Int.J.Curr.Microbiol.App.Sci (2018) Special Issue-7: 4456-4461

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Special Issue-7 pp. 4456-4461**
Journal homepage: http://www.ijcmas.com

Original Research Article

Screening of Rice Germplasm's for Resistance to Sheath Blight

S. Lalitha Pavani[1*], Vineeta Singh[1], P. K. Singh[2] and G. Pothiraj[1]

[1]Department of Mycology and Plant Pathology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, India
[2]Department of Genetics and Plant Breeding, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, India
**Corresponding author*

Keywords

Resistant, *Rhizoctonia solani* Kuhn, Screening, Sheath blight, Susceptible

A B S T R A C T

Rice sheath blight (ShB), caused by *Rhizoctonia solani*, is a devastating disease of rice which causes major yield loss in most rice growing regions of the world. ShB is the soil-borne fungal disease caused by *Rhizoctonia solani* Kuhn, which alone accounts to 25 per cent of yield losses Kumar *et al.*, (2009). Till date, no rice germplasm in the world has been found to be completely resistant to this fungus. This is mainly due to the lack of sources for resistance in cultivated and wild rice species possessing ShB resistance traits. Brooks, (2007). Hence, identification and subsequent development of disease resistance in rice cultivars is crucial. In the present study 196 germplasm lines were screened under natural conditions after inoculation with virulent isolate of *R.solani* (RS 49). None of the entries were found immune or resistant. Fifty seven entries were found moderately resistant, moderately susceptible and rest of the entries showed highly susceptible reaction.

Introduction

Rice is one of the most important and widely cultivated food crops of the world and the majority of rice (90 per cent) is being produced in Asian countries with China and India being the major producers (IRRI, 2013). In India rice is grown in 43.86 million ha, the production level is 104.80 million tones and the productivity is about 2404 kg/ha (Annual report 2016-2017). Major fungal diseases are Blast, Brown spot, Sheath rot, Sheath blight, Stem rot, and Seedling blight. Among these diseases the sheath blight disease caused by Rhizoctonia solani Kuhn. Earlier, considered to be minor disease is now regarded as an internationally important that is second only to and often rivals of the blast disease, because of the introduction of high yielding varieties since 1960. Sheath blight (ShB) of rice is an important soil-borne fungal disease caused by *Rhizoctonia solani* (Kuhn) causing up to 40 per cent of yield losses annually. (Shinde and Prashanthi, 2014). The causal agent of rice Sheath blight (ShB) has a broad host range (Srinivasachary *et al.*, 2011). In addition to rice, *R. solani* can infect many more plant species, including major crops like wheat, barley, and maize (Zhen *et al.*, 2013). To date, no rice accession with complete resistance to sheath blight has been reported. However, a number of genotypes with varying levels of resistance have been reported. Keeping this fact in view, to find out resistant/tolerant germplasm against the

causal pathogen, screening was under taken in field conditions.

Materials and Methods

Plant materials and experimental design

The seeds of 196 rice genotypes were collected from Department of Genetics and Plant Breeding, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, UP, India. Field experiment was conducted to screen 196 rice genotypes against artificial inoculation of *R. solani* AG-1IA in the experimental farm area, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, India during 2014-2015 and 2015-2016 cropping seasons. Five plants were selected for each treatment and there were three replications. Different rice genotypes were transplanted in the month of June along with the susceptible check (Pusa Basmati-1) and resistant check (Tetep) varieties. Disease rating scale (0-9) given by IRRI (2002) was used for the disease assessment, where, 0= free from infection; 1=lesion limited to lower 20% of the plant height; 3= 20-30%; 5=31-45%; 7= 46-65%; 9= more than 65%**.**

Artificial inoculation

196 genotypes of rice were artificially inoculated with immature sclerotia of virulent *R. solani* AG-1IA (RS49) isolate in two replicates. Sheath inoculation was done according to Singh *et al.*, 2000.

Disease assessment

Disease severity of sheath blight was scored with a scale of 0-9 based on relative lesion height on the whole plant as follows (IRRI, 2002). The inoculated plants were regularly examined for appearance of symptoms starting from 12 hours after inoculation like number of lesions and their length on the rice sheath around the inoculation point. The data on disease intensity were recorded on six different dates at seven days intervals i.e. 7^{th}, 14^{th} and 21^{sh}day after inoculation (Kumar *et al.*, 2008).

Data analysis

The relative lesion height (cm) in each tiller was calculated by using formula given by Sharma *et al.*, (1990).

RLH = Maximum height at which lesion appear/plant height x100.

Disease severity of sheath blight was scored with a scale of 0-9 based on relative lesion height on the whole plant as follows (IRRI, 2002).

The percentage disease index (PDI) and area under disease progress curve (AUDPC) (Campbell and Madden, 1990; Johnson and Wilcoxson, 1982; Shaner and Finney, 1977) were calculated as follows.

$$PDI = \frac{\text{(Sum of all ratings} \times 100)}{\text{(Total no. of observations} \times \text{Maximum rating scale)}}$$

Percent Disease Index (PDI) was worked out by using formula given by Wheeler (1969).

$$AUDPC = \sum_{i=1}^{n-1} \{[(X_{i+1} + X_i)/2] * (t_{i+1} - t_i)\}$$

Where;

X_i = disease index expressed as a proportion at the i^{th} observation.

t_i = time (days after planting) at the i^{th} observations and

n = the total number of observations.

Statistical analysis

The experiment was laid out in α-lattice design with two replications. The values of data obtained from the field were subjected to following statistical analysis. Analysis of variance (ANOVA) and DNMRT analysis by SAS was done on the basis of available data.

The differences in data in the various experiments were tested for their significance by employing α-lattice design. Each treatment was replicated twice for validation.

Results and Discussion

Identification of resistance sources in rice genotypes

The 196 rice genotypes were screened for sheath blight resistance under open field conditions artificial inoculation with highly virulent isolate of *R.solani* RS49. On the basis of area under disease progress curve (AUDPC), all the genotypes were divided into three categories.

These were: (I) moderately resistant (MR; AUDPC=237.22-291.67); (II) moderately susceptible (MS; AUDPC=295.56-350.00) and (III) Susceptible (S; AUDPC=357.78-618.33). Majority of the rice genotypes exhibited moderate susceptible disease reaction when compared to the moderately resistant check (Tetep). Fifty seven (29%)genotypes (IC281781, IC282528, IC282847, IC256523, IC282803, IC277284, IC260891, IC280478, IC280564, IC282808, IC283028, IC256534, IC277292, IC277313, IC282458, IC256527, IC283187, IC264725, IC282512, IC280529, IC282493, IC280538, IC282530, IC264151, IC282467, IC283023, IC277330, IC280479, IC283205, IC277338, IC282475, IC277275, IC279361, IC256629, IC282469, IC282486, IC282526, IC282824, IC281786, IC277281, IC277267, IC282455, IC256807, IC256528, IC283032, IC282514, IC256518, IC274408, IC277193, IC282421, IC283041, IC278777, IC282520, IC283038, IC277234, IC282517, IC282447, IC282822, IC260917, IC277309, IC264148, IC256521, IC277332, IC277314, IC281785 and Tetep) were found sheath blight moderately resistant with mean percent disease index (PDI) between 12.22 to 23.33 percent during the 2015 and 2016 crop seasons (Table 1).

109 genotypes (55.6%) IC256516, IC277317, IC280466, IC280528, IC282798, IC283132, IC256525, IC281783, IC282460, IC273558, IC256613, IC256621, IC282816, IC264136, IC277252, IC277264, IC283046, IC274397, IC256617, IC280541, IC282495, IC282437, IC283204, IC260937, IC256589, IC283089, IC260964, IC277343, IC281774, IC282448, IC278774, IC283120, IC264691, IC280555, IC282425, IC277331, IC282846, IC280504, IC282480, IC256616, IC264143, IC256520, IC279355, IC264149, IC282418, IC280550, IC282496, IC283000, IC277261, IC277321, IC282840, IC282508, IC282427, IC282471, IC260924, IC277290, IC280484, IC282438, IC282473, IC280500, IC256537, IC260961, IC283207, IC264141, IC280510, IC282840, IC283113, IC277274, IC277277, IC282801, IC282466, IC283139, IC283026, IC283195, IC277253, IC267416, IC277256, IC256535, IC281491, IC282815, IC282494, IC274377, IC282481, IC283085, IC282463, IC277326, IC282806, IC282513, IC282443, IC283206, IC28052, IC256514, IC260961, IC278776, IC279369, IC280552, IC282500, IC277328, IC280558, IC282807, IC264727, IC282809, IC267428, IC277291, IC282812, IC281508, IC277289, IC277259, IC282474 exhibited moderately susceptible with mean percent disease index (PDI) between 24.44 to 35.55 (Table 1).

Table.1 Screening of rice varieties/ germplasm for resistance against sheath blight caused by (*Rhizoctonia solani*) under natural conditions

Disease rating scale	Response	No. of entries	Name of varieties/ germplasm Kharif-2014-15&2015-16
0	Immune	Nil	Nil
1	Resistant	Nil	Nil
3	Moderately resistant	57	IC281781, IC282528, IC282847, IC256523, IC282803, IC277284, IC260891, IC280478, IC280564, IC282808, IC283028, IC256534, IC277292, IC277313, IC282458, IC256527, IC283187, IC264725, IC282512, IC280529, IC282493, IC280538, IC282530, IC264151, IC282467, IC283023, IC277330, IC280479, IC283205, IC277338, IC282475, IC277275, IC279361, IC256629, IC282469, IC282486, IC282526, IC282824, IC281786, IC277281, IC277267, IC282455, IC256807, IC256528, IC283032, IC282514, IC256518, IC274408, IC277193, IC282421, IC283041, IC278777, IC282520, IC283038, IC277234, IC282517, IC282447, IC282822, IC260917, IC277309, IC264148, IC256521, IC277332, IC277314, IC281785 and Tetep
5	Moderately susceptible	109	IC256516, IC277317, IC280466, IC280528, IC282798, IC283132, IC256525, IC281783, IC282460, IC273558, IC256613, IC256621, IC282816, IC264136, IC277252, IC277264, IC283046, IC274397, IC256617, IC280541, IC282495, IC282437, IC283204, IC260937, IC256589, IC283089, IC260964, IC277343, IC281774, IC282448, IC278774, IC283120, IC264691, IC280555, IC282425, IC277331, IC282846, IC280504, IC282480, IC256616, IC264143, IC256520, IC279355, IC264149, IC282418, IC280550, IC282496, IC283000, IC277261, IC277321, IC282840, IC282508, IC282427, IC282471, IC260924, IC277290, IC280484, IC282438, IC282473, IC280500, IC256537, IC260961, IC283207, IC264141, IC280510, IC282840, IC283113, IC277274, IC277277, IC282801, IC282466, IC283139, IC283026, IC283195, IC277253, IC267416, IC277256, IC256535, IC281491, IC282815, IC282494, IC274377, IC282481, IC283085, IC282463, IC277326, IC282806, IC282513, IC282443, IC283206, IC28052, IC256514, IC260961, IC278776, IC279369, IC280552, IC282500, IC277328, IC280558, IC282807, IC264727, IC282809, IC267428, IC277291, IC282812, IC281508, IC277289, IC277259, IC282474
7	Susceptible	22	IC277237, IC256515, IC277316, IC256754, IC283131, IC256538, IC267444, IC277248, IC277261, IC277266, IC282521, IC277319, IC256530, IC280477, IC282525, IC282454, IC275937, IC280569, IC277304, IC282450, IC282420, IC277287 and PB-1
9	Highly susceptible	Nil	Nil

The remaining twenty two genotypes (11.2%)(IC277237, IC256515, IC277316, IC256754, IC283131, IC256538, IC267444, IC277248, IC277261, IC277266, IC282521, IC277319, IC256530, IC280477, IC282525, IC282454, IC275937, IC280569, IC277304, IC282450, IC282420, IC277287 and PB-1) were graded as susceptible when compared

to moderately resistant check (Tetep) and were found susceptible with mean percent disease index (PDI) between 37.78 to 55.56.

Jiang *et al.,* (1993) evaluated 1,188 rice varieties from Zhejiang province, no highly resistant materials were found, and only 2.4% of accessions displayed resistance. Reddy *et al.*, (1997) also tested 457 breeding lines for sheath blight resistance and found two lines (RNR 15336 and RNR 82096) as resistant. Lee and Rush (1983) also reported that short and medium grain type Japonica rice showed highest degree of resistance. Singh and Borah (2000) also screened sixty local upland rice cultivars in Assam and reported that only one variety i.e. Chingdar was found to be resistant, seven moderately resistant and rest 52 were susceptible. Zuo *et al.,* (2009) mentioned that the resistance levels of Zhongbaiyou 1 and Teyou 338 are as high as YSBR1, a rice line that has been identified with high resistance to sheath blight. Yadav *et al.,* 2015 evaluated forty rice germplasm lines including 8 wild, 4 land races, 26 cultivated, and 2 advanced breeding lines were evaluated for their reaction to sheath blight. In the present study 196 germplasm lines were screened under natural conditions after inoculation with virulent isolate of *R. solani* (RS 49). None of the entries were found immune or resistant. Fifty seven entries were found moderately resistant, moderately susceptible and rest of the entries showed highly susceptible reaction.

The resistant rice genotypes can be used for the breeding program to develop promising resistant lines for the management of the disease. No rice cultivar is highly resistant against *R. solani.* A few moderately resistant cultivars against *R. solani* are known which are not sufficient to manage the disease. The management of the pathogen is mainly dependent on the use of toxic fungicides, which are not only harmful for the environment, but also leads to development of resistance and new strains in the pathogen. This makes the problem even more critical than solving it. So there is need to screen number of rice genotypes against *R. solani* AG-1IA. Keeping these problems into consideration the study was undertaken. In future, there is need for continuous screening of large number of rice genotypes against *R. solani* to find out resistant cultivars.

Acknowledgements

Facilities were provided by Dr. P.K Singh, Department of Genetics And Plant Breeding, Institute of Agricultural Sciences, Banaras Hindu University are acknowledged.

References

Brooks, S. A. 2007. Sensitivity to a phytotoxin from Rhizoctonia solani correlates with sheath blight susceptibility in rice. *Phytopathology*. 97:1207-1212.

Campbell, C.L. and Madden, L.V. 1990. Introduction to plant disease epidemiology. J Wiley, New York.

IRRI, 2013. Standard Evaluation System for Rice.4th Edition. Manila, *International Rice Research Institute*. Philippines

IRRI. 2002. Standard evaluation system for rice (SES). Manila, Philippines: Internation Rice Research Institute, DAPO Box 7777

Jiang H, Wu J and Wang G (1986). Famous and excellent rice resource - Suyunuo. China Seed Ind. 1: 37.

Johnson, D.A and Wilcoxson, R.D. 1982. A table of areas under disease progress curves. Technical Bulletin, Texas Agricultural Experiment Station, Texas.

Kumar, K.V.K., M.S. Reddy, M.W. Kloepper, K.S. Lawrence, D. E. Groth and M. E. Miller, 2009.Sheath blight disease of rice (Oryza sativa L.)- An overview. *Biosciences.* 6 (2):465-480.

Kumar, M., Singh, V., Singh, N and Vikram, P. 2008. Morphological and virulence characterization of *Rhizoctonia solani* causing sheath blight of rice. *Envir. Ecol.* 26(3): 1158-1166.

Lee, F.M and Rush, M.C. 1983. Rice sheath blight a major rice disease. *Plant Dis.* 67: 829-32.

Reddy, M.M, Madhusudhan, T., Kulkarni, N and Kashikar, M. 1997.Sources of resistance to sheath blight. *Int. Rice Res. Notes.*22: 1-25.

Shaner, G and Finney, R.E.1977.The effect of nitrogen fertilization on the expression of slow mildewing resistance in knox wheat. *Phytopathology*. 67:1051–1056.

Sharma, N. R., Teng, P. S and Oliver, F. M. 1990. Comparisons of assessment methods for rice sheath blight disease. *Phillip. Phytopath*. 26: 20-24.

Shinde, S.J and Prashanthi, S.K. 2014. Antipathogenic potentiality of fluorescent pseudomonads for the management of rice sheath blight pathogen, *Rhizoctonia solani*. *Asian Journal of Bio Science.* 9(2): 255-260.

Singh, K.D and Borah, P. 2000. Screening of local upland rice cultivars of Assam against sheath blight. *Ann. Biol.* 16: 161-162.

Singh, K.D., Borkakot, R.P and Pathak, A.K. 2000. Evaluation of rice for disease resistance against bacterial blight, sheath blight and grain discoloration. *Ann Biol*. 16:163–166.

Srinivasachary, S., Willocquet, L and Savary, S. 2011. Resistance to rice sheath blight (*Rhizoctonia solani* Kühn) [(teleomorph: *Thanatephorus cucumeris* (A.B. Frank) Donk.] disease: current status and perspectives. *Euphytica*. 178: 1–22.

Yadav, S., Anuradha, G., Kumar, R.R., Vemireddy, L.R., Sudhakar, R and Donempudi, K. 2015. Identification of QTLs and possible candidate genes conferring sheath blight resistance in rice (Oryza sativa L.). *Springer Plus*.4:175.

Zhen, A.P., Lin, R.M., Zhang, D.H., Qin, P.G., Xu, L.Z., Ai, P., Ding, L., Wang, Y.N., Chen, Y., Liu, Y., Sun, Z.G., Feng, H.T., Liang, X.X., Fu, R.T., Tang, C.G., Li, Q., Zhang, J., Xie, Z.L., Deng, Q.M., Li, S.C., Wang, S.Q., Zhu, J., Wang, L.X., Liu, H.N and Li, P.2013. The evolution and pathogenic mechanisms of the rice sheath blight pathogen. Nat. Comm. 4:1424.

Zuo, S.M., Wang, Z.B., Chen, X.J., Gu, F., Zhang, Y.F., Chen, Z.X., Pan, X.B and Pan, C.H. 2009. Evaluation of resistance of a novel rice line YSBR1 to sheath blight. *Acta Agronomica Sinica*.35:608–614.