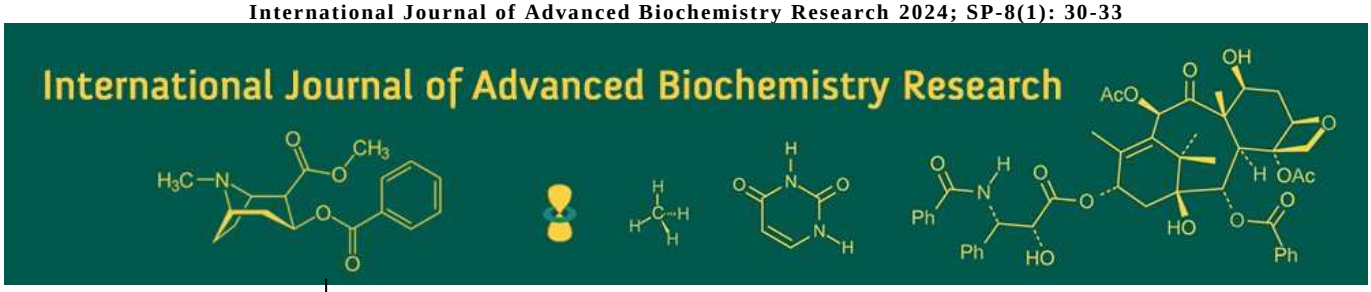

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Evaluation of fungicides against sheath blight of rice

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Abstract
Sheath blight of rice caused by *Rhizoctonia solani* Kuhn [teleomorph; *Thanatephorus cucumeris* (Frank) Donk] is most widely distributed and cause substantial yield loss. It is measure production constraint in high yielding varieties under intensive rice production system. The pathogen has very wide host range and exhibits considerable pathogenic and molecular variability. Due to non-availability of resistant cultivars, the management of sheath blight primarily dependence on chemical control. The present study focused on better chemical molecules for the management of this disease. In view of above seven fungicides (Difenoconazole 25% EC, Isoprothiolane 40% EC, Kasugamycin 3% SL, Kitazin 48% EC, Propineb 40% WP, Tebuconazole 25.9% EC and Thifluzamide 24% EC) were evaluated at 100, 200 and 500 ppm concentration *in vitro* against sheath blight pathogen. Difenoconazole 25% EC, Tebuconazole 25.9% EC and Thifluzamide 24% EC completely inhibited the growth of *R. solani* at all concentrations. Whereas as some mycelial growth of the pathogen were observed at 500 ppm after 72 hours in Isoprothiolane 40% EC and Kasugamycin 3% SL whereas very less growth in other fungicides treated plates. However all these fungicides were used to manage the sheath blight of rice under field condition also. Among these fungicides Tebuconazole 25.9% EC, Difenoconazole 25% EC were found highly effective followed by Thifluzamide 24% EC in comparison to other fungicides.

Keywords: Rice, sheath blight, fungicides

Introduction
Rice is an important cereal crop affected by various fungal, bacterial, and viral diseases. Among the fungal diseases sheath blight caused by *Rhizoctonia solani* Kuhn is one of the most widely distributed disease of rice. Its occurrence in India was reported by Paracer and Chahal (1963) [6] from Gurudaspur in the Punjab. It appears throughout the all rice growing areas. The disease appears both on sheath and leaf depending upon the age of the plant, time of infection and severity of disease. It causes yield loss to the extent of 59 to 69 per cent (Naidu 1992, Singh *et al.* 2016) [4, 9]. The incidence of disease has become severe with the introduction of semi dwarf, heavy tillering, early maturing and high yielding varieties. In the absence of suitable resistant varieties, chemical control is the only alternative to manage the disease since the seriousness of disease warrants chemicals protection. The disease managed mostly by application of systematic fungicides. It is important to explore alternative chemical molecule to avoid buildup of resistance in the pathogen. Several new fungicides have been recently developed which are known to possess good control against *Rhizoctonia solani*. However uses of some of them are restricted due to its residual effect in rice grain. The present study was undertaken to evaluate some newer effective fungicides against this disease *in vitro* and *in vivo.*

Methods and Materials
In vitro studies were conducted in the laboratory. The field experiments were conducted at Crop Research Station, Masodha, Ayodhya WS 2021& 2022. The pathogen was isolated from the sheath blight infected material on Potato Dextrose Agar medium in Petri plate. The culture was characterized on the basis of its morphological and cultural characteristic, pathogenicity of the pathogen confirmed by using Koch's postulate.
The stock cultures of the pathogen were maintained on slants containing Potato Dextrose Agar medium. To find out the effective chemicals against sheath blight, were evaluated *in vitro* and *in vivo*. Fungicides (Difenoconazole 25% EC, Isoprothiolane 40% EC, Kasugamycin 3% SL, Kitazin 48% EC, Propineb 40% WP, Tebuconazole 25.9% EC and

Thifluzamide 24% EC) were evaluated against *R. solani* at three concentration (100, 200, 500 ppm) along with check to observe the inhibitory effect on the mycelial growth of *R. solani* using Poison Food Technique (Nene 1971) [5] *in vitro* (each concentration of fungicides was replicated three times. Each Petri plate was centrally inoculated with 1.5 mm sclerotia from the seven days old culture of *R. solani* under aseptic conditions. Colony diameter was measured after 24, 48, 72 hours of inoculation. Percentage inhibition in untreated control was calculated by applying the following formula (Vincent 1927) [12]

$$I = \frac{C - T}{C} \times 100$$

Where
I = Percent inhibition
C = Colony diameter in control (mm)
T = Colony treatment in treatment (mm)

Efficacy of above fungicides under field were evaluated during kharif 2021 & 2022 in Randomized Block Design with four replication using susceptible check variety Pusa Basmati -1under artificially inoculated field condition. The dose of fungicides (Difenoconazole 25% EC @ 0.5 ml/l, Isoprothiolane 40% EC @ 1.5 ml/l, Kasugamycin 3% SL @ 2.0 ml/l, Kitazin 48% EC @ 1.0 ml/l, Propineb 40% WP @ 3.0 g/l, Tebuconazole 25.9% EC @ 1.5 ml/l and Thifluzamide 24% SC @ 0.8 g/l) of water were sprayed twice at 15 days interval starting from just appearance of disease symptoms under artificial inoculation. Control plot were sprayed with ordinary water. Disease observations were recorded after 15 days of last spray. The disease severity was recorded and increase in grain yield (kg/h) was calculated by using following formula:

$$\text{Percent increase in Yield} = \frac{\text{Yield in treated plot} - \text{yield in check plot}}{\text{Yield in check plot}} \times 100$$

Results

Bio-efficacy of seven fungicides (Difenoconazole 25% EC, Isoprothiolane 40% EC, Kasugamycin 3% SL, Kitazin 48% EC, Propineb 40% WP, Tebuconazole 25.9% EC and Thifluzamide 24% EC) with three concentration of each i.e. 100 ppm, 200 ppm and 500 ppm were used against *Rhizoctonia solani in vitro.* The observations on radial growth of *R. solani* were recorded at 24, 48 and 72 hours of inoculation (Table- 1). The response of Difenoconazole 25% EC, Tebuconazole 25.9% EC and Thifluzamide 24% EC treatment on mycelial growth of *R. solani* resulted complete inhibition of growth after 24, 48, and 72 hours of inoculation was observed at all the concentrations of these fungicides.

However, Isoprothiolane 40% EC treated plate showed radial growth of the fungus up to 4.6 cm diameter at 500 ppm concentration containing plate after 72 hours while 8.8 cm colony growth was observed in control plate. The other three fungicides showed very less mycelial growth (Table 1).

Table 1: *In-vitro* efficacy of fungicides against *R. solani* causing Sheath blight of rice

SN	Chemicals	Concentration in (ppm)	24 hrs		48 hrs		72 hrs	
			Average Diameter cm cm	Percent Inhibition cm	Average Diameter cm	Percent Inhibition	Average Diameter cm	Percent Inhibition
1	Difenoconazole 25% EC	0	2.8	------	6.7	-------	8.8	-----
		100	0	100	0	100	0	100
		200	0	100	0	100	0	100
		500	0	100	0	100	0	100
2	Isoprothiolane 40% EC	0	3.0	-------	7.0	------	8.8	-----
		100	2.3	23.3	5.4	22.8	6.6	25.0
		200	1.9	36.6	5.1	27.1	6.1	30.6
		500	1.4	53.3	4.2	40.0	4.6	47.7
3	Kasugamycin 3% SL	0	3.1	-----	6.8	------	9.0	-----
		100	1.4	54.8	4.5	33.8	5.7	36.6
		200	1.0	67.7	2.3	66.1	3.3	63.3
		500	0.5	83.7	1.5	77.9	1.8	80.0
4	Kitazin 48% EC	0	3.1	-----	7.1	------	9.1	-----
		100	2.1	32.2	5.2	26.7	6.2	31.8
		200	1.8	41.9	4.9	30.9	4.3	52.7
		500	1.4	54.8	2.5	64.7	2.8	69.2
5	Propineb 40% WP	0	3.1	-----	7.2	------	9.1	-----
		100	2.5	19.3	5.6	22.2	6.7	26.3
		200	2.1	32.2	5.4	25.0	6.3	30.7
		500	1.4	54.8	4.4	38.8	4.5	50.5
6	Tebuconazole 25.9% EC	0	2.9	-----	7.1	------	8.9	------
		100	0	100	0	100	0	100
		200	0	100	0	100	0	100
		500	0	100	0	100	0	100
7	Thifluzamide 24% EC	0	2.8	-----	7.2	------	9.1	------
		100	0	100	0	100	0	100
		200	0	100	0	100	0	100
		500	0	100	0	100	0	100

The field experiments data showed that the plots treated with Difenoconazole 25% EC, Tebuconazole 25.9% EC have exhibited very less infection 22.3%, 27.7% and 22.9%, 25.7% disease severity and 21.0%, 28.1% and 21.7%, 24.8% incidence respectively and more grain yield 3.913, 3.713 t/ha and 3.863,3.825 t/ha was recorded in two consecutive year. While severity and incidence of sheath blight had gone to the extent of 72.8%, 75.4% and 51.9%, 54.8% respectively in unsprayed control plots (Table: 2 & 3) In another treatment Thifluzamide 24% EC had also shown good response with 23.1%, 29.5% disease severity and 222.0%, 30.8% disease incidence while in the plot treated with Isoprothiolane 40% EC showed less effective disease severity 38.5%, 42.2% and disease incidence 37.0%, 40.0% was recorded.

The plots treated with Difenoconazole 25% EC, Tebuconazole 25.9% EC and Thifluzamide 24% EC were found highly effective and differences are not significant with each other, while differences are significant with Isoprothiolane 40% EC treated plot. All the fungicides Difenoconazole 25% EC, Isoprothiolane 40% EC, Kasugamycin 3% SL, Kitazin 48% EC, Propineb 40% WP, Tebuconazole 25.9% EC and Thifluzamide 24% EC also improved the grain yield of rice from 33.8-71.2% and 35.4-74.8% respectively as compared to untreated check plot (Table 2 & 3). Among the fungicides Tebuconazole 25.9% EC and Difenoconazole 25% EC were found best followed by Thifluzamide 24% EC in checking the disease severity and incidence of sheath blight on the basis of average of two year data. There were no any phytotoxic effect has been observed during crop season.

Table 2: Effect of different fungicides on severity and incidence of sheath blight of rice (WS 2021)

Sr. No	Name of Chemicals	Dose/lit water	Severity%	Incidence%	Yield t/ha	Yield increase% over control
1	Difenoconazole 25% EC	0.5 ml	22.3 (28.1)*	21.0 (27.2)	3.913	71.2
2	Isoprothiolane 40% EC	1.5 ml	38.5 (38.3)	37.0 (37.4)	3.063	33.8
3	Kasugamycin 3% SL	2.0ml	29.5 (32.8)	30.7 (33.6)	3.450	50.7
4	Kitazin 48% EC	1.0 ml	32.4 (34.7)	32.1 (34.5)	3.275	43.1
5	Propineb 40% WP	3.0 g	35.7 (36.6)	33.9 (35.6)	3.100	35.4
6	Tebuconazole 25.9% EC	1.5 ml	22.9 (28.5)	21.7 (27.7)	3.863	68.8
7	Thifluzamide 24% SC	0.8g	23.1 (28.7)	22.0 (27.9)	3.838	67.7
8	Check	-	72.8 (58.6)	51.9 (46.1)	2.288	-
CV			6.7	6.2	0.056	
CD @ 5%			3.5	3.1	0.173	

*AT Value – Arc sin transformed value in the parenthesis

Table 3: Effect of different fungicides on severity and incidence of sheath blight of rice (WS 2022)

Sr. No.	Name of Chemicals	Dose/litwater	Severity%	Incidence%	Yield t/ha	Yield increase% over control
1	Difenoconazole 25% EC	0.5 ml	27.7 (31.8)*	28.1 (32.0)	3.713	69.7
2	Isoprothiolane 40% EC	1.5 ml	42.2 (40.5)	40.0 (39.3)	2.963	35.4
3	Kasugamycin 3% SL	2.0 ml	33.6 (35.5)	33.2 (35.2)	3.338	52.5
4	Kitazin 48% EC	1.0 ml	38.1 (38.1)	35.6 (36.7)	3.175	45.1
5	Propineb 40% WP	3.0 g	39.3 (38.8)	36.6 (37.2)	3.063	39.9
6	Tebuconazole 25.9% EC	1.5 ml	25.7 (30.5)	24.8 (29.9)	3.825	74.8
7	Thifluzamide 24% SC	0.8 g	29.5 (32.9)	30.8 (33.7)	3.613	65.1
8	Check	-	75.4 (60.2)	54.8 (47.8)	2.188	-
CV			7.0	8.2	6.8	
CD @ 5%			1.9	2.1	154.5	

*AT Value – Arc sin transformed value in the parenthesis

Discussion

In *in-vitro* among the fungicides Difenoconazole 25% EC, Tebuconazole 25.9% EC and Thifluzamide 24% EC were observed highly effective 100% radial growth inhibition were recorded at all the concentrations while 25.0% – 47.7% in the case of Isoprothiolane 40% EC treated plate was recorded. Under field condition, chemical fungicides Difenoconazole 25% EC, Isoprothiolane 40% EC, Kasugamycin 3% SL, Kitazin 48% EC, Propineb 40% WP, Tebuconazole 25.9% EC and Thifluzamide 24% EC were used against sheath blight of rice. All these fungicides were found highly effective in checking in disease severity and incidence over untreated control and increased the grain yield of rice. The efficacy of the among fungicides Tebuconazole 25.9% EC, Difenoconazole 25% EC and Thifluzamide 24% EC were found best in compared to other fungicide treated plots. These chemicals are systematic in nature as well as suppressed the mycelial growth, sclerotia formation and their germination that might be cause of their excellent performance. Siddartha. *et al.* (2020) [8] also found the best curative and protective effects of Polyethylene glycol 400 based on nano- formulations against sheath blight of rice. Upmanyu *et al.* (2002) [10] also reported response of Carbendazim in reducing sheath blight severity and increased the grain yield. The reduction of disease severity may be one of the possible reasons for enhancement of grain yield. Uppala and Zhou 2018 [11], Behera *et al.*, (2022) [1] and Kabdwal *et al.*, (2023) [2] also observe that response of Azoxystrobin (alone or in combination with propiconazole), Trifloxytrobin plus propiconazole, pyraclostrobin and flutolanil fungicides against sheath blight of rice and increased the grain yield. The present findings are comparable with above work.

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