

Original Research Article

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A Combination Fungicide for the Management of Sheath Blight, Sheath Rot and Stem Rot Diseases of Paddy

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ABSTRACT

Keywords

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A new combination fungicide TAQAT 75% WP (Captan 70% + Hexaconazole 5%) was tested in different doses against rice sheath blight (ShB), sheath rot (ShR) and stem rot (StR) diseases under field conditions during Kharif 2013 and Rabi 2013-14. The combination fungicide TAQAT 75% WP (Captan 70% + Hexaconazole 5%) @ 750 g/ha was found effective against ShB, ShR and StR diseases recording least percent disease index (PDI) of 13.33, 14.44 and 13.7 respectively during Kharif 2013. Similar trend was observed during the Rabi 2013-14 where test fungicide TAQAT 75% WP recorded least PDI of 14.11, 14.16 and 17.49 against ShB, ShR and StR diseases respectively. Compared to TAQAT 75% WP, other test fungicides such as Captan 50% WP and Hexaconazole 5% SC at different doses recorded highest PDI against ShB, ShR and StR in both Kharif 2013 and Rabi 2013-2014. Significant increase in grain yield (67.25 q/h) was observed in the plots treated with test chemical TAQAT 75% WP 750 g/ha in Kharif 2013 and 64.35 q/ha during Rabi 2013-14, whereas, other fungicidal treatments recorded the yield in the range of 44.52-61.25 q/h (Kharif 2013) and 41.32-58.50 (Rabi 2013-14).

Introduction

Rice (*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 rice is grown and consumed in Asia where 60% of the earth's people live (Kole, 2006). Ever growing population in India is further demanding more rice production and 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 sheath blight, sheath rot and stem rot cause significant damage in irrigated rice (Jackson *et al.*, 1977; Bonman *et al.*, 1991; Kindo and Tiwar, 2015).

Rice sheath blight caused by *Rhizoctonia solani* Kuhn (Teleomorph: *Thanatephorus cucumeris* (Frank) Donk), is a destructive disease worldwide that causes significant yield loss and quality degradation (Lee and Rush, 1983; Ou, 1985; Teng *et al.*, 1990; Savary *et al.*, 2000; Savary *et al.*, 2006). In

India, a modest estimation of losses due to the sheath blight disease alone has been up to 54.3% (Rajan, 1987; Roy, 1993). The disease is particularly important in intensive rice production systems (Savary and Mew, 1996). Yield losses of 5-10% have been estimated for tropical lowland rice in Asia (Savary *et al.*, 2000).

Sheath rot caused by *Sarocladium oryzae* (Sawada) Games and Hawksworth has become a serious problem in most of the rice growing area of the country was first reported in 1973 (Agnihotrudu, 1973). Sheath rot has gained the status as a major disease of rice (Reddy and Gosh 1985) and yield losses varies from 9.6 to 85% depending on the weather conditions during the crop growth-period (Phookan and Hazarika, 1992). Yield loss up to 85% was also reported in most rice-growing regions of the world (Naeimi, *et al.*, 2003).

Stem rot of rice caused by *Sclerotium oryzae* is becoming a serious problem of rice cultivation in the Indian subcontinent (Singh *et al.*, 2002). The causal agent was first described from Italy in the sclerotial form and was named *S. oryzae* Catt. (Cattaneo, 1876). Singh and Devi (1999) reported the occurrence of the stem rot of rice in Manipur in almost all the varieties cultivated. In Karnataka, this disease occurred in epidemic form during 2012-13 and yield loss up to 30% was reported on paddy cultivar BPT5204 in North eastern part of Karnataka (Pramesh *et al.*, 2014). This disease was also reported to be the major constraint for paddy cultivation in Andhra Pradesh state in recent years (Gopika *et al.*, 2016).

Fungicide based management of sheath blight disease is successful at field 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). For sheath rot disease management,

several fungicides such as Hexaconazole 5 SC, Tebuconazole 250 EC and Carbendazim 50% WP were shown to be highly effective in reducing the sheath rot severity under field condition (Venkateswarlu and Venkateswarlu, 2004; Karamkar *et al.*, 1992; Vidhyasekaran and Lewin, 1987; Anonymus, 2009; Kindo and Tiwari, 2015).

Several cultural and biological methods have been reported for stem rot disease management under field condition (Cintas and Webster, 2001; Sakthivel and Gnanamanickam, 1987; Yang *et al.*, 2009; Gopika *et al.*, 2016). Several fungicides such as Benomyl, Edifenphos, Thiophanate Methyl, Propiconazole have been found to be effective in reducing stem rot disease severity under field condition (Singh *et al.*, 2002; Kumar *et al.*, 2003; Gopika *et al.*, 2016).

Fungicides have been used successfully to control fungal diseases of rice. Research findings suggest the chance of a pathogen developing resistance to a particular chemical increases with regular use over a period of time (Brent and Hollomon 1998; Zhang *et al.*, 2009). The alternatives are to develop a new chemical (fungicide) class that has no cross resistance to the chemical to which the pathogen developed resistance originally or to develop a combination products with different mode of action on fungal physiology. In this view, present study was undertaken to appraise the field efficacy of TAQAT 75% WP (Captan 70% + Hexaconazole 5%), a combination fungicide against sheath blight, sheath rot and stem rot diseases of paddy under field conditions.

Materials and Methods

Layout, fungicides and crop establishment

A field experiment was conducted to evaluate the bio-efficacy of new fungicide combination against sheath blight, sheath rot and stem rot

diseases at the experimental fields of Agricultural Research Station, Gangavathi, Karnataka (5.4319° N, 76.5315° E) during Kharif 2013 and Rabi 2013-14. A popular rice variety BPT5204 which is susceptible to sheath blight, sheath rot and stem rot diseases was used for the study. For Kharif 2013 experiment, seeds were sown in the month of July and planted in August. For Rabi 2013-14 experiment, seeds were sown in the month of November and planted in the month of December. 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 randomized complete block design (RCBD) with a plot size of 5 x 4 m each for all treatments. Seedlings of 30 days old were planted in trail plots at 20X10 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 (N₂:P₂O₅:K₂O::150:75:75).

The RCBD experiment comprises eight treatments with three replications each. A new combination formulations *viz.*, Captan 70% + Hexaconazole 5% (TAQAT 75 WP) was tested in two doses (500 g/ha and 750 g/ha) along Captan 50% WP (@ 700 g/ha and 1050 g/ha) and Hexaconazole 5 % SC (@ 500, 750 and 1000 ml/ha). Bio-efficacy was evaluated after spraying all the test chemicals twice at 20 days interval starting from the initiation of the disease.

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 (Bhaktavatsalam *et al.*, 1978).

Sheath rot and stem rot diseases were evaluated based on natural disease incidence.

Disease assessment and statistical analysis

Fifteen days after the fungicide application disease assessment was carried out. For measuring sheath blight and sheath rot diseases, 0-9 disease rating scale developed by International Rice Research Institute (IRRI, 1996) was used. For stem rot disease, disease severity was measured based on 0-9 scale (SES, IRRI, 1980). 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 (Seebold *et al.*, 2004) and tillers within the frame were cut and harvested in order to determine the yield. Subsequently, the data on disease severity and yield parameters were subjected to appropriate statistical analysis.

$$PDI = \frac{[(\text{Sum of the scores}) / (\text{Number of Observation} \times \text{Highest Number in Rating Scale})] \times 100}$$

Results and Discussion

Sheath blight

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 rice, 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.*, 2016b). In the present study, field experiment revealed that the treatment TAQAT 75% WP (Captan 70% + Hexaconazole 5%) @ 750 g/ha recorded lowest PDI of sheath blight in Kharif 2013

(13.33) and Rabi 2013-14 14.11) compared to other treatments (Table 1). There was a significant difference among the treatments with respect to PDI of sheath blight and all treatments recorded significantly lower PDI compare to untreated control in both the seasons. This finding is in full agreement with the previous reports, where combination fungicides Trifloxystrobin 25% + Tebuconazole 50% (Nativo 75 WG) @ 0.4 g/l performed better in reducing the sheath blight severity (Bag and Saha, 2009; Pramesh *et al.*, 2016a). Similarly, Bhuvaneshwari and Raju (2012) reported the better efficacy of a combination fungicide azoxystrobin 18.2% + difenoconazole 11.4% SC against sheath blight disease.

Sheath rot

For sheath rot disease management, several previous reports suggested the efficacy of solo fungicides such as Hexaconazole 5 SC, Tebuconazole 250 EC and Carbendazim 50% WP in reducing the sheath rot severity under field condition (Venkateswarlu and Venkateswarlu, 2004; Karamkar *et al.*, 1992; Vidhyasekaran and Lewin 1987; Anonymus, 2009; Kindo and Tiwari, 2015). In our experiment, test fungicide TAQAT 75% WP (Captan 70% + Hexaconazole 5%) @ 750 g/ha recorded lowest PDI of sheath rot in Kharif 2013 (14.4) and Rabi 2013-14 (14.16) compared to other treatments (Table 2) (Figs. 1 and 2).

Table.1 Effect of TAQAT 75% WP (Captan 70% + Hexaconazole 5%) on sheath blight disease of rice

Sl No.	Treatments	Dose/l	Disease Severity (PDI)	
			Kharif 2013	Rabi 2013-14
T 1	TAQAT 75% WP (Captan 70% + Hexaconazole 5%)	500g	22.96 (28.59)	24.67 (29.73)
T 2	TAQAT 75% WP (Captan 70% + Hexaconazole 5%)	750g	13.33 (21.39)	14.11 (22.06)
T 3	Captan 50% WP	700g	34.07 (35.67)	27.93 (27.20)
T 4	Captan 50% WP	1050g	37.77 (37.88)	25.37 (30.20)
T5	Hexaconazole 5% SC	500ml	31.48 (34.08)	31.93 (34.39)
T6	Hexaconazole 5% SC	750ml	31.10 (33.90)	28.74 (30.46)
T7	Hexaconazole 5% SC	1000ml	30.74 (33.65)	24.07 (29.33)
T8	Control	--	50.37 (45.17)	47.37 (43.39)
Co-efficient of Variance (CV)			13.43	12.68
Critical Difference (CD)			3.68	2.9

Figures in the parentheses represent arcsine transformed values

Table.2 Effect of TAQAT 75% WP (Captan 70% + Hexaconazole 5%) on sheath rot disease of rice

Sl No	Treatments	Dose/l	Disease Severity (PDI)			
			Kharif 2013		Rabi 2013-14	
			Before spray	20d after spray	Before spray	20d after spray
T 1	TAQAT 75% WP (Captan 70% + Hexaconazole 5%)	500g	15.55 (23.34)	22.2 (28.11)	27.77 (31.76)	28.55 (32.27)
T 2	TAQAT 75% WP (Captan 70% + Hexaconazole 5%)	750g	18.88 (25.70)	14.4 (22.30)	26.14 (30.72)	14.16 (21.97)
T 3	Captan 50% WP	700g	15.55 (23.34)	28.1 (32.01)	19.62 (26.28)	27.77 (31.76)
T 4	Captan 50% WP	1050g	12.22 (20.44)	24.1 (29.40)	29.99 (33.15)	25.55 (30.36)
T5	Hexaconazole 5% SC	500ml	17.77 (24.88)	29.6 (32.96)	28.03 (31.95)	36.56 (37.23)
T6	Hexaconazole 5% SC	750ml	18.88 (25.70)	26.7 (31.11)	20.36 (26.71)	28.88 (32.46)
T7	Hexaconazole 5% SC	1000ml	20.00 (26.57)	25.2 (30.13)	21.47 (27.56)	23.40 (28.93)
T8	Control	--	19.99 (26.56)	36.3 (37.05)	25.88 (30.53)	46.62 (43.03)
Co-efficient of Variance (CV)			NS	13.9	NS	13.9
Critical Difference (CD)			NS	4.20	NS	3.2

* Figures in the parentheses represent arcsine transformed values

Table.3 Effect of TAQAT 75% WP (Captan 70% + Hexaconazole 5%) on stem rot disease of rice

Sl No	Treatments	Dose/l	Stem rot Disease Severity (PDI)			
			Kharif 2013		Rabi 2013-14	
			Before spray	20d after spray	Before spray	20d after spray
T 1	TAQAT 75% WP (Captan 70% + Hexaconazole 5%)	500g	24.44 (29.60)	22.58 (28.35)	28.60 (32.35)	35.10 (36.33)
T 2	TAQAT 75% WP (Captan 70% + Hexaconazole 5%)	750g	17.77 (24.88)	13.7 (21.72)	15.55 (23.24)	17.49 (24.65)
T 3	Captan 50% WP	700g	32.22 (34.57)	36.29 (37.05)	33.66 (35.43)	39.22 (38.76)
T 4	Captan 50% WP	1050g	35.55 (36.57)	34.44 (35.94)	30.27 (33.40)	33.88 (35.61)
T5	Hexaconazole 5% SC	500ml	29.99 (33.15)	35.55 (36.60)	39.77 (39.06)	42.71 (40.80)
T6	Hexaconazole 5% SC	750ml	30.00 (33.21)	33.0 (35.06)	27.99 (31.88)	32.10 (34.51)
T7	Hexaconazole 5% SC	1000ml	25.55 (30.33)	30.74 (33.65)	25.55 (30.33)	27.49 (31.62)
T8	Control	--	45.55 (42.42)	44.07 (41.55)	40.82 (39.70)	49.71 (44.84)
Co-efficient of Variance (CV)			NS	13.7	NS	11.8
Critical Difference (CD)			NS	4.1	NS	4.9

* Figures in the parentheses represent arcsine transformed values

Table.4 Effect of TAQAT 75% WP (Captan 70% + Hexaconazole 5%) on grain yield

Sl No.	Treatments	Dose/l	Yield (q/ha)	
			Kharif 2013	Rabi 2013-14
T 1	TAQAT 75% WP (Captan 70% + Hexaconazole 5%)	500g	61.25	55.80
T 2	TAQAT 75% WP (Captan 70% + Hexaconazole 5%)	750g	67.25	64.35
T 3	Captan 50% WP	700g	52.67	49.23
T 4	Captan 50% WP	1050g	54.15	54.70
T5	Hexaconazole 5% SC	500ml	49.25	50.10
T6	Hexaconazole 5% SC	750ml	55.3	55.50
T7	Hexaconazole 5% SC	1000ml	53.3	58.50
T8	Control	--	44.52	41.32
Co-efficient of Variance (CV)			12.25	13.68
Critical Difference (CD)			4.59	3.2

Previous workers reported the efficacy of Hexaconazole 5 SC in reducing the sheath rot incidence (Vidhyasekaran and Lewin, 1987; Kindo and Tiwari, 2015) and in this present study we report the enhanced efficacy of Hexaconazole 5 % in combination with Captan 70% compared to the Hexaconazole 5% SC alone. In the present investigation, we have also tested the efficacy of Hexaconazole 5 SC in different doses (500, 750 and 1000 ml/ha) which recorded on par PDI among themselves but recorded higher PDI than TAQAT 75% WP (Captan 70% + Hexaconazole 5%) @ 750 g/ha in both the season.

Stem rot

Test fungicide TAQAT 75% WP (Captan 70% + Hexaconazole 5%) @ 750 g/ha performed better than the other chemicals in both the season in reducing the stem rot PDI. It recorded PDI of 13.7 and 17.49 in Kharif 2013 and Rabi 2013-14 respectively which is statistically significant over other treatments. Several fungicides in solo formulation such as Benomyl, Edifenphos, Thiophanate Methyl, Propiconazole have been reported earlier as effective in reducing stem rot disease under field condition (Singh *et al.*, 2002; Kumar *et al.*, 2003; Gopika *et al.*, 2016). In this experiment, we have reported the superiority of a combination fungicide (Captan 70% + Hexaconazole 5%) over other solo fungicide in reducing the stem rot disease severity under field condition (Table 3) (Figs. 1 and 2).

Yield

Difference in the disease severity of sheath blight, sheath rot and stem rot diseases in different treatment was finally reflected in the grain yield. Significant increase in the grain yield in Kharif 2013 (67.25 q/ha) and Rabi 2013-14 (64.35 q/ha) was observed in the plots treated with test chemical TAQAT 75% WP (Captan 70% + Hexaconazole 5%) @ 750

g/ha (67.25 q/h) (Table 4) (Figs. 1 and 2). Whereas, other fungicide treatments, recorded yield in the range of 44.52-61.25 q/ha in Kharif 2013 and 41.32-58.50 q/ha in Rabi 2013-14 (Table 4) (Figs. 1 and 2). Our results are in conformity with those of previous reports (Sood and Kapoor, 1997; Tirmali *et al.*, 2001; Prabhu *et al.*, 2003, Usman *et al.*, 2009; Naik *et al.*, 2012; Bhuvaneshwari and Raju, 2012; Bag *et al.*, 2016; Pramesh *et al.*, 2016 a,b) reported that fungicides application increases the yield of rice. The increased yield is mainly due to reduced disease severity of sheath blight, sheath rot and stem rot.

Combination fungicides are better compare to the other solo fungicides due to their broad range of action, lower dose and also posses lower risk of fungicide resistance development in target fungal population. In case of rice, resistance varieties for sheath blight, sheath rot and stem rot are not developed/available/ yet to the farmer. 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 disease management for 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 (Bag *et al.*, 2016).

In conclusion, present investigation provides the field efficacy of a fungicide premixture TAQAT 75% WP (Captan 70% + Hexaconazole 5%) @ 750 g/ha for management of sheath blight, sheath rot and stem rot diseases of paddy.

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