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Phenotyping of rice landraces for sheath blight resistance

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Abstract
Rice is one of the most important food crops of the world. However, rice production worldwide is affected by various biotic and abiotic stresses. Of different diseases, sheath blight of rice (*Rhizoctonia solani*) has led to large scale yield losses from last two decades and till now no complete resistance has been identified in rice germplasms for sheath blight disease. Rice landraces are important reservoirs of valuable traits and need special attention. In present study 30 landraces of rice were screened phenotypically by artificial inoculation of colonized typha bits with *Rhizoctonia solani* following 0-9 SES scale given by IRRI for sheath blight. None of the varieties were shown complete resistance reaction, but only Bangara Sanna was shown moderately resistance reaction against sheath blight disease. Most of the landraces were shown susceptible (15) and highly susceptible (11) reactions, three were shown moderately susceptible reaction against sheath blight.

Keywords: rice, Sheath blight, Landraces, Bangara Sanna and SES scale

Introduction

The slogan 'Rice is life' is most appropriate for India as it is the means of livelihood for millions of rural households of India. India has the largest acreage under rice with an area of 44.1 million hectare and stands 2nd in production with 105.5 million tonnes, next to China and productivity is 2391 Kg/ha. Global rice demand is estimated to rise from 6.76×10^8 tonnes in 2010 to 8.52×10^8 tonnes in 2035 (Khush, 2013) [6]. To produce 1.76×10^8 tonnes additional rice, it is needed to increase the yield and also minimize the yield loss caused by various diseases and insect pests. Between 10 and 30 per cent of the annual rice harvest is lost due to infection by many diseases, among that rice sheath blight is one of the most serious threat to rice production fom last two decades (Skamnioti and Gurr, 2009) [10].

Sheath Blight caused by *Rhizoctonia solani* Kuhn., is one of the major serious threats to the world food security as rice is the staple food for majority of population. It is a major biotic constraint in most of the rice growing countries of Asia. The pathogen is polyphagous competitive saprophyte and has a wide host range. Crop with a high plant density and closed canopy associated with high N management favours disease build up from panicle initiation onwards. The yield loss due to sheath blight ranges between 20-50 per cent depending on the severity of infection (Rao, 1995) [8]. The estimation of losses due to sheath blight of rice in India has been reported to be up to 54.3 per cent (Chahal, 2003) [1]. It has been reported that in China 15 to 20 million hectares of rice field affected by sheath blight, it leads to yield losses of 6 million tonnes every year (Chen *et al.*, 2012) [2]. In 2012, sheath blight affected about 491,932 ha of rice in Japan (JPPA 2013) [5]. In the USA, crop losses due to rice sheath blight have been recorded up to 50 % in susceptible cultivars (Prasad and Eizenga 2008) [7]. A crop loss of up to 40 % has been recorded in Bangladesh (Shahjahan *et al.*, 1986) [9].

Sheath blight management typically has relied on the application of fungicides in combination with cultural practices. It is believed that utilization of host plant resistance is the most economical and environmentally sound strategy in managing sheath blight but it is not an easy task with respect to sheath blight because of lack of resistant donors. The Sheath blight pathogen has a broad host range and several researchers have screened thousands of germplasm and no absolute resistance to sheath blight disease in rice germplasm has been reported so far.

Landraces are believed to be rich source of resistance for various biotic and abiotic stresses along with economically important traits. So the present study was carried out to screen 30 landraces of rice for sheath blight resistance by artificial inoculation, following Standard evaluation system (SES) scale (IRRI, 1996) [4] for sheath blight.

Material and Methods

Plant Materials

A set of 30 landraces that are popular in Karnataka and other parts of south India and some improved varieties were obtained from germplasm collection of Division of Rice Breeding, AICRP (Rice), Zonal Agricultural Research Station and were screened phenotypically for sheath blight resistance at ZARS, V. C. Farm, Mandya. The details of the source of 30 rice landraces were presented in Table 1.

Table 1: List of landraces used in this study

S. No	Landraces Names	Sl. No.	Landraces Names
1	Naweli	16	Kannur
2	Ambe mohar	17	Dodda Alur
3	Navara	18	Neergula Batta
4	Bidagi Kannapa	19	Duddoge
5	Raichur Sanna	20	Kari doodi
6	Mugad Suganda	21	Toranda batta
7	Dappaneya Bili Jaddu	22	Adri Batta
8	Dodda Baikalu	23	Basumathi
9	Gulwadi Sannakki	24	Mullu Batta
10	Dodda Batta	25	Intansel
11	Balaji	26	Manju Pani
12	Annaporna	27	Bili Munduga
13	Jenugudu	28	Rat Bat
14	Muttina Sanna	29	Kagi Sale 1
15	Bigan Munji	30	Bangara Sanna

Twenty one days old seedlings of landraces were transplanted in two rows of two meter length with a spacing of 20 cm between rows and 15 cm between plants. After every 5 landraces a local susceptible variety, HR-12 was planted. The entire nursery was surrounded on all sides by two rows of susceptible variety, HR-12 to create high disease pressure.

Artificial plant inoculation

Preparation of fungal inoculums

Rhizoctonia solani pure culture was obtained from the department of Plant Pathology, AICRP on Rice, ZARS, V. C. Farm, Mandya and it was mass multiplied on autoclaved typha bits (7-10 cm long). Typha bits were inoculated with the 5 mm diameter disc of actively growing mycelium and incubated for 15 days at 28 ± 2°C. These colonized typha pieces were used as inoculum. Landraces were inoculated at the maximum tillering stage with colonized typha pieces. Two-three pieces of typha stem bits were placed between tillers in the central region of rice hills, just above the water level. To maintain appropriate environmental condition, humidity to promote disease development 5-10 cm Water level was maintained constantly.

Disease scoring for sheath blight (*Rhizoctonia solani*)

The scoring of landraces was carried out based on the vertical spread of lesion following standard evaluation system (SES) for rice sheath blight (Table 2). First observations were recorded after 15-20 days of inoculation of sheath blight pathogen, second observations were recorded at the flowering stage. Based on the sheath blight severity the test lines were categorized into different categories of resistance and susceptibility. The overall process involved from culture preparation to disease scoring was shown in Fig.1.

Table 2: 0-9 grade disease rating scale used for screening of sheath blight disease (SES, IRRI, 1996)

0-9 Scale	Disease severity	Host response or reaction
0	No infection	Resistant
1	Vertical spread of the lesions up to 20 % of plant height	Moderately Resistant
3	Vertical spread of the lesions up to 20-30 % of plant height	Moderately Resistant
5	Vertical spread of the lesions up to 31-45 % of plant height	Moderately Susceptible
7	Vertical spread of the lesions up to 46-65 % of plant height	Susceptible
9	Vertical spread of the lesions up to 65-100 % of plant height	Highly Susceptible

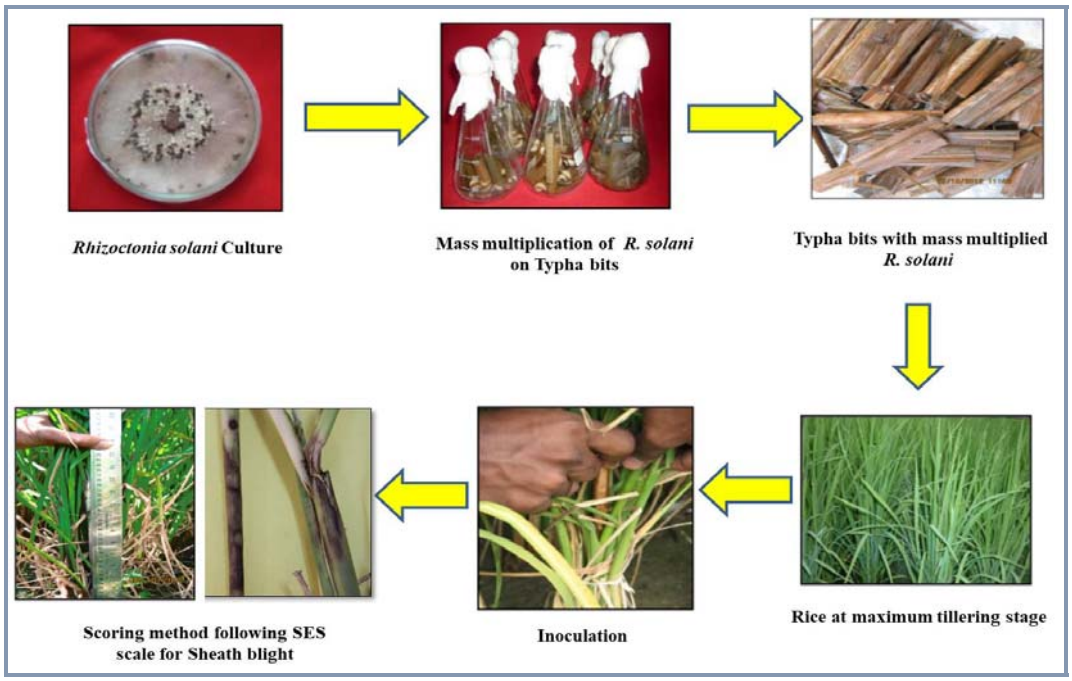

Fig 1: The step by step process involved from culture (*Rhizoctonia solani*) preparation to disease scoring following SES scale for sheath blight

Results and Discussion

About 30 landraces along with the susceptible check HR 12 were evaluated by artificial inoculation of *Rhizactonia solani* isolate following 0-9 SES scale.. Among all the 30 landraces evaluated for their reaction to sheath blight disease none of the genotypes recorded scores of 0 and 1. Hence, none of the landraces evaluated under the present investigation were found to be either highly resistant or resistant. However, the least score of 3 was recorded by just one entry Bangara Sanna and corresponded to moderate resistance. Three landraces like Dodda Alur, Kari doodi, Thoranda Batta were shown moderately susceptible reaction with phenotypic score of 5, Fifteen landraces *viz.*, Naweli, Ambe Mohar, Navara, Bidagi kannapa, Dappaneya Bili Jaddu, Gulwadi Sannakki, Balaji, Annaporna, Jenugudu, Muttina Sanna, Neergula Batta, Duddoge, Adri Batta, Mullu Batta, Intansel were shown susceptible reaction with phenotypic score of 7, eleven landraces *viz.*, Raichur Sanna, Dodda Batta, Mugad Suganda, Dodda Baikalu, Baigan Munji, Kannur, Basumathi, Manju Pani, Bili Munduga, Rat Bat, Kagi Sale 1 and susceptible check (HR 12) were shown highly susceptible reaction against sheath blight with phenotypic score of 9. Based on phenotyphic score (0-9) landraces were categorized into different groups from highly resistant to highly susceptible. The results of phenotypic screening were given in Table 3a and 3b.

Several researchers were screened thousands of rice varieties including improved varieties, landraces, wild types but they could not able to found the resistance source for sheath blight. Similar results were observed by Dubey *et al*. (2014) [3], who screened 100 genotypes including landraces and improved lines for sheath blight resistance and could not identify any rice genotype possessing high degree of resistance but four varieties *viz*., BPL7-12, BML27-1, BML21-1 and Kajarahwa shown high degree of tolerance against sheath blight. Yadav *et al.* (2015) [11] also screened 40 rice germplasms including eight wild, four landraces, twenty six cultivated and two advanced breeding lines utilizing the colonized bits of typha. He found that only Tetep and ARC10531 were shown moderately resistance reaction against sheath blight and none of the varieties shown high or complete resistance.

Table 3a: Phenotypic scoring of landraces for sheath blight at field condition

S. No	Landraces Names	Phenotypic score	Reaction status of host	S. No	Landraces Names	Phenotypic score	Reaction status of host
1	Naweli	7	S	16	Kannur	9	HS
2	Ambe mohar	7	S	17	Dodda Alur	5	MS
3	Navara	7	S	18	Neergula Batta	7	S
4	Bidagi Kannapa	7	S	19	Duddoge	7	S
5	Raichur Sanna	9	HS	20	Kari doodi	5	MS
6	Mugad Suganda	9	HS	21	Toranda batta	5	MS
7	Dappaneya Bili Jaddu	9	HS	22	Adri Batta	7	S
8	Dodda Baikalu	7	S	23	Basumathi	9	HS
9	Gulwadi Sannakki	9	HS	24	Mullu Batta	7	S
10	Dodda Batta	7	S	25	Intansel	7	S
11	Balaji	7	S	26	Manju Pani	9	HS
12	Annaporna	7	S	27	Bili Munduga	9	HS
13	Jenugudu	7	S	28	Rat Bat	9	HS
14	Muttina Sanna	7	S	29	Kagi Sale 1	9	HS
15	Bigan Munji	9	HS	30	Bangara Sanna	3	MR

Legends: MR-Moderately Resistant; MS-Moderately Susceptible; S-Susceptible; HS-Highly Susceptible

Table 3b: Response of landraces to sheath blight disease in field condition

0-9 scale	Reaction	Landraces Name	No. of landraces
0	Resistant	-	0
1-3	Moderately Resistant	IR 64 Bangara Sanna	1
5	Moderately Susceptible	Dodda Alur, Kari doodi, Thoranda Batta,	3
7	Susceptible	Naweli, Ambe Mohar, Navara, Bidagi kannapa, Dappaneya Bili Jaddu, Gulwadi Sannakki, Balaji, Annaporna, Jenugudu, Muttina Sanna, Neergula Batta, Duddoge, Adri Batta, Mullu Batta, Intansel	15
9	Highly Susceptible	Raichur Sanna, Dodda Batta, Mugad Suganda, Dodda Baikalu, Baigan Munji, Kannur, Basumathi, Manju Pani, Bili Munduga, Rat Bat, Kagi Sale 1, HR 12.	11

Note: HR 12 was used as susceptible check

Conclusion

In present study none of the rice landraces were shown high degree of resistance against sheath blight under field condition upon artificial inoculation but we were able to found Bangara Sanna as moderately resistance variety and it can be used in future breeding programme to develop sheath blight resistant cultivars or varieties.

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