seeds were sown in the month of July and planted in August. Before sowing, healthy seeds were water soaked overnight and incubated in the gunny bags for better sprouting in the nursery. The land was prepared by puddling method by applying one ploughing followed by two ploughing after one week. The experiment was laid out in RCBD with a plot size of 5 × 4 m each for all treatments. Seedlings of 30 days old were planted in trail plots at 20 ×10 cm spacing. All standard agronomic practices were followed except using higher nitrogenous (200 kg ha-1) and lower pottasic (50 kg ha-1) fertilizer dose than the normal dose (N_2:P_2O_5:K_2O:150:75:75).

The RCBD experiment comprises nine treatments with three replications each. A new formulations *viz.,* Trifloxystrobin 25% + Tebuconazole 50% (Nativo 75 WG), Kresoxim methyl (Ergon 44.3 SC), Thifluzmide 24 SC (Spencer), Avatar (Hexaconazole 4% + Zineb 68%), Merger (Tricyclazole 18 % + Mancozeb 62 % WP) and SAAF 75 WP (Carbendazim 12% + Mancozeb 63% WP) were included in the treatment. Commercially available popular fungicides like Tricyclazole 75 WP (Beam) @ 0.6 g/lit and Carbendazim 50 WP @ 1.5 g/lit were used for comparison (Table 1). Bio-efficacy was evaluated by spraying all the test chemicals twice at 15 days interval starting from the initiation of the disease.

2.2 Artificial Inoculation

Sheath blight disease was artificially inoculated to all experimental treatments after 45 days of planting following the mycelium with typha grass method described previously [27]. Blast disease was evaluated based on natural disease incidence.

2.3 Disease Assessment and Statistical Analysis

Fourteen days after the fungicide application disease assessment was carried out. The disease was measured using the disease rating scale of 0-9 developed by International Rice Research Institute (IRRI, 1996) for blast and sheath blight disease. Further, the scored data was converted into per cent disease index (PDI) using formula given below. The data on the yield were recorded by marking 3 x 2 m section within each plot using a wire frame as described by [28] and tillers within the frame were cut and harvested in order to determine the yield. Data from *autumn* 2014 & 2015 seasons were pooled to get the average PDI and yield values. Subsequently, the data on disease severity and yield parameters were subjected to appropriate statistical analysis. Cost to Benefit cost ratio (B:C) was calculated by considering the cost of cultivation (including the cost of test fungicides) and market price of the product.

PDI = [(Sum of the scores) / (Number of Observation × Highest Number in Rating Scale)] x 100

3. RESULTS AND DISCUSSION

Field experiment revealed that the treatment Trifloxystrobin 25% + Tebuconazole 50% (Nativo 75 WG) @ 0.4 g/l recorded lowest PDI of blast (17.02) and sheath blight (24.70) (Tables 1, 2 and Fig. 1). There was a significant difference among the treatments with respect to PDI of blast and sheath blight diseases and all treatments recorded significantly lower PDI compared to untreated control in both the seasons. Mean while, other combination fungicide *i.e.* Tricyclazole 18% + Mancozeb 62% WP (Merger) recorded blast PDI of 26.03 which is statistically on par with Kresoxim methyl 44.3 SC (Ergon) @ 1.0 ml/l (PDI 28.48) and Tricyclazole 75 WP (Beam) @ 0.6 g/l (PDI 25.91). This report is supported by the previous report [29], where they have reported the effectiveness of Trifloxystrobin 25% +Tebuconazole 50% 75WG in controlling the leaf blast disease of paddy under field condition. Previous workers have also reported the effectiveness strobilurin fungicides in reducing the blast disease compare to other fungicides [30].

Test fungicide Trifloxystrobin 25% + Tebuconazole 50% (Nativo 75 WG) @ 0.4 g/l performed better with PDI of 17.02 than the Tricyclazole 75 WP @ 0.6 g/h (PDI 25.91), a widely used fungicide against blast disease in India. This could be due to repeated use of Tricyclazole 75 WP for blast disease management from many years which may have lead to the development of resistant fungal population. This observation is in agreement with the previous researchers [31], where they have recommended the rotation of different groups of fungicide for managing the development of fungicide resistance population.

Table 1. Effect of Trifloxystrobin 25% + Tebuconazole 50% 75WG on blast disease of rice (Pooled from *autumn* – 2014 & 2015)

Sl. no	Treatments	Dose/l	Leaf Blast Disease Severity (PDI)				
			2014		2015		Pooled
			Before spray	14d after spray	Before spray	14d after spray	
T1	Trifloxystrobin 25% WP + Tebuconazole 50% WP (Nativo)	0.4 g	15.55 (23.18)	17.60 (24.80)	13.35 (21.42)	16.44 (23.93)	17.02 (24.35)
T2	Kresoxim methyl (Ergon 44.3 SC)	1.0 ml	14.38 (22.26)	27.21 (31.45)	14.26 (22.18)	29.75 (33.05)	28.48 (32.25)
T3	Thifluzamide 24 SC (Spencer)	0.75 ml	19.39 (26.12)	31.10 (33.89)	14.44 (22.32)	35.97 (36.85)	33.53 (35.38)
T4	Hexaconazole 4% + Zineb 68% (Avatar)	2.0 g	16.66 (24.08)	33.60 (35.43)	15.55 (23.22)	29.28 (32.77)	31.44 (34.10)
T5	Tricyclazole 18% + Mancozeb 62% WP (Merger)	1.5 g	15.11 (22.82)	25.71 (30.46)	13.86 (21.84)	26.35 (30.83)	26.03 (30.67)
T6	Tricyclazole 75 WP (Beam)	0.6 g	14.38 (22.28)	26.10 (30.72)	14.44 (22.32)	25.72 (30.46)	25.91 (30.59)
T7	Carbendazim 50 WP (Bavistin)	1.0 g	20.00 (26.57)	36.10 (36.93)	15.55 (23.18)	30.28 (33.40)	33.19 (35.11)
T8	Carbendazim 12% + Mancozeb 63% WP (SAAF)	2.0 g	14.44 (22.32)	31.12 (33.92)	13.82 (21.82)	34.55 (36.01)	32.83 (34.98)
T9	Unsprayed control		16.86 (24.24)	46.93 (43.23)	14.56 (22.42)	38.28 (38.45)	42.6 (40.74)
Co-efficient of Variance (CV)			NS	10.54	NS	13.56	11.52
Critical Difference (CD)			NS	4.17	NS	5.14	4.01

* *Figures in the parentheses represent arcsine transformed values*

Data from sheath blight disease suggested that the other fungicides of the experiment (solo / combination) such as Thifluzamide 24 SC (Spenser) @ 0.75 ml/l (PDI 37.26), Hexaconazole 4% + Zineb 68% (Avatar) @ 2.0 g/l (PDI 34.94) and Carbendazim 12% + Mancozeb 63% WP (SAAF) @ 2.0 g/l (PDI 36.66) are on par among themselves but stands next to the Trifloxystrobin 25% + Tebuconazole 50% (Nativo 75 WG) @ 0.4 g/l (PDI 24.70). This finding is supported by the results of previous investigations [25], where Trifloxystrobin 25% + Tebuconazole 50% (Nativo 75 WG) @ 0.4 g/l performed better in reducing the sheath blight severity. Similarly, Bhuvaneshwari & Raju, in 2012 [17] reported the better efficacy of a combination fungicide azoxystrobin 18.2% + difenoconazole 11.4% SC (strobilurin + triazole) against sheath blight disease. Our report also confirms the better efficacy of strobilurin derived fungicide (either solo or in combination) against sheath blight disease of rice [32]. Various experimental reports confirmed that strobilurin compounds found to be effective in controlling many rice diseases like grain discoloration [25], blast [33] sheath rot and brown spot [34].

In our study difference in the disease severity among different treatment was reflected in the final grain yield, a significant increase in the grain yield was observed in the plots treated with test chemical Trifloxystrobin 25% + Tebuconazole 50% (Nativo 75 WG) @ 0.4 g/l (55.13 q/h) compare to the other fungicidal treatments which recorded the yield in the range of 40.75-48.12 q/h (Table.3 & Fig.1). The lowest yield was recorded in the unsprayed control plots (36.33 q/h). Our results are in conformity with previous reports [17,29,32,35-38]. Previous workers reported that fungicides application increases the yield of rice. In the present study, the fungicide Trifloxystrobin 25% + Tebuconazole 50% (Nativo 75 WG) @ 0.4 g/l have found superior in reducing the leaf blast and sheath blight disease PDI and therefore increased the grain yield (55.13 q/h) (Table 3 and Fig. 1).

Due to non availability of location specific resistance varieties for blast disease, the chemical control is an important strategy for the farmers to harvest economic yield. Although, resistant variety is a best option to reduce the cost of cultivation but cultivation of such resistant varieties with few protective fungicidal spray will reduce the risk of development of matching virulence by suppressing the population growth of matching virulence. Moreover, poor bio-efficacy of the bio-control agents under the severe epidemic condition makes the chemical control is an inevitable and ultimate means for blast disease management for farmers. For sheath blight, though cultivation of resistant variety is the best option but till date no such variety is available to the farmers. Thus, in present situation cultural practices combined with foliar spray of fungicide is the most common practice to manage the disease and even in integrated pest management system need based application of fungicide has been recommended [32].

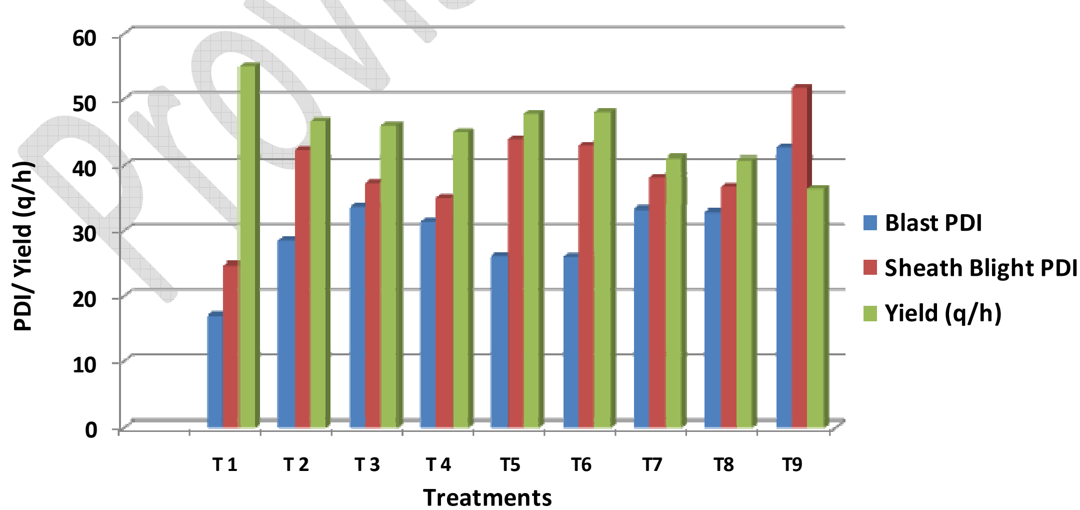

Fig. 1. Graphical representation of percent disease index (PDI) and yield (q/h) obtained in different treatments

Table 2. Effect of Trifloxystrobin 25% + Tebuconazole 50% 75WG on sheath blight disease of rice (Pooled from *autumn* – 2014 & 2015)

Sl no.	Treatments	Dose/l	Sheath blight (PDI)		
			2014	2015	Pooled
T 1	Trifloxystrobin 25% WP + Tebuconazole 50% WP (Nativo)	0.4 g	23.55 (29.05)	25.86 (30.55)	24.70 (29.80)
T 2	Kresoxim methyl (Ergon 44.3 SC)	1.0 ml	41.38 (40.00)	43.05 (41.00)	42.21 (40.53)
T 3	Thifluzamide 24 SC (Spencer)	0.75 ml	35.82 (36.78)	38.71 (40.87)	37.26 (37.60)
T 4	Hexaconazole 4% + Zineb 68% (Avatar)	2.0 g	33.33 (35.24)	36.55 (37.17)	34.94 (36.25)
T5	Tricyclazole 18% + Mancozeb 62% WP (Merger)	1.5 g	44.99 (42.12)	42.77 (40.82)	43.88 (41.48)
T6	Tricyclazole 75 WP (Beam)	0.6 g	39.99 (39.22)	45.85 (42.62)	42.92 (40.94)
T7	Carbendazim 50 WP (Bavistin)	1.0 g	37.33 (37.64)	38.88 (38.55)	38.10 (38.09)
T8	Carbendazim 12% + Mancozeb 63% WP (SAAF)	2.0 g	35.55 (36.60)	37.77 (37.90)	36.66 (37.25)
T9	Unsprayed control	--	47.77 (43.68)	55.68 (48.25)	51.72 (46.01)
Co-efficient of Variance (CV)			10.8	12.42	13.26
Critical Difference (CD)			4.7	5.13	4.98

**Figures in the parentheses represent arcsine transformed values*

Table 3. Effect of Trifloxystrobin 25% +Tebuconazole 50% 75WG on grain yield

Sl No.	Treatments	Dose/l	Yield (Q/h)			B:C
			2014	2015	Pooled	
T 1	Trifloxystrobin 25% WP + Tebuconazole 50% WP (Nativo)	0.4 g	56.50	53.75	55.13	2.21
T 2	Kresoxim methyl (Ergon 44.3 SC)	1.0 ml	46.50	47.00	46.75	1.87
T 3	Thifluzamide 24 SC (Spencer)	0.75 ml	50.62	41.50	46.06	1.9
T 4	Hexaconazole 4% + Zineb 68% (Avatar)	2.0 g	50.87	39.12	44.99	1.82
T5	Tricyclazole 18% + Mancozeb 62% WP (Merger)	1.5 g	48.62	47.15	47.88	1.66
T6	Tricyclazole 75 WP (Beam)	0.6 g	50.25	46.00	48.12	2.0
T7	Carbendazim 50 WP (Bavistin)	1.0 g	41.40	40.75	41.07	1.74
T8	Carbendazim 12% + Mancozeb 63% WP (SAAF)	2.0 g	43.00	38.50	40.75	1.7
T9	Unsprayed Control	--	37.36	35.30	36.33	1.6
Co-efficient of Variance (CV)			11.06	14.17	10.55	
Critical Difference (CD)			5.6	4.2	6.05	

Note: B:C – Benefit cost

4. CONCLUSION

Present investigation provides the field efficacy of a fungicide premixture Trifloxystrobin 25% + Tebuconazole 50% (Nativo 75 WG) @ 0.4 g/l for management of blast and sheath blight diseases of paddy.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/16852