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Assessment of new combination fungicides against sheath blight (*Rhizoctonia solani,* Kuhn) disease of rice (*Oryza sativa,* L.)

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Abstract
Sheath blight of rice is an important disease affecting rice production. Six fungicides were tested to know their efficacy in controlling the disease at the experimental field of Krishi Vigyan Kendra Majhgawan, Satna, (M. P.) during *Kharif* season of 2017-18. The fungicides *viz.*, tebuconazole + trifloxystrobin (Nativo 75% WG) @ 0.07% (T1), azoxystrobin + difenoconazole (Amistar top 29.6% SC) @ 1.33% (T2), captan + hexaconazole (Taqat 75% WP) @ 0.2% (T3), tebuconazole (Folicur 25.9% EC) @ 0.2% (T4), propiconazole (Tilt 25% EC) @ 0.1% (T5) and hexaconazole (Contaf plus 5% SC) @ 0.2% (T6). Out of six fungicides tested tebuconazole + trifloxystrobin 75% (WG) @ 0.7% and azoxystrobin + difenoconazole 29.6% (SC) @ 1.33% were found significantly superior in controlling the disease. The data reveals that, the per cent disease index (PDI) was significantly low (10.87%) in tebuconazole + trifloxystrobin 75% (WG) and azoxystrobin + difenoconazole 29.6% (SC) (13.46%) sprayed plots respectively, whereas the highest (69.74%) was recorded in unsprayed control plot. Significantly higher grain yield was recorded in tebuconazole + trifloxystrobin 75% (WG) sprayed plot (4702.32 kg / ha), followed by azoxystrobin + difenoconazole 29.6% (SC) (4211.67 kg / ha) and the lowest yield of 2617.21 kg / ha was recorded in the untreated control plot. From the present study we findings it may be concluded that tebuconazole + trifloxystrobin 75% WG (0.07%) and azoxystrobin + difenoconazole 29.6% SC (1.33%) were promising fungicides for lowering sheath blight severity and getting higher grain yield.

Keywords: Rice, fungicides, management, sheath blight (*Rhizoctonia solani*), yield

Introduction
Paddy (*Oryza sativa*, L.) is the world's most important crop and a primary source of food for more than half of the world's population. More than 90% of the world's paddy is grown and consumed in Asia where 60% of the earth's people live (Kole, 2006) [10]. In India Rice contribute 42% of the total food grain production and 45% of the total cereal production (Ramakrishna *et al*., 2016) [17]. India is also the leading exporter of rice. But most of the rice yield is reduced by the disease infestation. Sheath blight of rice caused by *Rhizoctonia solani* Kuhn, is a destructive disease worldwide that causes significant yield loss and quality degradation (Ou, 1985; Teng *et al.*, 1990; Savary *et al.*, 2000; Savary *et al.*, 2006) [14, 21, 19, 20]. This disease is recognized as a high priority constraint to rice production in Madhya Pradesh state. Since commercial rice cultivars are susceptible to sheath blight disease, particularly the high till ring varieties, or have only low level of resistance. With the wide coverage of high yielding semi dwarf varieties with high till ring ability, the disease has been aggravated in recent years in rice growing areas. The disease is particularly important in intensive rice production systems due to high plant density and high rate of application of nitrogenous fertilizers which favor the disease development (Savary and Mew, 1996) [18]. Losses due to sheath blight disease generally vary from 30 to 40 per cent and may be even 100 per cent in epidemic areas (Li *et al.*, 2009) [13]. The reduction in yield due to the disease has been estimated to vary from 5.2 to 50 per cent (Ou, 1985, Hori 1969) [14, 6]. Fungicide based management of sheath blight disease is successful at filed level in majority of the cases (Kandhari *et al*., 2003; Kandhari and Gupta, 2003; Groth and Bond 2006; Bhuvaneshwari and Raju, 2012; Kumar *et al*., 2013) [8, 9, 5, 3, 11]. Currently, the disease is managed mostly by application of systemic fungicides. Systematic evaluation of commercially available fungicides from time to time is needed for evolving recommendation on chemical fungicides, so that the farmers can choose the fungicides based on the efficacy as well as cost.

In this view, the present study was undertaken to appraise the field efficacy of different fungicides against sheath blight disease of rice under field conditions.

Disease Symptoms

A plant disease symptom is the phenotypic or physiological manifestation of a successful invasion in the host by the pathogen. The visible or otherwise detectable abnormality arising from a disease or a disorder is called symptom (Riley *et al*., 2002) [16]. Symptoms of this disease are generally observed from the milking stage to till ring stage of the rice crop. The symptoms are also seen in till ring to heading stage. Initially lesions occur on the sheaths with the diameter of 0.5-3 cm occurring below the leaf collar. Later, the lesions extent to 1 cm in width and 2-3 cm in length (Fleet and Rush, 1983). Oval or elliptical or irregular greenish grey colored spots are formed. When the spots enlarge, the center of the spots becomes grayish white with blackish brown irregular border. Blightening occurs as formation of several lesions and they coalesce with each other. As the disease severity increases, the infection extends to the inner sheaths which cause death of the whole rice plant.

(A) (B)

Fig 1: Symptoms of sheath blight on (A) paddy sheath and (B) leaf

Materials and Methods

In recent time, combination fungicides are widely used in disease management under field condition because of their curative action, broad range and lower dosage compared to their solo formulations. In paddy, efficacy of such combi - products in managing many fungal diseases has been reported (Bag and Saha, 2009; Bhuvaneshwari and Raju, 2012; Kumar and Veerabhadraswamy, 2014; Pramesh *et al.,* 2016) [1, 2, 3, 12, 5]. This finding is in full agreement with the combination fungicides Tebuconazole 50% + Trifloxystrobin 25% WG @ 0.4 g / l performed better in reducing the sheath blight severity (Bag and Saha, 2009; Pramesh *et al.*, 2016) [1, 2, 5]. Similarly, Bhuvaneshwari and Raju (2012) [3] reported the better efficacy of a combination fungicide azoxystrobin 18.2% + difenoconazole 11.4% SC @ 1.33 ml / l against sheath blight disease. Present study was conducted at the experimental field of Krishi Vigyan Kendra Majhgawan, Satna, (M. P.) during *Kharif* season of 2017-18 which is hot spot area for the sheath blight disease severity. The experiment was laid out in RBD with three replications and there are six fungicides with plot size of 3 x 2 m2. The fungicides *viz*., Tebuconazole 50% + Trifloxystrobin 25% WG (T1), Azoxystrobin + Difenoconazole 29.6% SC (T2), Captan + Hexaconazole 75 WP (T3), Tebuconazole 25.9% EC (T4), Propiconazole 25% EC (T5) and Hexaconazole 5% SC (T6). The agronomic practices were followed as per package of practices for raising the crop. The fungicides sprays were given twice. The first spray was given as soon as the disease appeared in field and the second spray was given 10 days after the first spray. The disease severity was recorded at ten days after second spray. The Per cent disease index was calculated on five plants / sampling unit by counting the number of infected tillers. The disease severity was assessed based on the Standard Evaluation System 0-9 disease rating scale developed by International Rice Research Institute (IRRI, 1996). Finally, the grain yield in each plot was recorded and expressed in kg / ha. The results of the experiment were analyzed statistically and the economics for the fungicides were worked out. The benefit: cost ratio was worked out based on the cost of fungicides, spray cost, yield and the market value of rice during 2017.

Per cent disease index (PDI) was calculated by using following formula (Wheeler, 1969) [22].

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

Results and Discussion:

The results of field experiment revealed that there was significant difference among the treatments in reducing sheath blight disease severity. The obtained on sheath blight disease severity and yield are given in Table 1. There was a significant difference among the treatments with respect to per cent disease index (%) of sheath blight disease and all treatments recorded significantly lower per cent disease index compared to untreated control plots. During *kharif* 2017, the per cent disease intensity was to the tune of 69.74 per cent. Proportionately different fungicides controlled the disease effectively. Among the fungicides, the disease severity was significantly less in Tebuconazole + Trifloxystrobin 75% WG (11.65%) and Azoxystrobin + Difenoconazole 29.6% SC (14.08%), followed by Tebuconazole 25.9% EC (16.13%), Further Captan + Hexaconazole 75 WP found effective in reducing the disease severity of 18.27% over

Untreated control and other fungicides. Maximum PDI of 69.74% was recorded in untreated control plot. The maximum grain yield and benefit: cost ratio was recorded in the plots that sprayed with Tebuconazole + Trifloxystrobin 75% WG (4602.33 kg / ha and 1:2.86), Azoxystrobin + Difenoconazole 29.6% SC (4311.67 kg / ha and 1:2.53) compared to untreated control plot (2617.21 kg / ha) respectively. In our study reduction in the relative lesion height per cent among different treatment was reflected in the final grain yield. The efficacy of Tebuconazole 50% + Trifloxystrobin 25% against sheath blight from West Bengal was reported by Bag (2009) [1, 2] and Johnson *et al.*, (2013) [7].

Table 1: Assessment of fungicides against Sheath blight disease of rice during *Kharif* 2017-18

Treatments	Conc. (%)	Per cent disease intensity (%) 10d after second spray	Grain yield (kg/ha)	B:C Ratio
Tebuconazole + Trifloxystrobin 75% WG	0.07	11.65	4602.33	1:2.76
Azoxystrobin + Difenoconazole 29.6% SC	1.33	14.08	4311.67	1:2.53
Captan + Hexaconazole 75% WP	0.2	18.27	3921.52	1:2.29
Tebuconazole 25.9% EC	0.2	16.13	4013.28	1:2.41
Propiconazole 25% EC	0.1	23.57	3714.61	1:2.18

Hexaconazole 5% SC	0.2	26.35	3603.84	1:1.97
Untreated control	-	69.74	2617.21	-
S. Em ±		1.06	87.06	
C.D @ 5%		3.12	243.57	
CV%		6.29	10.19	

Due to non-availability of location specific resistance varieties for sheath blight disease, the chemical control is an important strategy for the farmers to harvest economic yield. Although, resistant variety is the best option to reduce the cost of cultivation but cultivation of 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, under the severe epidemic condition chemical control is an inevitable and ultimate means for sheath blight disease management for the farming community. Though cultivation of resistant variety is the best option for sheath blight disease, but still today no such variety is available to the farmers. Thus, in present situation cultural practices combined with foliar application 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. Several previous reports enlights that fungicides application increases the yield of paddy. In the present study, the fungicide Tebuconazole + Trifloxystrobin 75% (WG) @ 0.07% and Azoxystrobin + Difenoconazole 29.6% (SC) @ 1.33% was found superior in reducing the sheath blight disease severity and increased the grain yield.

Conclusion

The present investigation provides the field efficacy of tebuconazole + trifloxystrobin 75% WG (0.07%) and azoxystrobin + difenoconazole 29.6% SC (1.33%) could be used effectively for the management of sheath blight disease of paddy and thus helped for getting higher grain yield and B: C ratio.

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