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Evaluation of Chemical Fungicides Against Sheath Blight Disease of Rice in India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Sheath blight of rice, caused by Rhizoctonia solani Kuhn, is emerging as a very destructive disease that causes significant yield losses. The present study was conducted at experimental field of College of Agriculture, Rewa, (M.P.) during 2018-2019. The experiment was laid out in Randomized Block Design (RBD) with three replications. Seven fungicide namely Flusilazole12.5%+carbendazim 25% SC, Azoxystrobin 18.2% w/w+difenoconazole 11.4 w/w SC, Azoxystrobin 11%+Tebuconazole 18.3% w/w SC, Tricyclazole 18%+ mancozeb 62%WP, Zineb 68% + hexaconazole 4% WP, Trifloxystrobin 25%+Tebuconazole 50%WG, Mancozeb 50%+carbendazim 25%WS, were tested for their efficacy to manage the sheath blight of rice. All

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the fungicide were found to reduce the sheath blight disease significantly. It can be concluded that among the tested fungicides, Azoxystrobin 11%+Tebuconazole 18.3% w/w SC was found highly effective for controlling sheath blight of rice.

Keywords: Oryza sativa; Rhizoctonia solani; fungicides; RLH; PDI.

1. INTRODUCTION

"Rice *(Oryza sativa L.)* is a graminaceous crop and considers as one of the most important staple food crop grown *kharif* in India and contributes 40% of total food grain production. Productivity of rice can be increased by adopting the hybrid verities, nutrient management and biotic stresses. In India, area 46.38 Mha with production 130.29 Mt and productivity 2809 kg/ha" [1]. "Sheath blight of rice caused by *Rhizoctonia solani* (teleomorph: *Thanatephorus cucumeris*), is emerging as a very destructive disease causing heavy yield losses" [2]. "It is soil- borne fungal disease. The natural infection of the sheath blight disease occurs at the seedling, tillering and booting stages of rice. Infection usually starts near the water line of rice plants in paddy fields. Lesions develop upward to the upper leaf sheaths and leaf blades. The centre of lesion become grayish white with brown margin, later several spots coalesce and show blight symptoms" [3]. When humidity exceeds 95 % and temperature ranges from 29 to 32^0c, infection spreads rapidly which appear on plant parts, including leaf blades, causing irregularly shaped lesions with brown borders as bands. This symptom generally referred as "banded blight". *Rhizoctonia solani* possess pale dark brown rapidly growing mycelium with septum in the branch near the point of origin. Fungicide application is the most prevalent strategy used by farmers worldwide to manage sheath blight. The use of fungicides to control illnesses has a number of negative consequences, including pathogen resistance development, residual toxicity, environmental pollution, and so on. The resistant or tolerant sources to sheath blight are not available and biological controls are still not successful at field level. However, novel fungicidal compounds or treatments must be screened to successfully manage the disease in order to avoid pathogen resistance and decrease fungicidal residues for environmental sustainability. The present study was undertaken to evaluate the different fungicides for control of sheath blight of rice.

2. MATERIALS AND METHODS

To test the evaluation of new fungicide the twenty one day old seedlings of the PS-4 variety were transplanted in a net plot size of 3 m x 2 m with a spacing of 1m between replication to replication. Row to row and plant to plant spacing was 25 cm and 15 cm. The field experiment was carried out at the experimental area of All India Coordinated Rice Improvement Project, JNKVV, College of Agriculture, Rewa (M.P.) during *Kharif* 2018-2019. The experiment was laid out in Randomized Block Design (RBD) with three replications. Fertilizer was applied @ N 80 P 60 K 40 Kg/ha. Fifty percent of N and total P were given as basal dose and remaining N applied in two split doses as top dressing at tillering and panicle initiation stage. There were 8 treatments *viz*, Flusilazole 12.5% + carbendazim 25% SC (Luster), Azoxystrobin 18.2% w/w + difenoconazole 11.4 w/w SC (Amister), Azoxystrobin 11%+Tebuconazole 18.3% w/w SC (Custodia), Tricyclazole 18% + mancozeb 62% WP (Merger), Zineb 68% + hexaconazole 4% WP (Avatar), Trifloxystrobin 25%+ Tebuconazole 50%WG (Nativo), Mancozeb 50%+carbendazim 25%WS (Sprint) and Control (Untreated). "In the field conditions, sclerotia from 7-9 days old culture and rice stem bits (*Rhizoctonia solani* mycelium profusely grown) were used for inoculation of the rice plants at the maximum tillering stage. The primary tillers of each hill were tagged and inoculated gently by punching and pushing single sclerotia or rice stem bit into the sheath just 1 ½ to 2 ½ cm above the water surface level as per the position of the sheath. After 6 days of inoculation, the first spray of each treatments was done, on 10^{th} day after first spray second spray was repeated. Disease severity was recorded at 21 days of inoculation of the disease crop in 0-9 scales by following the procedure of Standard Evaluation System of International Rice Testing Programme" [4].

Observations on vertical disease spread in terms of relative lesion height (RLH %) and percent disease index (PDI %) were recorded at dough stage. Yield attributing parameters namely plant height (cm), Number of tillers per plant, No. of panicle per plant, panicle length (cm) were

recorded at dough stage and Number of grain per plant, 1000 grain weight (g) and grain yield (kg plot^{-1}) was recorded at maturity and converted into kg /ha.

The percent disease index (PDI) was calculated by adopting the formula:

$$PDI = \frac{Sum\ of\ numerical\ rating}{Total\ numbers\ of\ plants\ observed\ X\ maximum\ disease\ scale} X\ 100$$

The percent disease index (%) value will be transformed by adopting the angular transformation table [5].

$$\%\ increase\ in\ yield = \frac{Yield\ of\ treatd\ plot - Yield\ in\ control}{Yield\ in\ control} X\ 100$$

3. RESULTS

Data on PDI % and percent decrease over control in PDI are presented in Table 1. Percent disease index varied from 11.16 to 34.85% was significant in different treatments. Minimum PDI was recorded in the treatment T3 (Azoxystrobin 11% + tebuconazole 18.3% w/w SC) (Custodia) was found highly effective in reducing the disease severity of sheath blight 11.16% and 67.9% decrease of the disease over control treatment was at par with T2 (Azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC (Amistar Top 325 SC) 11.90% reducing the disease severity and 65.8% decrease disease over control, T6 (Trifloxystrobin 25% + tebuconazole 50% WG) (Nativo 75WG), 13.38 % reducing the disease severity and 61.6 % decrease the disease over contro,T5 (Zineb 68% + hexaconazole 4% WP (Avatar) 14.12% reducing the disease severity and 59.4% decrease the disease over control treatment followed by T4 (Tricyclazole 18% + mancozeb 62% WP (Merger) 14.89% reducing the disease severity and 57.2% decrease the disease over control, T1 (Flusilazole12.5%+carbendazim 25% SC) (Luster) 15.60 % reducing disease severity and 55.2% decrease the disease over control, T7 Mancozeb 50%+carbendazim 25%WS (Sprint)16.34 % reducing the disease severity and recorded 53.1% decrease disease over control (34.85%).

Data on RLH (%) and percent decrease over control in RLH are presented in Table 1. Relative lesion height varied from 12.3 to 43% was significant in different treatments. Minimum RLH(12.3%) was recorded in the treatment T3 (Azoxystrobin 11% + tebuconazole 18.3% w/w SC) (Custodia) and closely followed by T_2 (Azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC (Amistar Top 325 SC) and T_6 (Trifloxystrobin 25% + tebuconazole 50% WG) (Nativo 75WG). These treatments were statistically at par. Rest of the treatments were also exhibited significantly effective. Percent decrease over control in RLH ranged 30.3 to 71.4% in different treatments being maximum in (T_3) followed by (T_2) and (T_6).

Data of plant height (cm) are presented in table-2. Plant height ranging from 109.8 to 116.7 cm was recorded. Significant difference in was plant height was observed in different treatments. Maximum Plant height (116.7) was recorded in T3 (Azoxystrobin 11% + tebuconazole 18.3% w/w SC) (Custodia) and closely followed by T_2 (Azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC (Amistar Top 325 SC)113.0cm and T_6 (Trifloxystrobin 25% + tebuconazole 50% WG) (Nativo 75WG) (112.8cm).

Data of tiller per plant are presented in Table 2. Tiller per plant ranging from 10.0 to 13.0 was recorded. Non-Significant difference was observed in different treatments. Maximum tiller per plant (13.0) was recorded in T3 (Azoxystrobin 11% + tebuconazole 18.3% w/w SC) (Custodia) and closely followed by T_2 (Azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC (Amistar Top 325 SC) (11..5) and T_6 (Trifloxystrobin 25% + tebuconazole 50% WG) (Nativo 75WG) (11.4)

Data of panicle per plant are presented in Table 2. Panicle per plant ranging from 9.4 to 12.9 was recorded. Significant difference panicle per plant was observed in different treatments. Maximum Panicle per plant (12.9) was recorded in T3 (Azoxystrobin 11% + tebuconazole 18.3% w/w SC) (Custodia) and closely followed by T_2 (Azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC (Amistar Top 325 SC) (11.2) and T_6 (Trifloxystrobin 25% + tebuconazole 50% WG) (Nativo 75WG) (10.8).

Data of panicle length (cm) are presented in table-2. Panicle length ranging from 22.4 to 26.7 cm was recorded. Significant difference in Panicle length was observed in different treatments. Maximum Panicle length (26.7cm) was recorded in T3 (Azoxystrobin 11% + tebuconazole 18.3% w/w SC) (Custodia) and closely followed by T_2 (Azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC (Amistar Top 325 SC) (25cm) and T_6 (Trifloxystrobin 25% + tebuconazole 50% WG) (Nativo 75WG) (24.7cm).

Table 1. Effect of fungicides on percent disease index of sheath blight of rice

Treatments	Conc.	PDI (%)	% Decrease Over Control	RLH (%)	%Decreas Over Control
Flusilazole 12.5% + carbendazim 25% SC	1 ml/l	15.60 (23.23)	55.2	25.2 (30.10)	41.3
Azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC	1 ml/l	11.90(20.14)	65.8	15.1 (22.81)	64.9
Azoxystrobin 11% + tebuconazole 18.3% w/w SC	1.5 ml/l	11.16 (19.42)	67.9	12.3 (20.50)	71.4
Tricyclazole 18% + mancozeb 62% WP	2.5 g/l	14.89 (22.66)	57.2	23.8 (29.19)	44.5
Zineb 68% + hexaconazole 4% WP	2.5g/l	14.12 (22.03)	59.4	20.8 (27.12)	51.6
Trifloxystrobin 25% + tebuconazole 50% WG	0.4 g/l	13.38 (21.44)	61.6	16.9 (24.16)	60.7
Mencozeb 50% + carbendazim 25% WS	2.5g/l	16.34 (23.82)	53.1	30.0 (33.14)	30.3
Control		34.85 (36.16)		43.0 (40.94)	0.0
CD (5%)		1.652		4.121	

Table 2. Effect of fungicides on yield components of rice

Fungicide	Conc.	Plant height (cm)	tiller per plant	Panicles per plant	Panicle length (cm)	Grains per plant	1000 grain weight (gm)
Flusilazole 12.5% + carbendazim 25% SC	1 ml/l	111.1	10.3	9.7	24.2	340.0	23.00
Azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC	1 ml/l	113.0	11.5	11.2	25.0	366.0	24.55
Azoxystrobin 11% + tebuconazole 18.3% w/w SC	1.5 ml/l	116.7	13.0	12.9	26.7	371.7	24.88
Tricyclazole 18% + mancozeb 62% WP	2.5 g/l	111.4	10.5	10.3	24.5	348.0	23.50
Zineb 68% + hexaconazole 4% WP	2.5g/l	112.3	10.9	10.5	24.7	360.7	23.75
Trifloxystrobin 25% + tebuconazole 50% WG	0.4 g/l	112.8	11.4	10.8	24.7	365.0	24.25
Mencozeb 50% + carbendazim 25% WS	2.5g/l	110.2	10.1	9.7	22.7	333.7	22.66
Control	-	109.8	10.0	9.4	22.4	253.0	20.80
Mean		112.2	11.0	10.9	24.7	342.3	16.7
CD (5%)		2.16	2.05	1.80	1.91	9.73	1.08

Table 3. Effect of fungicides on grain yield of rice

Treatments	Conc.	Grain yield (kg/ha)	% Increase Over Control
Flusilazole 12.5% + carbendazim 25% SC	1 ml/l	3293.3	14.7
Azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC	1 ml/l	3680.0	28.1
Azoxystrobin 11% + tebuconazole 18.3% w/w SC	1.5 ml/l	3761.0	31.0
Tricyclazole 18% + mancozeb 62% WP	2.5 g/l	3431.7	19.5
Zineb 68% + hexaconazole 4% WP	2.5g/l	3446.7	20.0
Trifloxystrobin 25% + tebuconazole 50% WG	0.4 g/l	3635.0	26.6
Mencozeb 50% + carbendazim 25% WS	2.5g/l	3203.3	11.5
Control		2872.0	0.0
Mean		3415.4	
CD (5%)		311.01	

Data of grains per plant are presented in Table 2. Grains per plant ranging from 253.0 to 371.7 were recorded. Significant difference Grains per plant was observed in different treatments. Maximum Grains per plant (371.7) was recorded in T3 (Azoxystrobin 11% + tebuconazole 18.3% w/w SC) (Custodia) and closely followed by T_2 (Azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC (Amistar Top 325 SC) (336) and T_6 (Trifloxystrobin 25% + tebuconazole 50% WG) (Nativo 75WG) (365).

Data of 1000 grain weight (gm) are presented in table-2. 1000 grain weight ranging from 20.80 to 24.88 gm was recorded. Significant difference in was 1000 grain weight (gm) observed in different treatments. Maximum 1000 grain weight (24.88gm) was recorded in T3 (Azoxystrobin 11% + tebuconazole 18.3% w/w SC) (Custodia) and closely followed by T_2 (Azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC (Amistar Top 325 SC) (24.55gm) and T_6 (Trifloxystrobin 25% + tebuconazole 50% WG) (Nativo 75WG) (24.25gm).

Data of grain yield in different treatments of fungicide control are presented in table-3. Grain yield ranging from 2872.0 to 3761.0 kg/ha was recorded. Significant difference in grain yield was observed in different treatments. Maximum grain yield (3761kg/ha) was recorded in T_3 (Azoxystrobin 11% + tebuconazole 18.3% w/w SC) (Custodia) and which was 31.0% higher than the control. The next effective treatment was T_2 (Azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC (Amistar Top 325 SC) (3680kg/ha) followed by T_6 (Trifloxystrobin 25% + tebuconazole 50% WG) (Nativo 75WG) (3635.0kg/ha) over untreated check.

4. DISCUSSION

In the present study, among the tested fungicides were found to reduce the sheath blight disease significantly. Percent disease index ranging from 11.16 to 34.85% with 53.1 to 67.9% reduction in PDI were recorded in different treatments. Azoxystrobin 11% + tebuconazole 18.3% w/w SC) (Custodia) was found the best to reduce the PDI 67.9% followed by T_2 (Azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC (Amistar Top 325 SC) and T_6 (Trifloxystrobin 25% + tebuconazole 50% WG) (Nativo 75WG) were equally effective to reduce the PDI 65.8 and 61.6%, respectively. RLH ranging from 12.30 to 43.0% with 30.3 to 71.4% reduction in RLH were recorded in different treatments. Azoxystrobin 11% + tebuconazole 18.3% w/w SC) (Custodia) was found best to reduce the RLH 71.4% followed by T_2 (Azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC (Amistar Top 325 SC) and T_6 (Trifloxystrobin 25% + tebuconazole 50% WG) (Nativo 75WG) were equally effective to reduce the RLH 64.9 and 60.7%, respectively. Significant increase in plant height ranging from 110.2 to 116.7 cm, panicle per plant ranging from 9.4 to 12.9, panicle length ranging from 22.4 to 26.7 cm, grains per plant ranging from 253.0 to 371.0 and 1000 grain weight (gm) ranging from 20.80 to 24.88 gm were also recorded. Tillers per plant ranged from 10.0 to 13.0 in different treatments, but statistically non-significant. Grain yield (kg/ha) ranging from 2872.0 kg/ha to 3780.0 kg/ha was recorded in the different treatments. An increase in grain yield ranging from 11.5 to 31.4.0% was recorded with maximum in Azoxystrobin 11% + tebuconazole 18.3% w/w SC) (Custodia) followed by T_2 (Azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC (Amistar Top 325 SC) and T_6 (Trifloxystrobin 25% + tebuconazole 50% WG) (Nativo 75WG) respectively. The similar findings were also reported by Akter et al. [6], Bag [7], Pramesh et al. [8], Neha et al. [9], Laxmikant et al. [10], Pramesh et al. [11], Swamy et al. [12], Bhuvaneswari and Raju [13], Kumar et al. [14] and Hegde [15] confirmed the present findings.

5. CONCLUSION

It can be concluded that among the tested fungicides, Azoxystrobin 11%+Tebuconazole 18.3% w/w SC (Custodia) was found highly effective for controlling sheath blight of rice.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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