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Cross Infectivity and Virulence of *Rhizoctonia Solani* in Rice and Maize and Its Management – First Report

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ABSTRACT

Sheath Blight of rice and Banded leaf and sheath blight of maize caused by Rhizoctonia solani (teleomorph: Thanatephorus cucumeris), is a complex pathogen and worldwide in distribution, a very destructive disease under favorable weather conditions causes substantial yield losses. Virulence and cross infectivity of the pathogen was studied in rice and maize crops under glasshouse condition at GBPUAT, Pantnagar, Uttarakhand, India and it was found that Rhizoctonia solani isolate of maize was more aggressive and virulent than the Rhizoctonia solani isolates of rice. For the management of the pathogen in rice field different fungicides, botanicals and biocontrol agents were evaluated in which ICF-110 a new formulated combo product was found superior over all.

Key words: *Crossinfectivity, Maize, Management, Rice, Rizoctonia solani, Virulence*

INTRODUCTION

Rice (*Oryza sativa L.)* and Maize *(Zea mays)* is a graminaceous crop. They are one of the important staple foods for Asian and Europian countries. Sheath blight disease in rice and Banded leaf and sheath blight in maize are important fungal diseases which is caused by *Rhizoctonia solani*. The disease is alarming due to its intensive cultivation of modern high yielding varieties with high doses of nitrogenous fertilizers. Yield losses due to this disease are estimated to be about 69 per cent[13,10]. in rice and 23.9 to 31.9 per cent in maize[7], depending on cultivars, environmental conditions, crop stages at which the disease appears and cultivation practices. Grain yield can be increased if there is an increase in traits showing positive and significant association with grain yield hence genetic characters can be given priority while selection for higher yield as these was mutually and directly associated with yield[8]. Currently, this pathogen is distributed in almost all the rice and maize growing areas. *R. solani* has potential to show variation in their characters. Cultural and morphological analysis of West Bengal isolates of rice has indicated that the diversity among the isolates does not correlated with their origin[6].

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After analyzing the morphological and cultural characters of the isolates, it was found that there was no relations between the isolates with respect to their origin from where they were collected. There is a significance importance of mycelial and sclerotial characteristics in studying the variations among different *R. solani* isolates[17,9,11,15]. Different isolates may produces different types of symptoms on different hosts. Isolate of Web blight fungus of mung bean (*R.solani*) are also virulent on rice but causes different type of symptom on it than do the isolates of *Rhizoctonia solani*, the causal agent of Rice sheath blight[16]. Efforts were made to study the virulence and cross infectivity among rice and maize isolates of *Rhizoctonia solani* and to develop suitable management strategy. Keeping this information in mind, the present investigation was carried out to find out aggressiveness and virulency of *R. solani* isolates of rice and maize.

MATERIAL AND METHODS

A. Cross infectivity and virulency test

Infected leaves of rice and maize exhibiting typical symptoms of sheath blight of rice and banded leaf and sheath blight of maize were collected in a paper bag from pathology block of N.E. Borlaug Crop Research Centre, GBPUA & T, Pantnagar, Uttarakhand, India. The leaves samples were brought to the laboratory for its microscopic examination and isolation. The pathogen was isolated on potato dextrose agar (PDA) and purified through hyphal tip / single sclerotial method[13]. Pure culture maintained and stored in refrigerator at 5º C for further studies. Cross infectivity and virulency test was observed under glasshouse conditions. Sixty days after sowing, rice plants were artificially inoculated with *R. solani* of rice and maize and similar treatment was repeated with maize plants. Symptoms appeared after 3 days of pathogen inoculation and observations were recorded 10 days after appearance of symptoms.

B. In vivo evaluation of fungicides, Botanicals and Biocontrol agents against the *Rhizoctonia solani*

The field trials were conducted during *Kharif* season 2015-16 in a Randomized Block Design (RBD) with three replications and plot size of 5.0m X 2.0 m (spacing 15cm X 20 cm) on rice variety Pant Dhan - 4 at N. B. Crop Research Centre, GBPUA&T, Pantnagar to study the efficacy of different fungicides, botanicals and bioagents against sheath blight of rice. For this evaluation seven fungicides viz; ICF-110 (tricyclazole 45% + hexaconazole 10% WG), Merger (tricyclazole 18% + mancozeb 62% WP), Beam (tricyclazole 75% WP), Contaf (hexaconazole 5% EC), Indofil (mancozeb 75% WP), Companion (mancozeb 63% WP + carbendazim 12% WP) and Bavistin (carbendazim 50% WP) four botanicals Neem, Turmeric, Tulsi and Bhang as well as three biocontrol agents PBAT-01, PBAT-02 and PBAT-03 were used for the control of the pathogen at different stages of the plant and were sprayed thrice 60 DAT at 10 days interval with recommended formulation/l. Grain yield was observed and recorded on plot basis and expressed as q/ha.

Percent disease index:

1. Disease severity of sheath blight was recorded after each spray by Relative Lesion Height (RLH) method (**IRRI, 2002)** by using the following formula:

$$\text{RLH} = \frac{\text{Lesion Height}}{\text{Plant Hieght}} \times 100$$

Five sampling units of 1 m^2 area were marked in each plot at random. The disease severity was recorded on fifteen plants per sampling unit.

2. Per cent disease control over check was calculated by using the following formula:

$$\text{Per cent disease control over check} = \frac{\text{(\%) disease severity in check} - \text{(\%) disease severity in treatment}}{\text{(\%) disease severity in check}} \times 100$$

3. Per cent yield increase over check was calculated by using the following formula:

$$\text{Per cent yield over check} = \frac{\text{Yield (q/ha) in treatment} - \text{Yield (q/ha) in check}}{\text{Yield (q/ha) in treatment}} \times 100$$

RESULT AND DISCUSSION

Mycelial growth and sclerotia formation of *Rhizoctonia solani*

Rhizoctonia solani is a fast growing fungi which produces, whitish fluffy growth and later turns brown on PDA medium. It was found that in rice isolates, the growth pattern of colony was sparse and sclerotia were formed in PDA media at the centre of the plates which were brown in colour. Whereas in case of maize isolates of *Rhizoctonia solani*, colony colour was creamy white in PDA media with cottony fluffy growth, Sclerotial formation was scattered, bigger in size and white in colour at its initial stage and more in numbers as comparison to rice isolates after 5 days of incubation at 28±1^{0}C. (photo a). The discolorations of the growth media is mainly attributed to the production of pigments by the pathogen.

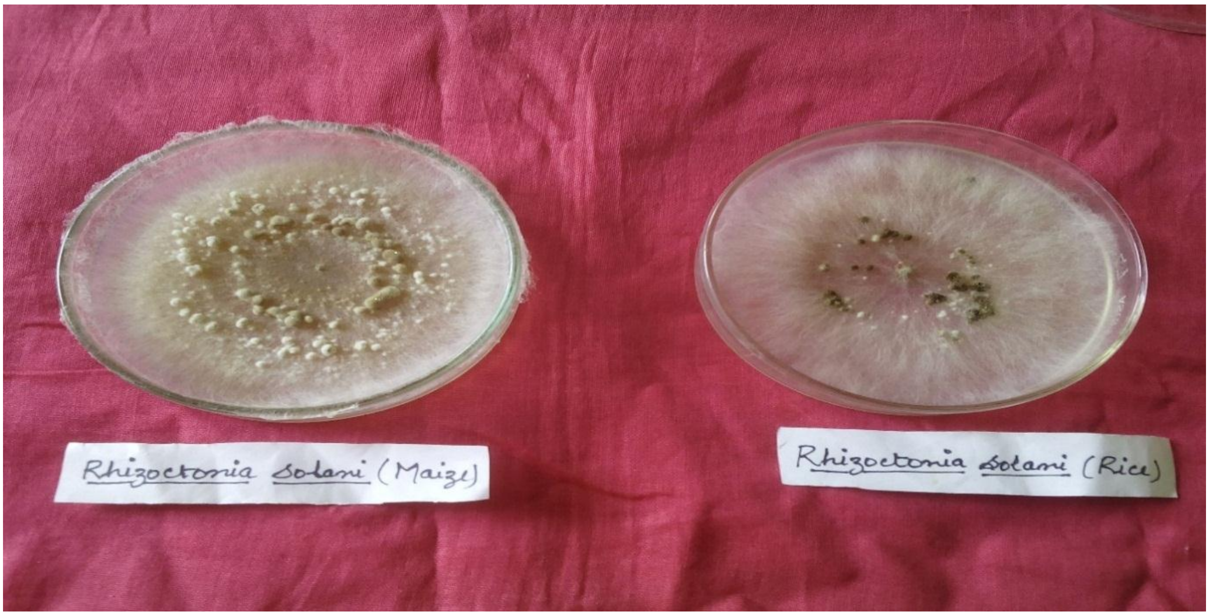

Photo a- Mycelial growth and sclerotia formation of *Rhizoctonia solani* isolates of Maize and Rice.

Disease assessment, Cross infectivity and virulency test

In the glasshouse experiment it was found that the *R. solani* of maize was more aggressive and virulent when compared with *R. solani* of rice. Disease severity was recorded and it was found that maximum disease severity (30.56%) occurred when rice plants inoculated with maize isolates of *R. solani*, while it was 9.51 per cent when inoculated with rice isolates of *R. solani*. Whereas in maize plants treated with maize isolates of *R. solani* disease severity was 11.66 per cent, whereas 8.33 per cent when inoculated by rice isolates of *R. solani*. Shahjahan *et al.*[14], reported that growth rate and the virulence of the fungus were related to each other. So the present investigation resembles with the growth rate and virulency.

Table 1: Effect of cross infectivity of *Rhizoctonia solani* isolates on rice and maize.

S.No	Crop	*Pathogen isolates	**Disease severity
1.	Rice	RsR	9.51 (17.95)
2.	Rice	RsM	30.56 (33.55)
3.	Maize	RsM	12.33 (20.49)
4.	Maize	RsR	9.16 (17.61)
SEm ± 0.74 CD at 5% = 2.19 CV = 11.81			

*RsR = *Rhizoctonia solani* (rice), RsM= *Rhizoctonia solani* (maize)

**Values in the parenthesis are after angular transformation

Management

***In vivo* evaluation of different fungicides**

Field trial conducted during *kharif* season 2015-16 and it was found that all the test fungicides botanicals and Bio-agents reduced disease severity and increased grain yield of cultivar Pant Dhan-4 significantly (Table 2.0 and Table 3.0) and among all ICF-110 (tricyclazole 45 % + hexaconazole 10% WG) was proved to be best followed by hexaconazole 5% EC in reducing disease and increasing yield. Among seven fungicides, ICF-110 (tricyclazole 45% + hexaconazole 10% WG) showed minimum disease severity (39.30%) with 49.71 per cent disease control over check followed by hexaconazole 5% EC (43.82 %) with 43.92 per cent disease control over check as compared to control with disease severity (78.15 %) along with maximum yield (69.83q/ha) and (69.54q/ha) respectively while in case of botanicals and biocontrol agents minimum disease severity (67.17 %) was recorded in PBAT-03 and in neem (71.88 %), present study corroborating the earlier reports. Akter *et al*.[1], who tested different fungicides namely Bavistin 50 WP (carbendazim), Contaf 5EC (hexaconazole), Forastin 50 WP (carbendazim), Anvil 5 SC (hexaconazole) and Tilt 25 EC (propiconazole) against sheath blight. They found Contaf 5EC (hexaconazole), to be the best in reducing the percent relative lesion length, percent disease index (PDI) and tiller infection, whereas Karthikeyan[5] observed that combination of triazophos with tricylazole reduced the incidence of sheath blight with 80.04 per cent over control followed by triazophos + hexaconazole and tricylazole with 75.38 and 73.07 per cent respectively. While according to Biswas[2], Neem formulation 0.03 % EC (300ppm azadirachtin) were found superior. It performed best in reducing the disease severity and improves yield, however no botanical was significantly superior over the control fungicides[3].

Table 2: Effect of fungicides on yield and disease parameter in sheath blight of rice during *kharif* season 2015-16

S.No.	Treatments	Disease incidence	Disease severity	Percent (%) disease control over check	Yield (q/ha)	Percent (%) Yield increase over check
1	ICF-110	75.91 (58.64)	39.30 (38.82)	49.71	69.83	32.45
2	Merger	88.16 (69.93)	57.33 (49.21)	26.64	64.62	22.57
3	Beam	91.34 (72.91)	56.12 (48.51)	28.18	63.63	20.69
4	Contaf	71.45 (57.70)	43.82 (41.46)	43.92	69.54	31.90
5	Indofil M -45	97.41 (80.80)	60.99 (51.35)	21.95	59.14	12.17
6	Companion	95.96 (78.49)	62.85 (52.45)	19.57	59.10	12.10
7	Bavistin	96.78 (78.86)	62.17 (52.04)	20.44	60.00	13.80
8.	Check	99.41 (85.80)	78.15 (64.14)	-	52.72	-
SEm± CD at 5% CV		1.02 3.10 2.43	0.81 2.64 2.84		0.69 2.11 1.93	

Table 3. Effect of botanicals and bioagents on yield and disease parameter in sheath blight of rice during *kharif* season 2015-16

S.No.	Treatments	Disease incidence	Disease severity	Percent (%) disease control over check	Yield (q/ha)	Percent (%) Yield increase over check
1	Neem	76.14 (60.76)	71.88 (57.99)	17.46	51	13.87
2	Turmeric	80.43 (63.74)	76.26 (60.84)	14.27	48.99	9.12
3	Tulsi	77.06 (61.38)	73.06 (58.73)	15.96	49.68	10.39
4	Bhang	84.24 (66.38)	78.04 (62.06)	11.71	46.67	4.61
5	PBAT-01	73.36 (58.93)	68.54 (55.88)	21.11	53.84	17.31
6	PBAT-02	75.14 (60.03)	69.98 (56.77)	19.52	52.44	15.10
7	PBAT-03	72.23 (58.20)	67.17 (55.04)	23.55	55.32	19.52
8.	Check	99.18 (85.89)	89.52 (71.18)	-	44.52	-
SEm CD at 5 % CV		0.84 2.57 2.27	1.94 0.64 1.85		1.40 4.25 4.82	

**Values in the parenthesis are after angular transformation

CONCLUSION

In the present investigation it was observed that the *R.solani* of maize was more aggressive and virulent than the *R.solani* of rice. Rice - Maize cropping pattern is followed in most of the part of the world therefore, present study is useful to develop suitable management strategy, so that infestation of the disease can be reduce that ultimately increase the yield to fulfill the word food grain basket and nutritional requirement of the people of the world as well a new formulation of fungicide i.e ICF-110 (tricyclazole 45% + hexaconazole 10% WG) is more effective when used in combination rather than used as individual.

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