Screening of Rice Germplasm Against Blast Disease Under Temperate Conditions

ABSTRACT

Dar S.H. Rather A.G.1, Najeeb S.2, Ashraf Ahangar M.2
1. Division of Plant Breeding and Genetics, SKUAST-Kashmir, Shalimar, Srinagar, 190025 India.
2. Mountain Research Centre for Field Crops Khuwdani, Anantnag, SKUAST-Kashmir

Corresponding authors email: dar.sajad@rediffmail.com

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Abstract Rice is the world’s most important food crop as it provides nutrition to the two third of its population. The improvement in yield of this crop is challenged by several biotic and abiotic factors. Among the biotic stresses rice blast is a serious production constraint for rice under Kashmir conditions. Keeping in view a disease screening field trial of rice germplasm consisting of 9 parents, 27 crosses and one local check was established during the kharif, 2012 at two sites in Kashmir (India) to determine resistance intensity in rice germplasm against Pyricularia grisea, the cause of rice blast disease. Screening was done under natural epiphytotic conditions and the results revealed that none of the test lines was immune or highly resistant. Four crosses namely K-08-60 x IR-68888A, K-08-61 x SKAU-11A, K-08-61 x IR-68888A, PS-5 x SKAU-11A and one parent PS-5 were found to be resistant. Seven hybrids and four parents displayed moderately resistant response. Three crosses and equal number of parents were found to be moderately susceptible. Rest of the crosses and parents showed susceptible to highly susceptible response. Genotypes performed almost equally at both of these locations with respect to their disease intensity. All the resistant and moderately resistant crosses and parents can be utilized as a source of resistance for developing blast resistant cultivars especially for temperate ecologies.

Keywords Rice blast; Screening; Pyricularia grisea; Resistant; Susceptible

1 Background

Rice (Oryza sativa L.) is a major cereal crop and staple food of Kashmir (India). The demand of rice continues to rise because of increase in population and improvement in living standards. Based on population projections from the Food and Agricultural Policy Research Institute (FAPRI), global rice demand is expected to rise from 439 million tons (milled rice) in 2010 to 496 million tons in 2020, to 555 million tons in 2035. Asian rice consumption is projected to account for 67% of the total increase, rising from 388 million tons in 2010 to 465 million tons in 2035 despite a continuing decline in per capita consumption in China and India (IRRI, 2012). Keeping in view the projected increase in demand of this crop yield has to increase many folds.

In Jammu & Kashmir rice is cultivated on an area of 0.25 m ha with a total production and productivity of 0.56 million tons and 2.24 tons ha⁻¹, respectively (Anonymous, 2010-2011). This data shows that the yield of rice in Kashmir is very low and this low production is attributed to several biotic and abiotic factors (Sanghera et al., 2011). Among the biotic factor diseases are the most important factor which results in severe crop losses. Rice blast is a major challenge than all other diseases under Kashmir conditions. Among all rice blast caused by Pyricularia grisea Sacc [Telipomorph Magnaporthe grisea (Hebar) Brarr] is one of the important factors for low productivity of rice in the valley. It causes 5-70 per cent yield loss depending upon the stage of the crop infected and severity of the disease (Dubey, 1995). Rice blast epidemics are often more severe in temperate and subtropical ecosystems. This disease has caused significant yield losses in many rice growing countries e.g. 75% losses of grains in India (Padmanaban, 1965), 50% loss in Philippines (Awodera and Esunuso, 1975) and 40% loss in Nigeria (Ou, 1985). The disease can be managed by the use of fungicides, resistant cultivars, agronomic practices and biotechnological methods (Ribot et al., 2008, Bhat et al., 2013). However, the use of resistant cultivars is the most economical and environment friendly method for the management of rice blast (Castano et al., 1990; Saifullah et al., 2011).
1995; Khan et al., 2001; Haq et al., 2002) but the resistance is subject to break down due to appearance of new/more virulent races of the pathogen. The present study reports on the screening/evaluation of rice germplasm for sources of resistance against rice blast disease.

2 Results and Discussion

The screening of all the parents and crosses against rice blast disease revealed that, none of the variety was immune, four crosses K-08-60 x IR-68888A, K-08-61 x SKAU-11A, K-08-61 x IR-68888A, PS-5 x SKAU-11A and only one parent PS-5 were found to be resistant against blast (Table 1). Seven crosses namely SKAU-382 x SKAU-11A, SKAU-382 x IR-68888A, SR-1 x SKAU-7A, SR-1 x SKAU-11A, SR-1 x IR-68888A, K-08-61 x SKAU-7A, PS-5 x IR-68888A, and four parents SR-1, KO-8-60, KO-8-61 and IR-68888 were found to be moderately resistant. Three hybrids SKAU-382 x SKAU-7A, K-08-60 x SKAU-11A, PS-5 x SKAU-7A and three parents SKAU-382, SKAU-7A and SKAU-11A displayed susceptible response toward the disease. All the remaining hybrids K-08-59 x SKAU-7A, K-08-59 x SKAU-11A, K-08-59 x IR-68888A, Jhelum x SKAU-7A, Jhelum x SKAU-11A, Jhelum x IR-68888A, SK-389 x SKAU-7A, Ch-988 x SKAU-7A, Ch-988 x SKAU-11A and three parents SKAU-382, SKAU-7A and SKAU-11A showed susceptible to highly susceptible response. These sources of resistance identified from rice germplasm, can be exploited in breeding programs for the development of disease resistant commercial cultivars after determining their genetics, if these are found to possess other desirable agronomic characters. Since I have also analyzed the general and specific combining ability of all these parents and crosses besides their pollen and spikelet fertility in a separate experiment and I have found that out of twelve resistant and moderately resistant cross combinations six have shown full restoration and hence good yield and other agronomic characters. Further as the experiment was carried out at two locations and the results indicated almost equal range of disease infestation at both of these locations.

Very few reports are available on the screening of rice germplasm against the blast disease (Table 2). Saifullah, (1995) screened 23 genotypes during 1990 and 1991 that 19 genotypes were highly resistance and 3 resistant to leaf and neck blast caused by Pyricularia oryzae.
(Khan et al., 2001) screened 39 (course) and 40 (fine) entries/varieties for three years from Rice Research Institute Kala Shah Kaku and NIAB, Faisalabad. The screening revealed that amongst the course entries/ Varieties like IR-6 and KS-282 were found highly resistant in 1998 and resistant in 1999 and 2000 while on over all basis IR-8, DR-82 and DM- 15-1-95 were found resistant in the entire test. Similar results were also reported by (Haq et al., 2002) in screening of twenty five rice germplasm lines and found that two lines KSK-282 and IRRI-6 were highly resistant. Field screening of 40 entries/varieties during 2005-2006 against the blast disease revealed that only one entry 99513 of PARC, one entry of KSK-10 from Rice Research Institute, Kala Shah Kaku and DM-2-25- 9-02 from NIAB, showed resistant response (Arshad et al., 2008). The screening of germplasm against the blast disease was also carried out in other rice growing countries. (Mohanta et al., 2003) in screening trials at Bangladesh reported that among twenty eight restored line and four standard checks, three were highly resistant, 12 resistant, 16 moderately susceptible. (Castano et al., 1990) developed methods for screening of 437 upland genotype from Indonesia (IAT), Colombia and IRRI (Philippines) for resistance to *Pyricularia oryzae* six times within two years and found that 176 genotype were highly resistant while other had low to high susceptibility to rice blast disease.

### 3 Conclusion

Blast disease of rice is the most economical problem for rice growers of Kashmir valley. Inherent resistance or tolerance of crop plants to infection by the pathogen can most likely be a safe alternative and most economical and ecofriendly disease management venture. So to breed for resistant/tolerant lines for blast disease is the need of hour for the economic rice production under temperate agro-ecology. This will not only lower the cost of production by reducing application of chemicals but will prove way for agronomic rice production in an eco-friendly manner.

During the present study the genotypes viz., K-08-60 x IR-68888A, K-08-61 x SKAU-11A, K-08-61 x IR-68888A, PS-5 x SKAU-11A and PS-5 were found resistant against blast disease under temperate agroclimatic conditions. Moreover eleven genotypes were found moderately resistant including SKAU-382 x SKAU-11A, SKAU-382 x IR-68888A, SR-1 x SKAU-7A, SR-1 x SKAU-11A, SR-1 x IR-68888A, K-08-61 x SKAU-7A, PS-5 x IR-68888A, SR-1, K0-8-60, K0-8-61 and IR-68888. The resistant sources found in the present study can be utilized profitably for developing new rice cultivars possessing desirable traits besides resistance to blast disease especially for temperate ecologies. Since the experiment was carried out at two locations and the genotypes displayed almost equal response against blast causing pathogen which indicates less role of environment being played in disease development and more of genetic nature.

### 4 Materials and Methods

The present study was carried out at two diverse locations viz. Mountain Research Centre for Field Crops, Khudwani (1580 m asml) [E1], and at the Experimental Farm of Krishi Vighyan Kandra Pombay, Kulgam, Kashmir (India) (2000m asml) [E2] during Kharif, 2011 and 2012. During the present study nine rice lines namely Jhelum, Pusa Sughandh-5 (PS-5), China-988, Shalimar Rice-1 (SR-1), SKAU-382, SKAU-389, K-08-59, K-08-60 and K-08-61 were crossed with three CMS lines (SKAU-7A, SKAU-11A and IR-68888A) used as testers in a line x tester fashion to generate 27 cross combinations. The genetic material was chosen from a broad assay of germplasm maintained at Mountain Research Centre for Field Crops, Khudwani. The crosses were attempted in Kharif 2011. The resulted 27 F1s, 12 parents and one standard check (Jhelum) were evaluated separately against *Pyricularia grisea* at two locations during kharif 2012 using complete randomized block design with three replications. Thirty days old seedlings were transplanted with single plant hill with inter row and intra row spacing of 20 cm and 15 cm respectively. Recommended packages of practices were followed to raise a good crop. The observations were recorded on 15 days interval and then mean was worked out.

### Table 2 Responses of rice germplasm (lines, testers and crosses) to rice blast disease caused by *Pyricularia grisea*

| Genotype | Resistant | Moderately Resistant | Moderately susceptible | Susceptible | Highly susceptible |
|----------|-----------|----------------------|------------------------|-------------|-------------------|
| Cross    | 7         | 1                    | 9                      | 4           | 3                 |
| Parent   | 1         | 4                    | 3                      | 1           | 3                 |
4.1 Screening of rice germplasm for resistance against rice blast disease

Observations on leaf blast were taken at 15 days interval starting from first disease appearance up to physiological maturity of the crop. The observations were recorded as per the standard evaluation system of rice on 0-9 scale (IRRI, 1996) depending up on the leaf area covered by the disease.

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