

Evaluation of Azoxystrobin and Thifluzamide-Based Treatments for Effective Management of Sheath Blight in Rice

BIJENDER KUMAR, SONAM BHATT AND ASHISH SINGH BISHT*

Department of Plant Pathology, G. B. Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand - 263145

Received : 12.02.2025

Accepted : 14.05.2025

Published : 30.06.2025

Rice (*Oryza sativa* L.) serves as the staple food for more than 60% of the global population and remains a crucial agricultural commodity in India, where it is cultivated over an area exceeding 40 million hectares. However, its productivity is substantially hindered by biotic stresses, particularly insect-pests and fungal diseases. Among these, sheath blight, caused by *Rhizoctonia solani* Kuhn, is one of the most devastating diseases, often resulting in yield losses ranging from 30% to 40% under favorable environmental conditions. To assess effective disease management strategies, a field study was conducted during the Kharif seasons of 2018 and 2019 to evaluate the efficacy of the fungicidal formulation -Azoxystrobin 20% + Thifluzamide 15% SC against sheath blight in rice. The experiment was designed following a randomized complete block design (RCBD) with seven treatments, including an untreated control. Pooled data analysis from both cropping seasons indicated that all fungicidal treatments significantly reduced the per-cent disease index (PDI) compared to the control. Among the treatments, two foliar applications of Azoxystrobin 20% + Thifluzamide 15% SC @ 600 ml/ha (T3) recorded the lowest PDI (27.60%), demonstrating the highest efficacy and highest grain yield (63.55 q/ha). This treatment was found to be statistically on par with the application of Azoxystrobin 20% + Thifluzamide 15% SC @ 500 ml/ha (T2), which exhibited a PDI of 29.11% and provided grain yield of 62.25 q/ha). Considering both efficacy of disease control and economics, of the treatments two foliar applications of Azoxystrobin 20% + Thifluzamide 15% SC @ 500 ml/ha can be recommended for the management of sheath blight in rice.

Keywords : Azoxystrobin, *Rhizoctonia solani*, Rice, Sheath blight, Thifluzamide

INTRODUCTION

A significant portion of the world's population relies on rice (*Oryza sativa* L.) as their primary food supply, making it one of the most important staple crops in the world. Rice cultivation is predominantly higher in Asia and Southeast Asia, with India ranking among the largest producers. As the global population is projected to surpass 9 billion by 2050, food production will only be able to supply 60% of the demand (FAO, 2018). The productivity of rice is significantly hampered by biotic stresses, *Rhizoctonia solani*, the causal agent of sheath blight (ShB), representing a major threat, leading to yield losses of up to 45% (Margani *et al.* 2018).

Sheath blight was initially documented in Japan in 1910 and has since disseminated across major rice-growing regions, especially in areas with extensive cultivation (Srinivasachary *et al.* 2011). In India, the disease was first identified in Gurdaspur (1963) and has since spread to all major rice-producing states, adoption of high-yielding varieties and changing climatic conditions making disease more severe (Praksham *et al.* 2013). The disease usually first appears during the late stage of tilling and becomes more severe at the panicle initiation stage, causing greenish-gray, water-soaked lesions on the leaf sheath, which eventually coalesce and extend to the upper leaves and panicles, causing seed discoloration and impaired grain filling (Singh *et al.* 2016). In severe infections, complete necrosis of the leaves and plant mortality occur, disease also cause frequently the distinctive 'bird's nest' pattern in affected fields (Hollier *et al.* 2009). Through direct contact between plant tissues, like tillers and

*Correspondence: ashbisht111@gmail.com

leaves, as well as through sclerotia found in surface water, the pathogen spreads easily, helping in the spread of the disease (Tsiboe *et al.* 2017). Effective disease management is made more difficult by *R. solani*'s wide host range and the persistent nature of its sclerotia. In intensive rice production systems, the use of various cultural practices can be challenging, despite the fact that they may reduce the prevalence of disease (Singh *et al.* 2016). Since no resistant cultivars have been created, systemic fungicides are currently the primary means of efficient sheath blight management. Numerous fungicides have been effective in managing disease, such as benomyl, captafol, chloroneb, carbendazim, ediphenphos, and mancozeb. However, use of fungicides with single mode action for long time may lead to the development of resistance among pathogen populations (Zhang *et al.* 2009; Kumar, 2020). In order to improve disease control and reduce the impact on the environment, the combination of fungicidal mixes with precision-based application techniques is being explored. Considering these challenges, the current study was conducted to evaluate the effectiveness of the fungicide combination Azoxystrobin (20%) + Thifluzamide (15%) SC for the control of sheath blight in rice in field conditions.

MATERIALS AND METHODS

Experimental site

The current experiment was carried out during the Kharif seasons of 2018 and 2019, at the Norman E. Borlaug Crop Research Centre's Rice Pathology Block of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand.

The experiment was laid out in Randomized Block Design consisting of 7 treatments with three replications and each treatment was assigned randomly in the plots of experimental field during the experimentation. The plots size of 5x5 m with a spacing of 20 cm row to row and 15 cm plant to plant were maintained. The variety used in experiment was Pant Dhan 4.

Treatments

A knapsack sprayer with a hollow cone nozzle was used to apply two foliar sprays of the

pesticides. In 2018, the first spray was administered on October 6 and the second on October 16, while in 2019, the first spray was administered on September 16 and the second on September 26. Details of treatment given are enlisted in Table 1.

Observation and analysis

The crop was periodically observed for the symptoms of the target diseases. The per cent disease index of sheath blight was calculated in each replication of each treatment according to the standard evaluation system (SES) using 0-9 rating scale (Anonymous, 2013) where, 0= no infection, 1= vertical spread of the lesions up to 20% of the plant height, 3= vertical spread of the lesions up to 21-30%, 5= vertical spread of the lesions up to 31-45%, 7= vertical spread of the lesions up to 46-65%, 9= vertical spread of the lesions up to 66-100%.

The percent disease index (PDI) and per cent control over untreated check was computed using the following formula:

$$PDI = \frac{\text{sum of all numerical ratings}}{\text{Total no. of plants} \times \text{maximaum scale}} \times 100$$

$$\text{Per cent control over untreated check} = \frac{(\text{PDI in control plot} - \text{PDI in treatment plot})}{(\text{PDI in control plot})} \times 100$$

The yield in kilogram (kg) per hectare (ha) was calculated by using the following formula and then was converted into quintal per hectare.

$$\text{Yield (KgD ha)} = \frac{(\text{Yield per plot})}{(\text{Net plot area})} \times 10,000$$

RESULTS AND DISCUSSION

Effect of Azoxystrobin 20% + Thifluzamide 15% SC against sheath blight of rice

The experimental data pertinent to per cent disease index (PDI) of sheath blight of rice during 2018 and 2019 kharif seasons are presented in Table 2 and Table 3, respectively. During 2018, the PDI 10 days after second spray ranged between 28.09% to 87.55% whereas, during 2019, the PDI ranged between 27.10% to 86.98%.

Table 1: Details of the treatments carried out-

Treatments	Dosage/ha	
	Active substance (g or ml)	Formulation (g or ml)
T1: Azoxystrobin 20% + Thifluzamide 15% SC	80+60	400
T2: Azoxystrobin 20% + Thifluzamide 15% SC	100+75	500
T3: Azoxystrobin 20% + Thifluzamide 15% SC	120+90	600
T4: Azoxystrobin 23% SC	125	500
T5: Thifluzamide 24% SC	90	375
T6: Azoxystrobin 18.2% + Difenconazole 11.4% SC	0.03% or 0.3 g/L	0.1% or 1 ml / L water
T7: Untreated control	-	-

Table 2: Effect of *Azoxystrobin 20% + Thifluzamide 15% SC* against Sheath blight of rice during 2018.

Treatments	Dosage/ha		Before spray	Sheath blight (PDI)				Per cent control over untreated check
	a.i. (g or ml)	Form. (g or ml)		5 DAFS	10 DAFS	5 DASS	10 DASS	
T ₁ - Azoxystrobin 20%+Thifluzamide 15% SC	80+60	400	20.04	32.65	35.61	35.90	41.28	36.93
T ₂ - Azoxystrobin 20%+Thifluzamide 15% SC	100+75	500	19.54	28.24	29.10	29.60	30.01	65.72
T ₃ - Azoxystrobin 20%+Thifluzamide 15% SC	120+90	600	19.49	26.05	27.55	27.90	28.09	67.92
T ₄ - Azoxystrobin 23% SC 500 ml/ha	125	500	19.49	39.88	44.07	47.83	49.64	43.30
T ₅ - Thifluzamide 24% SC	90	375	19.33	35.22	38.79	41.24	44.45	49.23
T ₆ - Azoxystrobin 18.2%+Difenconazole 11.4% SC	0.03% or 0.3 g/L	0.1% or 1 ml / L water	19.48	28.56	30.99	33.58	34.38	60.73
T ₇ - Untreated control	-	-	19.46	44.50	52.64	65.17	87.55	-
CD at 5%			1.10	2.23	2.60	2.82	2.10	
SE(m)			0.37	0.74	0.87	0.94	0.70	

PDI= Per cent Disease Index, a.i.=Active Ingredient, Form. = formulation, DAFS: Days after first spray; DASS: Days after second spray; g: gram; ml: Millilitre

Table 3: Effect of Azoxystrobin 20% + Thifluzamide 15% SC against Sheath blight of rice during 2019

Treatments	Dosage/ha		Before spray	Sheath blight (PDI)				Per cent control over untreated check
	a.i. (g or ml)	Form. (g or ml)		5 DAFS	10 DAFS	5 DASS	10 DASS	
T ₁ - Azoxystrobin 20%+Thifluzamide 15% SC	80+60	400	19.48	28.80	30.64	31.05	35.90	58.73
T ₂ - Azoxystrobin 20%+Thifluzamide 15% SC	100+75	500	19.25	26.51	27.01	27.50	28.20	67.58
T ₃ - Azoxystrobin 20%+Thifluzamide 15% SC	120+90	600	19.31	24.85	25.42	26.63	27.10	68.84
T ₄ - Azoxystrobin 23% SC	125	500	19.67	32.15	34.42	37.44	40.16	53.83
T ₅ - Thifluzamide 24% SC	90	375	19.47	30.69	32.52	33.07	37.24	57.19
T ₆ - Azoxystrobin 18.2%+Difenoconazole 11.4% SC	0.03% or 0.3 g/L	0.1% or 1 ml / L water	19.40	26.73	29.26	31.06	34.11	60.78
T ₇ - Untreated control	-	-	19.52	45.65	49.62	63.88	86.98	-
CD at 5%			1.03	1.76	2.74	2.33	2.63	
S E(m)			0.34	0.59	0.91	0.78	0.88	

PDI= Per cent Disease Index, a.i.= Active Ingredient, Form. = formulation, DAFS: Days after first spray; DASS: Days after second spray; g: gram; ml: Millilitre

In 2018, the lowest PDI, was recorded in T₃, Azoxystrobin 20% + Thifluzamide 15% SC @ 600 ml/ha (28.09%) followed by T₂, Azoxystrobin 20% + Thifluzamide 15% SC @ 500 ml/ha (30.01%) which were significantly at par with each other but differed significantly from rest of the treatments. However, highest PDI was recorded in untreated control (87.55%). Similar trend was observed in second season too in 2019 where lowest PDI was recorded in T₃, Azoxystrobin 20% + Thifluzamide 15% SC @ 600 ml/ha (27.10%) followed by T₂, Azoxystrobin 20% + Thifluzamide 15% SC @ 500 ml/ha (28.20%) which were significantly at par with each other while differed significantly from rest of the treatments. However, highest PDI was recorded in untreated control (86.98%). During both the crop seasons

maximum PDI was recorded in untreated control and lowest in T₃ (Azoxystrobin 20% + Thifluzamide 15% SC @ 600 ml/ha) at par with T₂ (Azoxystrobin 20% + Thifluzamide 15% SC @ 500 ml/ha).

Pooled analysis of per cent disease index of two crop seasons (Table 4) revealed that although all the treatments were significantly effective in reducing the per cent disease index. However, two foliar sprays of Azoxystrobin 20% + Thifluzamide 15% SC @ 600 ml/ha (T₃) was found to be the best as it resulted in lowest per cent disease index (27.60%) 10 days after the second spray followed by Azoxystrobin 20% + Thifluzamide 15% SC @ 500 ml/ha (29.11%) (T₂) which were significantly at par but differed significantly from rest of the treatments.

Table 4: Effect of Azoxystrobin 20% + Thifluzamide 15% SC against Sheath blight of rice (Pooled)

Treatments	Dosage/ha		Sheath blight (PDI)				
	a. i. (g or ml)	Form (g or ml)	Before spray	5 DAFS	10 DAFS	5 DASS	10 DASS
T ₁ - Azoxystrobin 20%+Thifluzamide 15% SC	80+60	400	19.76	30.72	33.12	33.47	38.59
T ₂ - Azoxystrobin 20%+Thifluzamide 15% SC	100+75	500	19.40	27.38	28.06	28.55	29.11
T ₃ - Azoxystrobin 20%+Thifluzamide 15% SC	120+90	600	19.40	25.45	26.09	27.27	27.60
T ₄ - Azoxystrobin 23% SC	125	500	19.58	36.02	39.24	42.64	44.90
T ₅ - Thifluzamide 24% SC	90	375	19.40	32.96	35.66	37.15	40.85
T ₆ - Azoxystrobin 18.2%+Difenoconazole 11.4% SC	0.03% or 0.3 g/L	0.1% or 1 ml / Litre water	19.44	27.65	30.13	32.32	34.25
T ₇ - Untreated control	-	-	19.49	45.08	51.13	64.53	87.27
CD at 5%			0.85	1.95	2.60	1.61	2.31
S E(m)			0.28	0.65	0.87	0.54	0.77

PDI= Per cent Disease Index, a.i.= Active Ingredient, Form. = formulation, DAFS: Days after first spray; DASS: Days after second spray; g: gram; ml: Millilitre

Effect of Azoxystrobin 20% + Thifluzamide 15% SC on yield

During 2018, the grain yield ranged between 54.67 q/ha to 63.41 q/ha while in 2019, it ranged between 54.93 to 63.69 q/ha (Table 5). In first season (2018), Azoxystrobin 20% + Thifluzamide 15% W/V SC @ 600 ml/ha (T₃) recorded maximum yield (63.41 q/ha) however it was found to be significantly at par with Azoxystrobin 20% + Thifluzamide 15% SC @ 500 ml/ha (T₂) with 61.91 q/ha but differed significantly from rest of the treatments. It was lowest in untreated control (54.67 q/ha). The same trend was observed in second season (2019). Here also Azoxystrobin 20% + Thifluzamide 15% SC @ 600 ml/ha (T₃) recorded maximum yield (63.69 q/ha) however it was significantly at par with T₂ i.e. Azoxystrobin 20% + Thifluzamide 15% SC 500 ml/ha with 62.59 q/ha grain yield but differed significantly from rest of the treatments. It was lowest in untreated control (54.93 q/ha). It is evident from the analysis

that all the treatments significantly increased the grain yield as compared to control. However, two foliar sprays of Azoxystrobin 20% + Thifluzamide 15% SC @ 500-600 ml/ha were found to be the best provided highest grain yield (63.55 – 62.25 q/ha).

To control sheath blight in rice, a number of chemical formulations are used, with an emphasis on finding fungicides that target novel sites and have a different of mechanisms of action. Currently, the most popular method for managing sheath blight in rice is to use systemic fungicides belonging to the Strobilurin group (Yellareddygar *et al.* 2014). This group includes *azoxystrobin*, which successfully controls the disease and increases yield by blocking the pathogen's electron transport pathway (Groth *et al.* 2007). Another popular fungicide that is well-known for its effectiveness in controlling sheath blight in rice is thifluzamide, a succinate dehydrogenase inhibitor (FRAC Group 7) (Chen

Table. 5: Effect of Azoxystrobin 20% + Thifluzamide 15% SC on yield

Treatments	Dosage/ha		Yield (q/ha)		
	a.i.	Form	2018	2019	Pooled
	(g or ml)	(g or ml)			
T ₁ - Azoxystrobin 20%+Thifluzamide 15% SC	80+60	400	59.70	60.32	60.02
T ₂ - Azoxystrobin 20%+Thifluzamide 15% SC	100+75	500	61.91	62.59	62.25
T ₃ - Azoxystrobin 20%+Thifluzamide 15% SC	120+90	600	63.41	63.69	63.55
T ₄ - Azoxystrobin 23% SC	125	500	57.75	59.00	58.38
T ₅ - Thifluzamide 24% SC	90	375	58.67	59.35	59.01
T ₆ -Azoxystrobin 18.2%+Difenoconazole 11.4% SC	0.03% or 0.3 g/L	0.1% or 1 ml / Litre water	61.42	62.32	61.87
T ₇ - Untreated control	-	-	54.67	54.93	54.81
CD at 5%			1.90	1.30	1.36
S E(m)			0.63	0.43	0.44

et al. 2012). Research indicates that *Thifluzamide* exhibits high effectiveness against most field isolates of *Rhizoctonia solani*, with a relatively low risk of resistance development (Mu *et al.* 2017).

However, if a single fungicide is used repeatedly with the same administration technique, the pathogen population may become resistant (Uppala *et al.* 2018). Combining fungicidal formulations have been suggested as a way to reduce this danger. These consist of the following: Pyraclostrobin 10% + Thifluzamide 10% SC at 80 + 80 g a.i./ha (Gowdar *et al.* 2024); Propiconazole + Difenoconazole (Kandhari *et al.* 2007); Prothioconazole + Tebuconazole 240 g/kg SC (Chen *et al.* 2021); Trifloxystrobin 25% + Tebuconazole 50% (Shahid *et al.* 2014); and *Carbendazim* 25% + *Flusilazole* 12.5% SE (Sanjay *et al.* 2012). These combination formulations prolong the effectiveness of fungicides in managing rice sheath blight by improving disease control efficacy and reducing the possibility of resistance development.

CONCLUSION

Based on the findings, it can be concluded that two foliar applications of Azoxystrobin 20% + *Thifluzamide* 15% SC at 600 ml/ha (T3) demonstrated the highest efficacy in managing sheath blight and enhancing rice grain yield. However, the lower dose of Azoxystrobin 20% + *Thifluzamide* 15% SC at 500 ml/ha (T2) exhibited comparable performance to T3, yielding similar disease suppression and productivity outcomes. T2 (500 ml/ha), that provides both efficient disease management and financial sustainability, stands out as a better option for farmers due to its efficacy and cost-effectiveness.

DECLARATION

Conflict of Interest. Authors declare no conflict of interest.

REFERENCES

Anonymous 2013. Standard Evaluation System for Rice, 5thEdn. IRRI, Los Banos, P.O. Box 933, IRTP, Manila, Philippines. 65 p.

- Chen, C. H. E. N., Kun, Z. H. A. N. G., Tao, D. I. N. G., Jianguo, F. E. N. G., Jin, Y. A. N. G., Zhen, H. E., Xijun, C. H. E. N. 202). Development of prothioconazole+ tebuconazole 240 g/ kg SC and its control effect on rice sheath blight and wheat sharp eyespot in the field. *Chinese J. Pesticide Sci.* **23**: 578-586.
- Chen, Y., Zhang, A. F., Wang, W. X., Zhang, Y., Gao, T. C. 2012. Baseline sensitivity and efficacy of thifluzamide in *Rhizoctonia solani*. *Ann. Appl. Biol.* **161**: 247-254.
- FAO (Food Agriculture Organization). 2018. Rice market monitor. <http://www.fao.org/economic/est/publications/rice-publications/rice-market-monitor/mm/en/>
- Gowdar, S. B., Hurali, S., Raddy, G. 2024. Study on Efficacy of Pyraclostrobin 10%+ Thifluzamide 10% SC against Blast and Sheath Blight Diseases of Paddy Crop. *Inter. J. Environ. Climate Change* **14**: 525-536.
- Groth, D. E., Bond, J. A. 2007. Effects of cultivars and fungicides on rice sheath blight, yield, and quality. *Plant Dis.* **91**: 1647-1650.
- Hollier, C. A., Rush, M. C., Groth, D. E. 2009. Sheath Blight of Rice. Louisiana Plant Pathology Disease Identification and Management Series (Online Publication 3123, LSU Ag Centre Research & Extension, Baton Rouge, Louisiana)
- Kandhari, J. 2007. Management of sheath blight of rice through fungicides and botanicals. *Indian Phytopathology* **60**: 214-217.
- Kumar B. 2020. Efficacy of modern combination fungicide molecules against sheath blight of rice. *Ind. Phytopathol.* **73**: 725-729.
- Margani, R., Hadiwiyono, Widadi, S. 2018. Utilizing *Bacillus* to inhibit the growth and infection by sheath blight pathogen, *Rhizoctonia solani* in rice. In IOP conference series: Earth and environmental science (Vol. 142, p. 012070). IOP Publishing.
- Mu, W., Wang, Z., Bi, Y., Ni, X., Hou, Y., Zhang, S., Liu, X. 2017. Sensitivity determination and resistance risk assessment of *Rhizoctonia solani* to SDHI fungicide thifluzamide. *Ann. Appl. Biol.* **170**: 240-250.
- Prakasam, V., Ladhakshmi, D., Laha, G.S., Krishnaveni, D., Seshu Madhav, M., Jyothi Badri, Srinivas Prasad, M., Vikramath B.C. 2013. Sheath blight of rice and its management. Technical Bulletin No. 72, Directorate of Rice Research (ICAR), Rajendranagar, Hyderabad-500030, Telangana., India. p 58.
- Sanjay, G., Thind, T.S., Kaur, R., Kaur, M. 2012. Management of sheath blight of rice with novel action fungicides. *Ind. Phytopathol.* **65**:92-93.
- Shahid, A. A., Shahbaz, M., Ali, M. 2014. A comparative study of the commercially available fungicides to control sheath blight of rice in Lahore. *J. Plant Pathol. Microbiol.* **5**: 2157-7471.
- Singh, R., Sunder, S., Kumar, P. 2016. Sheath blight of rice: current status and perspectives. *Ind. Phytopathol.* **69**: 340-351.
- Srinivasachary, Willocquet, L., Savary, S. 2011. Resistance to rice sheath blight (*Rhizoctonia solani* Kühn)[(teleomorph: *Thanatephorus cucumeris* (AB Frank) Donk.)] disease: current status and perspectives. *Euphytica* **178**: 1-22.
- Tsiboe, F., Nalley, L. L., Durand, A., Thoma, G., Shew, A. 2017. The economic and environmental benefits of sheath blight resistance in rice. *J. Agricult. Resource Econ.* **42**: 215-235.
- Uppala, S., Zhou, X. G. 2018. Field efficacy of fungicides for management of sheath blight and narrow brown leaf spot of rice. *Crop Protect.* **104**: 72-77.
- Yellareddygar, S. K. R., Reddy, M. S., Kloepper, J. W., Lawrence, K. S., Fadamiro, H. 2014. Rice sheath blight: a review of disease and pathogen management approaches. *J. Plant Pathol. Microbiol.* **5**: 1.
- Zhang, C. Q., Liu, Y. H., Ma, X. Y., Feng, Z., Ma, Z. H. 2009. Characterization of sensitivity of *Rhizoctonia solani*, causing rice sheath blight, to mepronil and boscalid. *Crop Protect.* **28**: 381-386.