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Screening of Rice F_5 Families for Sheath Blight and Bacterial Leaf Blight

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Abstract

Forty three F_5 families of rice obtained from the two crosses MTU 7029/ PAU 3116-25-5-1 and MTU 7029/ PAU 3140-126-1were screened against sheath blight by adopting typha leaf bit method of artificial inoculation followed by field screening using 0-9 scale of SES, 2014. Same families were also screened against bacterial leaf blight using leaf clipping method of artificial multiplication and observed that no family was found immune or resistant to both the diseases. 21 families reported moderate resistance to sheath blight whereas only six families showed moderate resistance to bacterial leaf blight. Three families MTU 2468-25-2-1, MTU 2469-6-1-2 and MTU 2469-6-5-1 recorded moderate resistance to both the diseases and hence can be selected.

Keywords: Kresek, typha leaf bit method, leaf clipping, screening

Introduction

Rice is the staple food crop for two thirds of the world population with varied consumer preference. Paddy cultivation suffers from several biotic and abiotic stresses that seriously affect its production among which Sheath blight, caused by *Rhizoctonia solani* (teleomorph: *Thanatephorus cucumeris*) and Bacterial leaf blight, caused by *Xanthomonas oryzae pv. oryzae* were the two major devastating diseases in many countries affecting more than 50% of global rice production (Singh *et al*., 1977; Khush and Ogawa, 1989; Groth *et al*., 1991 and Marchetti and Bollich, 1991). Rice sheath blight spreads through sclerotia present in the soil which develops primary mycelium with the onset of favourable conditions that forms initial lesions on sheath which later develops into runner hyphae that grow on the surface of rice plant tissues, and develop infection structures that generate new lesions. Disease intensification and spread are also favoured by long duration of tissue wetness, crop canopy and canopy microclimate. The fungus affects the crop from tillering to heading stage. Initial symptoms are noticed on leaf sheaths near water level. On the leaf sheath oval or elliptical or irregular greenish grey spots are formed. As the spots enlarge, the centre becomes greyish white with an irregular blackish brown or purple brown border. Lesions on the upper parts of plants extend rapidly coalescing with each other to cover entire tillers from the water line to the flag leaf. The presence of several large lesions on a leaf sheath usually causes death of the whole leaf, and in severe cases all the leaves of a plant may be blighted in this way. The infection extends to the inner sheaths resulting in death of the entire plant. Older plants are highly susceptible. Five to six week old leaf sheaths are highly susceptible. Plants heavily infected in the early heading and grain filling growth stages produce poorly filled grain, especially in the lower part of the panicle. Many rice cultivars have been identified as moderately resistant to sheath blight, however no resistant cultivar has been found so far (Prasad and Eizenga, 2008).

Bacterial leaf blight affects the rice crop in all major rice growing countries of Asia. in India, it is a serious problem during south west monsoon. The bacterium induces either wilting of plants or leaf blight. Wilt syndrome known as Kresek is seen in seedlings within 3-4 weeks after transplanting of the crop. Kresek results either in the death of whole plant or wilting of only a few leaves. The bacterium enters through the hydathodes and cut wounds in the leaf tips, becomes systemic and cause death of entire seedling. The disease is usually noticed at the time of heading but in severe cases occur earlier also. In grown up plants water soaked, translucent lesions appear usually near the leaf margin. The lesions enlarge both in length and width with a **wavy margin** and turn straw yellow within a few days, covering the entire leaf. As the disease progresses, the lesions cover the entire leaf blade which may turn white or straw coloured. Lesions may also be seen on leaf sheaths in susceptible varieties. Milky or opaque dew drops containing bacterial masses are formed on young lesions in the early morning.

They dry up on the surface leaving a white encrustation. The affected grains have discoloured spots surrounded by water soaked areas. If the cut end of leaf is dipped in water, bacterial ooze makes the water turbid.The most effective approach to control these two diseases is using resistant varieties. Development of disease resistant rice is one of the most important achievements rice breeders attempt to accomplish .The genetic diversity of rice may incorporate genes that directly contribute to physiological host plant resistance to sheath blight (Srinivasachary *et al.,* 2011), genes that determine the architecture of plants, and thus contribute to the structure of crop canopies, as well as genes from these different groups that collectively confer resistance through interactions which can be identified by field screening by standardized methods. Hence, the objective of the present study therefore was to screen forty three F_5 families of rice against sheath blight and bacterial leaf blight which will enable us to identify rice varieties resistant to these diseases.

Materials and Methods

In the present study, during *kharif* 2015, all the forty three F_5 families obtained from two crosses MTU 7029/ PAU 3116-25-5-1 and MTU 7029/ PAU 3140-126-1 along with their susceptible check (MTU 7029) were sown in two rows each with a spacing of 20 x 15 cm at Andhra Pradesh Rice Research Institute and Regional Agricultural Research Station, Maruteru, West Godavari District, Andhra Pradesh and were screened against sheath blight by adopting typha leaf bit method of artificial inoculation done at 69 DAS followed by field screening at maximum tillering stage and panicle initiation stage when 95% of check variety was affected using 0-9 scale of Standard Evaluation System give by IRRI, 2014 (Table 1). These families were also screened separately for bacterial leaf blight by following leaf clipping method for artificial multiplication of bacteria at 80 DAS followed by field screening at maximum tillering stage and later at panicle initiation stage when 95% of check variety TN-1 was affected using 0-9 scale of Standard Evaluation System (SES) of IRRI, 2014 (Table 2). Fertilizer management and plant protection measures for other pests and diseases were followed as per recommendations. Screening for disease resistance based on natural infection may not always be conclusive due to environmental variation and the absence of adequate inoculum that initiates the disease. Artificial inoculation minimizes such problems. Hence, for proper infestation and to get good reaction of test seedlings, artificial inoculation by typha leaf bit method for sheath blight and leaf clipping method for bacterial leaf blight were practiced in the present study.

Table 1: Standard Evaluation System, IRRI (2014) scale for sheath blight

Scale	Rating	Disease symptoms
0	Highly Resistant	No Infection (Immune reaction)
1	Resistant	Lesions limited to lower 20% of the plant height
3	Moderately Resistant	20-30
5	Susceptible	31-45
7	Highly Susceptible	46-65
9	Highly Resistant	>65

Table 2: Standard Evaluation System, IRRI (2014) scale for bacterial leaf blight

Scale	Rating	% Leaf area diseased
1	Highly Resistant	1-5
3	Resistant	6-12
5	Moderately Resistant	13-25
7	Susceptible	26-50
9	Highly Susceptible	51-100

Typha leaf bit method

This method was first used by Bhaktavatsalam *et al.* (1978) for mass multiplication of Sheath blight causing fungus. In this method, uniform sized typha bits were cut and sterilized in autoclave and inoculated with *Rhizoctonia solani*. The material is kept under wet condition for multiplication of the fungus. After complete coverage of the typha bits with fungal mat, the bits were used for artificial inoculation. Two bits per hill were used for artificial inoculation. The bits were inserted in between the tillers at the base of the plant and tied with thread so as to come in contact with the neighbouring tillers. Inoculated hills were observed for the appearance of the symptoms twice, initially at maximum tillering stage and later at panicle initiation stage and scores were recorded as per 0-9 scale of SES, IRRI, 2014. Highest score among the two was considered as final one.

Leaf clipping method

Kauffman *et al*. (1973) reported the leaf clipping method of artificial inoculation for bacterial leaf blight disease. In this method, sterilized surgical scissors dipped in bacterial suspension were used for inoculation. Leaves of all the three plants in a pot were grasped in one hand and the top 1-3 inches of three leaves were clipped off simultaneously. The inoculum should be used within two hours after preparation as *Xanthomonas oryzae* pv. *oryzae* quickly losses its viability. A control of each variety was also maintained, by using scissors dipped in sterile water for clipping off the leaves. This method is very efficient for inoculating large amount of breeding materials in the field and is currently being used at IRRI, Phillippines. One should note that in both seedling and field tests, folded young leaves and old leaves or leaves with symptoms of nutrient deficiency or other diseases should be avoided for inoculation.

Results and Discussion

Screening was conducted at Andhra Pradesh Rice Research Institute and Regional Agricultural Research Station, Maruteru during *kharif*, 2015 based on SES, IRRI, 2014. All the forty three F_5 families were grouped into five classes based on their susceptibility to that disease *viz.*, immune or highly resistant with score 1, resistant with score 3, moderately resistant with score 5, susceptible with score 7 and highly susceptible with score 9.

Immunity refers to the inability of the pathogen to cause disease symptoms on host plant. No yield loss will be observed in this case where as Resistance refers to the ability of a plant to overcome completely or in some degree the effect of a pathogen or damaging factor. Yield loss is very low or neglible when seen in economic terms. Moderately reistant plants can tolerate disease to some extent giving moderate to high yield when disease intensity is low where as suscetibility refers to inability of a plant to resist the effect of a pathogen or other damaging factor. Yield loss will be high in this case. Highly susceptible plants cannot withstand lower intensity of disease and complete yield loss will be observed under such circumstances. Practically it is very difficult to develop immune varieties. Hence plant breeders mostly concentrate on developing resistant and moderately resistant varieties.

In the present study, among the forty three F_5 families screened against sheath blight and bacterial leaf blight, no family was found to be immune or resistant. In the F_5 population obtained from the cross MTU 7029/ PAU 3116-25-5-1, among the fifteen F_5 families, six recorded moderate resistance (score 5) while nine were susceptible to sheath blight (score 7) where as two families recorded moderate resistance (score 5) while thirteen were susceptible (score 7) to bacterial leaf blight (Table 3).

Table 3: Screening of F_5 families for sheath blight and bacterial leaf blight resistance

Sl. No.	Cross	Number of families screened	Number of families with score		
			5	7	9
	Sheath blight resistance				
1	MTU 7029/ PAU 3116-25-5-1	15	6	9	-
2	MTU 7029/ PAU 3140-126-1	28	15	13	-
	Total	43	21	22	-
	Bacterial leaf blight resistance				
1	MTU 7029/ PAU 3116-25-5-1	15	2	13	-
2	MTU 7029/ PAU 3140-126-1	28	4	22	2
	Total	43	6	35	2

Out of twenty eight F_5 families obtained from the cross MTU 7029/ PAU 3140-126-1, fifteen families recorded moderate resistance (score 5) while thirteen families showed susceptibility (score 7) for sheath blight where as for bacterial leaf blight, four families recorded moderate resistance (score 5) while twenty two families showed susceptibility (score 7) in addition to two highly susceptible families which reported 9 score (Table 3).

In total, out of 43 F_5 families, 21 families reported moderate resistance to sheath blight while 22 families were susceptible. Regarding bacterial leaf blight, only six families showed moderate resistance while 35 families were susceptible and two families were found to be highly susceptible. Diseases resistance scores for all the 43 F_5 families were provided in table 4. Graphical representation for number of families under each cross was represented in Fig. 1. Similar results were reported by Channamallikarjuna *et al.* (2010), Ling *et al.* (2011), Shamim *et al.* (2014) and Yadav *et al.* (2015) for sheath blight and Ahmed Khan *et al.* (2009) and Thimmegowda *et al.* (2011) for bacterial leaf blight.

Three families MTU 2468-25-2-1, MTU 2469-6-1-2 and MTU 2469-6-5-1 recorded moderate resistance to both the diseases and hence can be selected (Table 4).

Table 4: Screening scores of 43 F_5 families

S. No.	Code	Entry	Cross Combination	Scores		Remarks
				ShB	Blb	
1	TSM-118	MTU 2468-1-1-1	MTU 7029/ PAU 3116-25-5-1	5	7	Moderately resistant to sheath blight but susceptible to bacterial leaf blight
2	TSM-120	MTU 2468-2-1-1	MTU 7029/ PAU 3116-25-5-1	7	5	Moderately resistant to bacterial leaf blight but susceptible to sheath blight
3	TSM-128	MTU 2468-8-2-1	MTU 7029/ PAU 3116-25-5-1	7	7	Susceptible to both the diseases
4	TSM-132	MTU 2468-18-1-1	MTU 7029/ PAU 3116-25-5-1	7	7	Susceptible to both the diseases
5	TSM-133	MTU 2468-18-1-2	MTU 7029/ PAU 3116-25-5-1	5	7	Moderately resistant to sheath blight but susceptible to bacterial leaf blight
6	TSM-134	MTU 2468-20-1-1	MTU 7029/ PAU 3116-25-5-1	7	7	Susceptible to both the diseases

S. No.	Code	Entry	Cross Combination	Scores		Remarks
				ShB	Blb	
7	TSM-138	MTU 2468-21-4-1	MTU 7029/ PAU 3116-25-5-1	7	7	Susceptible to both the diseases
8	TSM-141	MTU 2468-25-2-1	MTU 7029/ PAU 3116-25-5-1	5	5	Moderately resistant to both the diseases, hence can be selected
9	TSM-146	MTU 2468-27-2-1	MTU 7029/ PAU 3116-25-5-1	7	7	Susceptible to both the diseases
10	TSM-147	MTU 2468-28-1-1	MTU 7029/ PAU 3116-25-5-1	7	7	Susceptible to both the diseases
11	TSM-148	MTU 2468-29-2-1	MTU 7029/ PAU 3116-25-5-1	5	7	Moderately resistant to sheath blight but susceptible to bacterial leaf blight
12	TSM-149	MTU 2468-29-3-1	MTU 7029/ PAU 3116-25-5-1	5	7	Moderately resistant to sheath blight but susceptible to bacterial leaf blight
13	TSM-150	MTU 2468-29-4-1	MTU 7029/ PAU 3116-25-5-1	7	7	Susceptible to both the diseases
14	TSM-152	MTU 2468-30-2-2	MTU 7029/ PAU 3116-25-5-1	5	7	Moderately resistant to sheath blight but susceptible to bacterial leaf blight
15	TSM-153	MTU-31-1-1	MTU 7029/ PAU 3116-25-5-1	7	7	Susceptible to both the diseases
16	TSM-164	MTU 2469-6-1-2	MTU 7029/ PAU 3140-126-1	5	5	Moderately resistant to both the diseases, hence can be selected
17	TSM-165	MTU 2469-6-2-1	MTU 7029/ PAU 3140-126-1	7	7	Susceptible to both the diseases
18	TSM-166	MTU 2469-6-3-1	MTU 7029/ PAU 3140-126-1	7	5	Moderately resistant to bacterial leaf blight but susceptible to sheath blight
19	TSM-167	MTU 2469-6-3-2	MTU 7029/ PAU 3140-126-1	5	7	Moderately resistant to sheath blight but susceptible to bacterial leaf blight
20	TSM-168	MTU 2469-6-5-1	MTU 7029/ PAU 3140-126-1	5	5	Moderately resistant to both the diseases, hence can be selected
21	TSM-169	MTU 2469-7-1-1	MTU 7029/ PAU 3140-126-1	5	7	Moderately resistant to sheath blight but susceptible to bacterial leaf blight
22	TSM-171	MTU 2469-8-1-1	MTU 7029/ PAU 3140-126-1	5	7	Moderately resistant to sheath blight but susceptible to bacterial leaf blight
23	TSM-174	MTU 2469-10-2-1	MTU 7029/ PAU 3140-126-1	7	5	Moderately resistant to bacterial leaf blight but susceptible to sheath blight
24	TSM-175	MTU 2469-11-1-1	MTU 7029/ PAU 3140-126-1	5	7	Moderately resistant to sheath blight but susceptible to bacterial leaf blight
25	TSM-178	MTU 2469-14-1-1	MTU 7029/ PAU 3140-126-1	7	7	Susceptible to both the diseases
26	TSM-183	MTU 2469-23-2-1	MTU 7029/ PAU 3140-126-1	5	9	Moderately resistant to sheath blight but highly susceptible to bacterial leaf blight
27	TSM-184	MTU 2469-23-2-2	MTU 7029/ PAU 3140-126-1	5	7	Moderately resistant to sheath blight but susceptible to bacterial leaf blight
28	TSM-190	MTU 2469-32-1-1	MTU 7029/ PAU 3140-126-1	5	7	Moderately resistant to sheath blight but susceptible to bacterial leaf blight
29	TSM-191	MTU 2469-32-2-1	MTU 7029/ PAU 3140-126-1	7	7	Susceptible to both the diseases
30	TSM-200	MTU 2469-36-1-1	MTU 7029/ PAU 3140-126-1	5	7	Moderately resistant to sheath blight but susceptible to bacterial leaf blight

S. No.	Code	Entry	Cross Combination	Scores		Remarks
				ShB	Blb	
31	TSM-204	MTU 2469-38-4-1	MTU 7029/ PAU 3140-126-1	5	7	Moderately resistant to sheath blight but susceptible to bacterial leaf blight
32	TSM-211	MTU 2469-41-2-2	MTU 7029/ PAU 3140-126-1	7	7	Susceptible to both the diseases
33	TSM-213	MTU 2469-42-1-1	MTU 7029/ PAU 3140-126-1	5	7	Moderately resistant to sheath blight but susceptible to bacterial leaf blight
34	TSM-215	MTU 2469-42-3-1	MTU 7029/ PAU 3140-126-1	7	7	Susceptible to both the diseases
35	TSM-216	MTU 2469-42-4-1	MTU 7029/ PAU 3140-126-1	7	7	Susceptible to both the diseases
36	TSM-219	MTU 2469-55-1-1	MTU 7029/ PAU 3140-126-1	7	7	Susceptible to both the diseases
37	TSM-220	MTU 2469-55-2-1	MTU 7029/ PAU 3140-126-1	7	7	Susceptible to both the diseases
38	TSM-221	MTU 2469-55-2-2	MTU 7029/ PAU 3140-126-1	5	7	Moderately resistant to sheath blight but susceptible to bacterial leaf blight
39	TSM-223	MTU 2469-57-1-2	MTU 7029/ PAU 3140-126-1	7	7	Susceptible to both the diseases
40	TSM-228	MTU 2469-68-1-1	MTU 7029/ PAU 3140-126-1	5	7	Moderately resistant to sheath blight but susceptible to bacterial leaf blight
41	TSM-229	MTU 2469-68-1-2	MTU 7029/ PAU 3140-126-1	5	7	Moderately resistant to sheath blight but susceptible to bacterial leaf blight
42	TSM-230	MTU 2469-68-2-1	MTU 7029/ PAU 3140-126-1	7	9	Susceptible to sheath blight and highly susceptible to bacterial leaf blight
43	TSM-235	MTU 2469-74-2-1	MTU 7029/ PAU 3140-126-1	7	7	Susceptible to both the diseases
44		MTU 7029		9	-	Highly susceptible check for sheath blight
45		TN-1		-	9	Highly susceptible check for bacterial leaf blight

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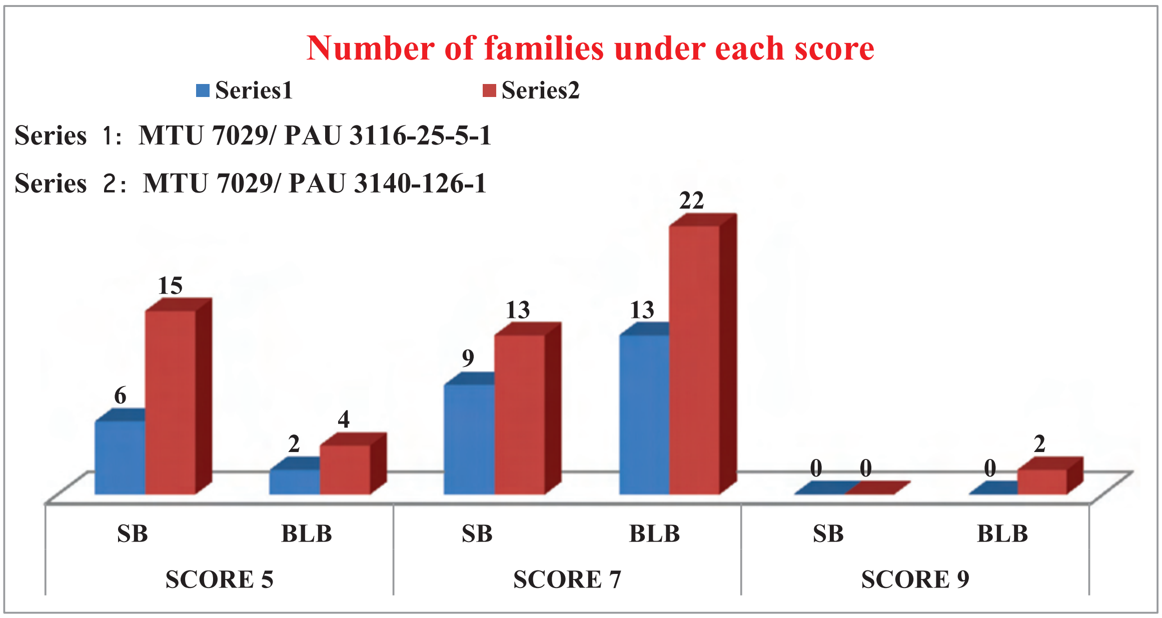

Fig. 1. Graphical representation of number of families of each cross under each score