**Thifluzamide 24% SC: A cost effective fungicide for managing sheath blight of rice**

**ABSTRACT**

Sheath blight caused by *Rhizoctonia* *solani* is a significant soil-borne disease of rice prevalent in all rice-growing regions of Telangana state, resulting in significant yield losses up to 50%. Owing to non-availability of resistance sources, fungicide application has become the predominant method for control of sheath blight in rice. Hitherto, strobilurins and triazole group of systemic fungicides were mostly widely preferred to manage the diseases in rice, apart from pathogen developing resistance due to their repeated use. Keeping this in view, studies were conducted with seven fungicides during *kharif*, 2021 and 2022 which revealed that, two foliar spraying of Thifluzamide 24% SC @ 375 ml/ha at initial appearance of sheath blight symptoms (maximum tillering stage) followed by another at 15-20 days interval resulted in highest reduction of sheath blight incidence (50.9%) followed by Difenconazole 25% EC @ 250 ml/ha (27.5%) and Tebuconazole 25.9% EC @ 750 ml/ha (19.7%), enhanced grain yield (21.9 to 36.5%) compared to untreated control. Further, this study also identified most effective fungicide *i.e.* Isoprothiolane 40% EC against neck blast of rice. In conclusion, Thifluzamide 20% SC is cost-effective and alternative fungicide, offering better protection against sheath blight with an ICBR of 1:3.6. Additionally, it is also demonstrated superior efficacy in managing sheath blight compared to the most commonly used fungicides, Tebuconazole and Difenconazole.

***Key Words:*** *Rice, Rhizoctonia solani, sheath blight and Thifluzamide 24% SC*

**1. INTRODUCTION**

Rice (*Oryza sativa* L.) is a vital staple food crop that sustains more than half of the world’s population, playing a pivotal role in global food security and livelihoods (Pramesh *et al*., 2017). India is the second largest producer of rice in the world, plays a significant role in meeting both the domestic and global food demands (Rajeswari *et al*., 2024). In India, particularly in the rice growing regions of Telangana serves as the backbone of the agricultural economy. In recent years, rice cultivation has witnessed a steady expansion in production areas across India, with Telangana emerging as one of the leading rice-producing states. The introduction of improved irrigation infrastructure, access to high-yielding varieties, and government initiatives, such as subsidies and procurement policies, have played a pivotal role in this growth (Aravind *et al*., 2022). Telangana’s distinctive agro-climatic conditions, fertile soils, and the availability of water resources have facilitated a significant increase in the rice-growing area.

Despite this progress, rice production is significantly impacted by numerous biotic and abiotic stresses, with biotic stresses, including various diseases, posing a formidable threat to yield stability. Among the diseases, neck blast caused by *Magnaporthe* *oryzae* and sheath blight, caused by the soil-borne pathogen *Rhizoctonia solani*, stands out as most destructive diseases of rice, inflicting substantial economic losses over years. Sheath blight is a soil-borne fungal disease that significantly affects rice crops, with natural infections typically occurring during the seedling, tillering and booting stages of plant development. The initial symptoms often emerge near the waterline in paddy fields, where environmental conditions favour pathogen establishment. Disease progression is characterized by the development of lesions on the lower leaf sheaths, which gradually extend upward to involve the upper leaf sheaths and leaf blades. These lesions initially present as water-soaked spots, eventually becoming grayish-white at the center with distinctive brown margins. As the infection advances, multiple lesions may merge, leading to extensive blighting of the affected tissues (Sharma et al., 2024). Yield reductions due to sheath blight can ranged from 9.6 to 85%, depending on weather conditions, crop management practices, and disease severity (Phookan and Hazarika, 1992).

The absence of resistant rice cultivars has necessitated the reliance on chemical fungicides as the primary management strategy (Chou *et al*., 2020). Although, strobilurins and triazole-based fungicides have been widely used due to their systemic action. The continuous and indiscriminate application of these fungicides has led to concerns about pathogen resistance and environmental safety (Kumar *et al*., 2021). Therefore, identifying and evaluating cost-effective, environmentally sustainable alternatives to manage sheath blight and neck blast is highly imperative.

Given the significance and constraints imposed by major rice diseases, the present study assessed the field efficacy of selected fungicides against sheath blight and neck blast in rice, with the objective of evaluating their efficacy in terms of cost-effectiveness and alternative safe fungicide for sustainable disease management in rice cultivation.

**2. MATERIAL AND METHODS**

The field trials were conducted during the *kharif* seasons of 2020, 2021 and 2022 at the Institute of Rice Research, Agricultural Research Institute, PJTAU, Rajendranagar, Hyderabad, India, to evaluate the efficacy of seven fungicides in managing sheath blight in rice under artificial inoculation conditions, whereas neck blast under natural conditions. The tested fungicides were listed in Table 1. The trials were conducted in a randomized complete block design (RCBD) with three replications with popular rice variety BPT 5204, known for its susceptibility to blast and sheath blight, was used as the test crop. The seeds were soaked overnight and incubated in gunny bags for better sprouting, followed by transplantation into the main field after 30 days of nursery growth. The field preparation and standard agronomic practices, including irrigation and fertilization, were followed throughout the crop's growth period.

**Table 1. List of fungicides used in the present study**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S. No.** | **Name of the fungicide** | **Trade name** | **Manufacturing company** | **Recommended dosage** |
| 1. | Difenconazole 25% EC | Score | Syngenta India Ltd. | 0.5 ml/l |
| 2. | Isoprothiolane 40% EC | Fujione | Tata Rallis | 1.5 ml/l |
| 3. | Kasugamycin 3% SL | Kasu - B | Dhanuka Agritech Ltd. | 2.0 ml/l |
| 4. | Kitazin 48% EC | Kitazin | PI Industries | 1.0 ml/l |
| 5. | Propineb 70% WP | Antracol | Bayer Crop Science Limited | 3.0 g/l |
| 6. | Tebuconazole 25.9% SC | Folicur | Bayer Crop Science Limited | 1.5 ml/l |
| 7. | Thifluzamide 24% SC | Pulsor | Insecticides (India) Limited | 0.8 ml/l |

**2.1 Pathogen inoculation and disease assessment**

To maintain consistent disease pressure, artificial inoculation was performed using a virulent isolate of *Rhizoctonia solani*, which was mass multiplied on typha (*Typha angustata* L.) leaf bits (Bhaktavatsalam *et al.,* 1978). These colonized typha bits were placed between the tillers of rice plants, approximately 5–10 cm above the water level at PI to booting stage. An untreated control was also included for comparison. The treatments were imposed at initiation of sheath blight symptoms on inoculated plants and care was taken to reach the chemical to the bottom portion of rice plant, where sheath blight symptoms noticed. Further, another spray of treatments were imposed after 15-20 days after first spray. A total of two foliar sprays of treatments were imposed in order to efficacy evaluation of different fungicides against sheath blight of rice. The efficacy of the fungicides was assessed on 20 randomly selected plants in each replication. The incidence of neck blast was recorded at maturity stage of the crop. The disease severity of sheath blight was assessed at 7 and 14 days after post application of first and second spray using the Standard Evaluation System (SES) scale (0–9 rating scale) developed by IRRI, 2014, whereas the neck blast severity was recorded at maturity stage of the crop. The severity scores were converted into a Percent Disease Index (PDI) using the formula (Sharma *et al.,* 2024):

The data collected from the *kharif* seasons of 2020, 2021 and 2022 were pooled to calculate average PDI and yield (kg/ha). Subsequently, the data on disease severity and yield parameters were subjected to appropriate statistical analysis to assess the effectiveness of the fungicide treatments against sheath blight of rice.

**3. RESULTS AND DISCUSSION**

**3.1 *Kharif*, 2020**

During 2020 wet season, the incidence of neck blast and sheath rot was recorded in this trial. The efficacy of fungicides in managing neck blast and sheath rot during *kharif*, 2020 revealed that, minimum PDI of neck blast was recorded with Isoprothiolane 40% EC (2.8%) followed by Kitazin 48%EC (6.5%) and Difenconazole 25% EC (6.8%), as compared to the control (26.4%). Among the fungicide treatments, the maximum neck blast PDI (14.9%) was recorded in Propineb 70%WP @ 3 g/l when compared to untreated control (26.4%). Among the treatments, spraying of Isoprothiolane @ 1.5 ml/l was found to be best fungicide against neck blast followed by Kitazin 48% EC (6.5%) as compared to control (26.4%). The minimum sheath rot incidence was recorded with Tebuconazole 25.9% SC (11.4%) followed by Kitazin 48% EC (13.3%) as compared to untreated control (29.7%), whereas, Difenconazole 25% EC was found to be most effective fungicide (20.0%) against grain discolouration under field conditions. Higher yields were recorded with Kitazin 48% EC (5448 kg/ha) as compared to untreated control (3309 kg/ha). However, yield differences across the treatments except untreated control were non-significant (Table 2).

**Table 2. Evaluation of fungicides against location specific diseases during *kharif (Vanakalam*), 2020**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Trt No.** | **Treatments** | **Per Cent Disease Index (PDI)** | | | **Grain yield (Kg/ha)** |
| **NB** | **ShR** | **GD** |
| **T1** | Difenconazole 25% EC @ 0.5 ml/l | 6.8abc  (2.6)# | 23.3c  (28.8)\* | 20.0a  (26.5) | 5298bc |
| **T2** | Isoprothiolane 40%EC @ 1.5 ml/l | 2.8a  (1.6) | 19.5bc  (26.19) | 32.0ab  (34.28) | 5172bc |
| **T3** | Kasugamycin 3%SL @ 2 ml/l | 7.6bc  (2.7) | 23.5c  (28.94) | 29.5ab  (32.58) | 5058bc |
| **T4** | Kitazin 48% EC @ 1 ml/l | 6.5ab  (2.5) | 13.3a  (21.36) | 31.0ab  (33.52) | 5448c |
| **T5** | Propineb 70% WP @ 3 g/l | 14.9d  (3.8) | 16.3ab  (23.79) | 33.5b  (35.1) | 4377abc |
| **T6** | Tebuconazole 25.9% EC @ 1.5 ml/l | 8.8bc  (2.9) | 11.4a  (19.59) | 32.8ab  (34.82) | 4912bc |
| **T7** | Thifluzamide 24% SC @ 0.8 g/l | 11.1cd  (3.3) | 23.6c  (28.98) | 37.0b  (37.46) | 3989ab |
| **T8** | Control (Water spray) | 26.4e  (5.1) | 29.7d  (32.93) | 41.5b  (40.1) | 3309a |
| SEm± | | 1.9 | 1.7 | 3.5 | 595.8 |
| CD (p = 0.05) | | 3.9 | 3.5 | 7.3 | 1239.1 |
| CV (%) | | 14.9 | 9.1 | 14.5 | 17.9 |

\*Figures in parenthesis are angular transformed values. @Dunccan multiple range test (DMRT).

#Figures in parenthesis are square root transformed values

NB: Neck Blast; ShR: Sheath Rot and GD: Grain Discolouration

**3.2. *Kharif*, 2021**

During *kharif* 2021, the lowest sheath blight was recorded with foliar spraying of Thifluzamide (32.1%) at initial appearance of sheath blight (PI to booting stage) followed by second spray at 15-20 days after first spray was found to be most effective when compared with untreated control (65.9%) under field conditions, whereas spraying of isoprothiolane was found to be most effective fungicide against neck blast (13.4%) compared to untreated control (26.3). The higher grain yield was obtained with foliar spraying of tebuconozole (4949 kg/ha) followed by difenconazole (4830 kg/ha) and Thifluzamide (4793 kg/ha) compared to untreated control (3761 kg/ha) (Table 3, Figure 1).

The pooled data on neck blast over two seasons / years (*Kharif*, 2020 and 2021) revealed that, spraying of Isoprothiolane @ 1.5 ml/l at PI to booting stage followed by second spray at 15 – 20 days after first spray was found to be most effective fungicide in controlling the neck blast (8.1%) compared to untreated control (26.4%). However, the pooled data of grain yield over two seasons showed that, spraying of difenconazole recorded significantly higher yield (5064 kg/ha) compared to untreated control (3535 kg/ha).

**Table 3. Evaluation of fungicides against location specific diseases during *Kharif (Vanakalam)*, 2021**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Trt No.** | **Treatments** | **Per Cent Disease Index (PDI)** | | | | | **Grain yield (Kg/ha)** |
| **ShB-I** | **ShB-II** | **ShB-III** | **ShB-IV** | **NB#** |
| **T1** | Difenconazole 25% EC @ 0.5 ml/l | 8.2ab@ | 25.0a  (30.0)\* | 31.3ab  (34.0) | 41.0b  (39.8) | 16.9ab  (4.1)# | 4830c |
| **T2** | Isoprothiolane 40%EC @ 1.5 ml/l | 8.7ab | 27.6ab  (31.7) | 33.4abc  (35.2) | 44.1c  (41.6) | 13.4a  (3.7) | 4139b |
| **T3** | Kasugamycin 3%SL @ 2 ml/l | 7.7ab | 30.3b  (33.3) | 38.7de  (38.5) | 62.1e  (52.0) | 22.0cd  (4.7) | 4046b |
| **T4** | Kitazin 48% EC @ 1 ml/l | 7.8ab | 29.7ab  (33.0) | 37.6cde  (37.8) | 53.0d  (46.7) | 18.9bc  (4.3) | 4309b |
| **T5** | Propineb 70% WP @ 3 g/l | 8.5ab | 28.9ab  (32.5) | 35.3bcd  (36.5) | 51.7d  (46.0) | 18.0b  (4.2) | 4212b |
| **T6** | Tebuconazole 25.9% EC @ 1.5 ml/l | 8.0ab | 26.7ab  (31.1) | 32.9abc  (35.0) | 46.4c  (42.9) | 24.1de  (4.9) | 4949c |
| **T7** | Thifluzamide 24% SC @ 0.8 g/l | 7.4a | 27.7ab  (31.7) | 28.3a  (32.1) | 32.1a  (34.5) | 23.3de  (4.8) | 4795c |
| **T8** | Control (Water spray) | 9.7b | 37.2c  (37.6) | 42.5e  (40.7) | 65.9f  (54.3) | 26.3e  (5.1) | 3761a |
| SEm± | | 0.7 | 1.5 | 1.7 | 1.0 | 1.8 | 91.8 |
| CD (*p* = 0.05) | | 1.9 | 4.5 | 4.9 | 3.0 | 3.8 | 270 |
| CV (%) | | 15.7 | 10.7 | 9.5 | 4.1 | 12.5 | 4.2 |

\*Figures in parenthesis are angular transformed values. @Dunccan multiple range test (DMRT).

#Figures in parenthesis are square root transformed values; NB: Neck Blast; ShB: Sheath Blight

**ShB-I:** Pre-Count; **ShB-II:** 7 days after 1st spray; **ShB-III:** 15 days after 1st spray; **ShB-IV:** 10 days after 2nd spray



**Figure 1. Field view of experiment during *kharif,* 2021**

**3.3. *Kharif*, 2022**

Among the fungicides tested, the lowest incidence of sheath blight was recorded with foliar spraying of thifluzamide (26.3%) at PI to booting stage followed by second spray at 15-20 days after first spray was found to be most effective fungicide against sheath blight when compared with untreated control (62.2%) under field conditions, whereas foliar spraying of isoprothiolane was found to be most effective fungicide against neck blast (31.3%) compared to untreated control (42.0%). The higher grain yield was obtained with foliar spraying of tebuconozole (7467 kg/ha) followed by Kitazin (7373 kg/ha), however thifluzamide recorded the yield of 6698 kg/ha compared to untreated control (5630 kg/ha) (Table 4, Figure 2 and 3).

**Table 4. Evaluation of fungicides against location specific diseases during *Kharif* (*Vanakalam*), 2022**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Trt No.** | **Treatments** | **Per Cent Disease Index (PDI)** | | | | | | | **Grain yield (Kg/ha)** |
| **ShB-I** | **ShB-II** | **ShB-III** | **ShB-IV** | **ShB-FINAL** | **NB** | **GD** |
| T1 | Difenconazole 25% EC @ 0.5 ml/l | 17.3  (24.6) | 32.5  (34.78) | 42.5  (40.67) | 48.4  (44.05) | 56.0  (48.50) | 32.4 ab  (34.66) | 14.0  (21.89) | 6840b |
| T2 | Isoprothiolane 40%EC @ 1.5 ml/l | 15.9  (23.5) | 37.3  (37.59) | 49.3  (44.61) | 50.2  (44.95) | 60.3  (51.00) | 31.3a  (33.98) | 11.4  (19.64) | 7026b |
| T3 | Kasugamycin 3%SL @ 2 ml/l | 15.0  (22.8) | 40.6  (39.58) | 53.3  (46.89) | 55.6  (48.23) | 59.7  (50.62) | 40.7cd  (39.62) | 15.0  (22.72) | 7311b |
| T4 | Kitazin 48% EC @ 1 ml/l | 13.9  (21.8) | 34.2  (35.77) | 49.8  (44.89) | 55.2  (47.96) | 60.5  (51.11) | 36.0abcd  (36.83) | 9.9  (18.32) | 7373b |
| T5 | Propineb 70% WP @ 3 g/l | 14.6  (22.4) | 35.2  (36.35) | 53.1  (46.78) | 53.1  (46.80) | 59.3  (50.40) | 38.6bcd  (38.38) | 13.2  (20.89) | 7251b |
| T6 | Tebuconazole 25.9% EC @ 1.5 ml/l | 12.0  (20.3) | 28.9  (32.51) | 46.5  (42.99) | 47.6  (43.62) | 56.4  (48.70) | 34.1abc  (35.75) | 10.3  (18.67) | 7467b |
| T7 | Thifluzamide 24% SC @ 0.8 g/l | 13.5  (21.6) | 26.1  (30.68) | 26.8  (31.15) | 24.1  (29.38) | 26.3  (30.80) | 39.0cd  (38.63) | 16.6  (24.05) | 6698b |
| T8 | Control (Water spray) | 12.6  (20.8) | 43.9  (41.5) | 56.6  (48.83) | 58  (49.62) | 62.2  (52.09) | 42.0d  (40.38) | 28.1  (31.96) | 5630a |
|  | SE(M) | 0.77 | 1.70 | 2.24 | 3.56 | 1.79 | 2.02 | 1.45 | 315.80 |
|  | CD (5%) | 2.27 | 5.00 | 6.59 | 10.48 | 5.28 | 5.9 | 4.27 | 928.80 |
|  | CV (%) | 10.7 | 9.80 | 9.50 | 14.50 | 6.50 | 11.0 | 19.60 | 9.10 |

\*Figures in parenthesis are angular transformed values; @Dunccan multiple range test (DMRT). NB: Neck Blast; ShB: Sheath Blight

**ShB-I:** Pre-count; **ShB-II:** 7 days after 1st spray; **ShB-III:** 15 days after 1st spray; **ShB-IV:** 10 days after 2nd spray



**Figure 2. Field view of experiment during *kharif,* 2022**



**Figure 3. Close view of sheath blight artificial inoculation**

**3.4 Pooled Analysis (2020–2022)**

The pooled analysis of fungicides efficacy evaluation against sheath blight (ShB) and neck blast (NB) during *Kharif* (*Vanakalam*) 2020, 2021, and 2022 showed the significant differences among the treatments in controlling the sheath blight and neck blast under field conditions (Table 5, Figure 4). Among the treatments, Thifluzamide 24% SC @ 0.8 g/l exhibited the lowest ShB severity of 17.0%, significantly outperforming with all other treatments, including the control (34.6%). In support of results achieved from this study, Masurkar et al. (2019) reported that Thifluzamide 24% SC at 90 g a.i./ha effectively reduced the sheath blight disease index to 29.58% and 32.58% after prophylactic and curative sprays during *Kharif* 2016 and 2027. Further, Gowdar et al. (2024) found that Pyraclostrobin 10% + Thifluzamide 10% SC, applied at 90+90 g a.i./ha, recorded the lowest sheath blight disease index of 17.95 and 11.75 in *Kharif* 2021 and Summer 2022, respectively, 10 days after the second spray.

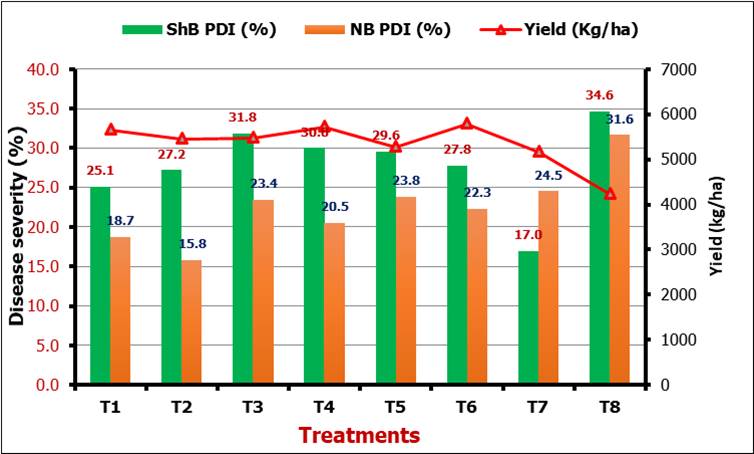
For NB severity, Isoprothiolane 40% EC @ 1.5 ml/l recorded the lowest severity of 15.8%, followed by Difenconazole 25% EC @ 0.5 ml/l with 18.7%, while the untreated control recorded the highest neck blast severity of 31.6%. Shi et al. (2025) demonstrated that the combination of thifluzamide and tricyclazole in a 1:2 ratio exhibited significant synergy in controlling rice blast and sheath blight diseases. Field trials revealed that applying thifluzamide + tricyclazole (1107 g/ha) to seedling trays effectively controlled rice blast (83.74–84.96% in 2022, 81.34–83.26% in 2023) and sheath blight, outperforming untreated controls. This treatment also increased grain yield by up to 18.91%, with the highest yields of 7429.73 kg/ha in 2022 and 7404.73 kg/ha in 2023. These findings highlight seedling tray application as a labor-efficient strategy for integrated disease management and yield enhancement. The highest grain yield (5776 kg/ha) was recorded with Tebuconazole 25.9% EC @ 1.5 ml/l closely followed by Kitazin 48% EC (5710 kg/ha) and Difenconazole (5656 kg/ha). In contrast, the pooled data over seasons revealed that, untreated control resulted in lowest yield of 4233 kg/ha. Overall, Thifluzamide demonstrated superior control efficacy of ShB under field conditions over 3 seasons (2021 to 2023), while Isoprothiolane was found to be most effective fungicide against neck blast. The pooled data revealed that, the fungicide *i.e.* Tebuconazole 25.9% EC consistently provided the highest grain yield, however yield differences among the treatments were non-significant indicating the potential as an effective fungicide for managing the location-specific diseases and enhancing rice productivity.

**Table 5. Pooled analysis on evaluation of fungicides against location specific diseases during *Kharif (Vanakalam)*, 2020, 2021 and 2022**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Trt No.** | **Treatments** | **ShB Severity (%) (2021 & 2022)** | **NB Severity (%) (2020 to 2022)** | **Yield (Kg/ha)** |
| **T1** | Difenconazole 25% EC @ 0.5 ml/l | 25.1b  (30.1) | 18.7ab  (25.6) | 5656bc |
| **T2** | Isoprothiolane 40%EC @ 1.5 ml/l | 27.2c  (31.4) | 15.8a  (23.4) | 5446bc |
| **T3** | Kasugamycin 3%SL @ 2 ml/l | 31.8e  (34.3) | 23.4cd  (28.9) | 5471bc |
| **T4** | Kitazin 48% EC @ 1 ml/l | 30.0d  (33.2) | 20.5bc  (26.8) | 5710c |
| **T5** | Propineb 70% WP @ 3 g/l | 29.6d  (33.0) | 23.8d  (29.2) | 5280bc |
| **T6** | Tebuconazole 25.9% EC @ 1.5 ml/l | 27.8c  (31.8) | 22.3cd  (28.2) | 5776c |
| **T7** | Thifluzamide 24% SC @ 0.8 g/l | 17.0a  (24.3) | 24.5d  (29.6) | 5161b |
| **T8** | Control (Water spray) | 34.6f  (36.0) | 31.6e  (34.2) | 4233a |
| SEm± | | 0.35 | 0.99 | 152.8 |
| CD (p = 0.05) | | 1.0 | 2.9 | 1449.3 |
| CV (%) | | 2.2 | 8.7 | 5.7 |

Figures in parenthesis are angular transformed values. \*Dunccan Multiple Range Test (DMRT).

NB: Neck Blast; ShB: Sheath Blight

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**Figure 4. Graph showing the efficacy evaluation of fungicides against sheath blight and neck blast severity during *Kharif (Vanakalam)*, 2020 to 2022.**

**3.5 Cost Economics**

The cost economic analysis of fungicides for managing location-specific rice diseases during *Vanakalam* (2020 – 2022) presented as incremental benefit-cost ratios (B:C ratio) (Table 6). Among the treatments, the highest ICAR was achieved with Propineb 70% WP @ 3 g/l (1:4.2) followed by Thifluzamide 24% SC @ 0.8 g/l (1:3.6). Although, the fungicide treatment *i.e.* Propineb 70% WP @ 3 g/l has recorded the highest ICBR due to low cost of fungicide but found to be ineffective against sheath blight and neck blast.

The efficacy of fungicides in managing neck blast (NB) and sheath blight (ShB) during *Kharif* seasons (2020–2022) can be attributed to their mode of action, timing of application, and pathogen-specific targeting site of the fungicides. Isoprothiolane 40% EC effectively controlled the NB (pooled PDI of 15.8%) due to its systemic action and ability to inhibit fungal biosynthesis, while Thifluzamide 24% SC demonstrated superior control of ShB (pooled ShB severity of 17%) by targeting fungal respiration and providing residual protection. In contrast, Tebuconazole 25.9% SC consistently enhanced yields (5776 kg/ha) through broad-spectrum activity against multiple pathogens and improved plant health. Timely application during the panicle initiation (PI) to booting stage, followed by a second spray, minimized pathogen colonization and ensured prolonged protection. The use of systemic fungicides, with their protective and curative properties, effectively suppressed disease while promoting grain formation. Additionally, reduced disease severity contributed to higher photosynthetic efficiency and healthier crop development, leading to increased yield. The cost-benefit analysis identified Thifluzamide (ICBR of 1:3.6) as an economically viable option for controlling sheath blight in rice, particularly in situations where no other management practices are available aside from timely fungicide application. Overall, the integration of fungicides with varying modes of action, applied at critical growth stages, proved effective in controlling neck blast and sheath blight, enhancing rice productivity and ensuring economic sustainability.

Thifluzamide 24% SC has been proven effective both as a preventive and curative agent in reducing disease severity and increasing yield, as shown by Kumar *et al.* (2012). Systemic fungicides, in general, offer superior disease management compared to non-systemic fungicides. Timely application of selective fungicides, especially between panicle differentiation and heading stages, is crucial for effective disease control. Regular monitoring of rice fields and fungicide application at the early stages of infection, particularly at the booting stage, is recommended for managing sheath blight in susceptible rice varieties. However, prolonged use of a single fungicide with the same mode of action may lead to resistance development in pathogens (Uppala *et al*., 2018). To counteract this, a combination of fungicides with different modes of action, such as Azoxystrobin 18.2% + Difenoconazole 11.4% (Bhuvaneswari *et al*., 2012), Propiconazole + Difenoconazole (Kandhari, 2007), and Trifloxystrobin 25% + Tebuconazole 50% (Sanjay *et al*., 2012), is recommended for managing sheath blight disease in rice.

**Table 6. Cost economics on evaluation of fungicides against location specific diseases of rice during *Kharif,* 2020 to 2022 under field conditions**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Trt No.** | **Treatments** | **Mean Grain yield (q/ha)** | **Additional yield over control (q/ha)** | **Additional cost of cultivation (Rs/ha)** | **Additional returns over control (Rs/ha)** | **Incremental net B:C ratio** |
| **T1** | Difenconazole 25% EC @ 0.5 ml/l | 56.56 | 14.23 | 4729 | 29029 | 5.1 |
| **T2** | Isoprothiolane 40%EC @ 1.5 ml/l | 54.46 | 12.13 | 2686 | 24745 | 8.2 |
| **T3** | Kasugamycin 3%SL @ 2 ml/l | 54.71 | 12.38 | 2655 | 25255 | 8.5 |
| **T4** | Kitazin 48% EC @ 1 ml/l | 57.10 | 14.77 | 2700 | 30131 | 10.2 |
| **T5** | Propineb 70% WP @ 3 g/l | 52.80 | 10.47 | 4100 | 21359 | 4.2 |
| **T6** | Tebuconazole 25.9% EC @ 1.5 ml/l | 57.76 | 15.43 | 4910 | 31477 | 5.4 |
| **T7** | Thifluzamide 24% SC @ 0.8 g/l | 51.61 | 9.28 | 4100 | 18931 | 3.6 |
| **T8** | Control (Water spray) | 42.33 | 0.00 | 0 | 0 | - |

*ICBR: Incremental Cost Benefit Ratio. Market price of Paddy: Rs. 2040/quintal.*

**4. CONCLUSION**

Among the fungicides tested, thifluzamide 24%SC @ 0.8 g/l was found to be the best fungicide against sheath blight, whereas isoprothiolane 40%EC @ 1.5 ml/l was found to be most effective against neck blast during *Kharif*, 2020 to 2022 at IRR, Rajendranagar under field conditions. In this context, Thifluzamide belongs to thiazole carboxamide fungicide group acting against succinate dehydrogenase complex II affecting fungal respiration has been identified as an alternative and cost-effective fungicide against sheath blight of rice.

**Disclaimer (Artificial intelligence)**

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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