VARIATION PATTERN AND RESISTANT LEVELS OF LOCAL AND IMPROVED CULTIVARS OF RICE TO BLAST DISEASE IN NIGERIA

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ABSTRACT

A total of one hundred and nine rice varieties were screened for blast disease to identify their level of resistance to the disease. The trial was conducted in an augmented design where checks were randomized at every 10th test entry. The entries included local varieties collected from farmers' fields, improved varieties collected from National Cereals Research Institute (NCRI) Badeggi and landraces collected from International Institute of Tropical Agriculture (IITA) Gene Bank. The scoring was done at 20, 40 and 60 days after seeding (DAS). The result showed that at 20 DAS most entries exhibited some level of resistance to the disease especially horizontal resistance (score 3). The infestations at 40 DAS showed that none of the entries scored 0, that is, none was highly resistant. At 60 DAS none of the entries was highly resistant or resistant (score 0 or 1) to the disease. Based on the spread of the disease from 20 DAS to 60 DAS, forty-seven of the entries were selected for low disease progression. Danboto was the only entry in which the spread of the disease could not increase from 20 DAS to 60 DAS. These entries could be used for blast Control in blast endemic areas and as donor genes during hybridization programs.

Key words: Resistance, blast, rice and reaction

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INTRODUCTION

Rice blast, caused by *Pyricularia oryzae* is now the most destructive fungal disease of rice in the West African Subregion (Fomba and Taylor, 1994). The fungus produces spots or lesions on leaves, nodes and different parts of the panicles and the grains (Ou, 1985). The leaf spots are typically elliptical with more or less pointed ends. The centre of the spots is usually greyish or whitish and the margin is typically brown or reddish brown. Fully developed lesions reach 1-1.5cm long, 0.3-0.5cm broad and usually develop a brown margin. On resistant cultivars, only minute brown specks of pinhead size may be observed. Numerous spots may occur on the leaf, which may soon be killed. This is followed by the drying up of the leaf sheath. Seedling or plant at the tillering stage is often completely killed in the field.

Blast is rarely a problem in Sahel region of the country because of the low relative humidity and lack of prolonged wetness of aerial surface of the rice plant and temperature extremes (Reckhaus and Adamou, 1986). However, the disease has recently been reported in southernmost rice scheme in Niger State, occurring mainly in the rainy season (Reckhaus and Adamou, 1986). Crop losses ranged from 3.2% to 14.5% in several popular upland and lowland rice cultivars in Sierra Leone and over 77% in Liberia (Raymundo, 1975; Carpenter, 1977). Fomba (1986) reported losses in grain yield of mangroove rice due to neck blast at 16.0-30.9%. Awoderu, (1990) estimated grain yield losses of 0.5-58.5% on IRAT 112 and IAC 164 in On-station and researchers managed On-farm trials. Therefore these varieties were screened to select promising lines to be used for hybridization programs.

MATERIALS AND METHODS

A total of one hundred and nine rice varieties were screened for blast at International Institute of Tropical Agriculture blast screen house in 2001. The land was harrowed and leveled. The experiment was laid out in an augmented design where the checks were randomized at the end of every 10th test entry. Spreader rows were planted two weeks before planting the test entries. The trial was seeded by hand drilling at a spacing of 20 x 20 cm between rows and length of one meter. The spreader rows were inoculated twice. The checks included ITA 306, IR 64, Cisadane and ITA 150. Blast score was taken by observing lesions on the leaf surface and scored based on the standard evaluation system for rice (IRRI, 1996) (Table 1). Blast infestation was scored at 20, 40 and 60 days after seeding. The test entries included local materials collected from farmers field (LC), improved varieties collected from National Cereals Research Institute (NCRI), Badeggi (I) these are represented by FARO names and landraces collected from IITA Ibadan (L), they are represented by TOS names.

Table 1: Scale used for scoring rice blasts

Scale	Description	Rate
0	No lesions observed	Highly resistant
1	Small brown specks of pin point size	Resistant.
3	Small roundish to slightly elongated, necrotic grey spots 1-2 mm.	Moderately resistant.
5	Lesions 3mm longer infecting up to 4- 26 % of the leaf area	Moderately susceptible.
7	Lesions infecting 26-50 % of the leaf area.	Susceptible.
9	More than 50 % of the leaf area affected	Highly susceptible.

RESULT

The score of the checks to the disease is presented in Table 2. The score was 1-2 at 20 DAS and 1-3 at 40 DAS and 4-5 at 60 DAS. Reaction to blast at 20, 40, and 60 DAS is as shown in Figs 1-3, which indicate the percentage number of lines infested by the disease. In Fig. 1, (blast reaction at 20 DAS) the landraces had 42.8% highly resistant reaction (0 score) while the improved cultivars had 6.6% and 3.6% for local varieties. At score rate of 1, the percentages are 14.28% (landraces), 20.45% (improved) and 21.43% for the local varieties. At the rate of 3 the values are 42.8% (landraces), 31.11 % (improved) and 48.2% for the local varieties. For the rates of 5 and 7, it was 26.79% and 40.9% for the local and improved varieties respectively (Fig. 1). None of the entries scored 9 (highly susceptible) at 20 DAS.

Table 2: Blast reaction for the checks

Varieties	1st score	2nd score	3rd score
ITA 230	1	2	4
ITA 306	1	1	4
IR 64	-	-	-
Cisadane	2	3	5
ITA 150	2	2	4

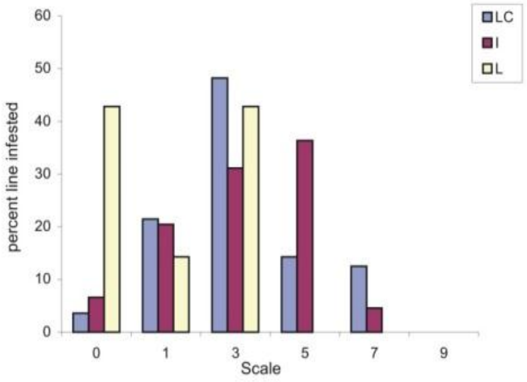

Fig: 1 Blast Score at 20 DAS

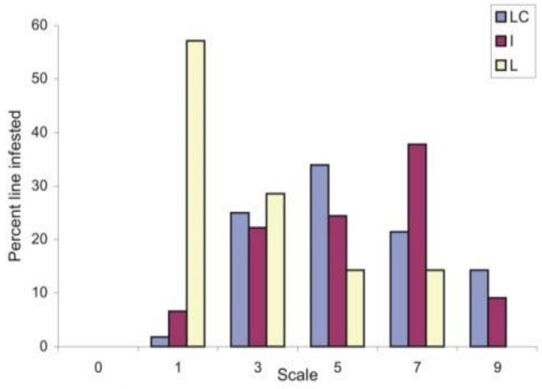

Fig:2 Blast Score at 40 DAS

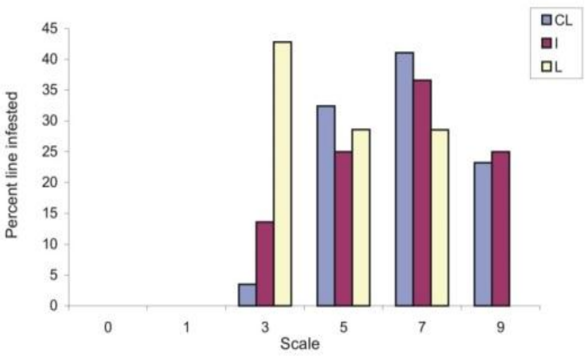

Fig: 3 Blast Score at 60 DAS

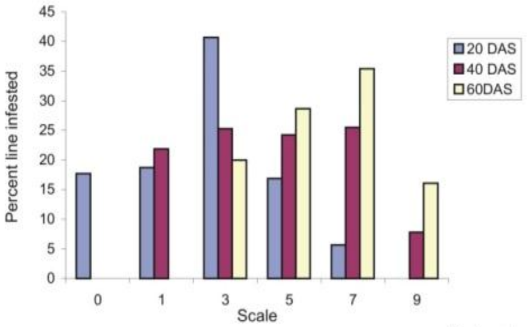

Fig: 4 Blast infestation

LC - Local
I - Improved
L - Landraces

Table 3: Varietal names and their reaction to Blast at 60 DAS.

Scale	Variety
3.	Manbechi (Ed), Danboto, Manbechi (Gd), Faro 31, Faro 23, Faro 18, Faro 48, Faro 28, Faro 5, Tos 8081, Tos 14499, Tos 14519. (12)
5.	Jufangi, Somazhigi, Gabachi, Dokochi, Shagari, Eyewawagi, Bisanleyakolo, Dubbu 1 Karankuara, Ndabissangi, Kpuruga, Gbagudu, Manbekochi, Bubanfari, Ebangichi, Nasara 2, Egwazawunkpa, Fari22, Faro4, Faro8, Faro15, Faro33, Faro7, Faro46, Faro13, Faro37, Faro20, Tos 7730, Tos 8183. (29)
7.	Nasara, Gyanako(K), Ebangichi(GB), Toma, Philippines, Danmale, Gargaza, Mass Ebangichi(E), Faro-sipi, Manbechi, Shakuyagi, Ndawodzufangi, Bokuchi, Gyanako(Ch), Ebangichu(KK), Nnakashi Kpanti, Ndachelegbo, Farankuara, Akpuruka, Pasakunya, Janiri, Egwazawunkpa, Faro1, Hta60, Faro21, Faro45, Faro12, Faro36, Faro38, Ncri l, Faro29, Faro44, Faro30, Faro35, Faro28, Faro43, Faro19, Tos2985, Tos12465. (41)
??	Tomawawagi, Ebangichi(B), Saganuwangi, Tomako, Ladanchi, Ebangichi(K), Egwazawunkpa, Finniko, Dubbu2, Nassara1, Ndachelegbo, Kparazhikogi, Faro26, Faro32, Faro17, Faro2, Faro47, Faro11, Faro16, Faro10, Faro34, Faro50, Faro45, Faro40, Faro51.(25)

Table 4: Selection for entries with slow disease development

Varieties	20 DAS	60 DAS	Difference
Danboto	3	3	0
Sagannuwngi	7	9	2
Landachi	7	9	2
Ebangichi (Ku)	7	9	2
Gyanako (Ku)	5	7	2
Toma	5	7	2
Finiko	3	5	2
Ebangichi (Ed)	5	7	2
Somazhigi	3	5	2
Bokuchi	5	7	2
Shagari	5	7	2
Ebangichi	5	7	2
Manbechi	1	3	2
Dubbu 1	3	5	2
Akparuga	5	7	2
Gbagudu	3	5	2
Pasankunya	5	7	2
Manbekochi	3	5	2
Bubanfari	3	5	2
Ebangichi (Gz)	3	5	2
Dubbu 2	7	9	2
Nasara 1	7	9	2

Manbechi	1	3	2
Egwazawunkpa (Gz)	3	5	2
Faro 32	7	9	2
Faro 2	7	9	2
Faro 22	3	5	2
Faro 1	5	7	2
Faro 4	3	5	2
Faro 23	1	3	2
Faro 18	1	3	2
Faro 45	5	7	2
Faro 8	3	5	2
Faro 36	5	7	2
NCRI 1	5	7	2
Faro 15	3	5	2
Faro 29	5	7	2
Faro 39	5	7	2
Faro 28	5	7	2
Faro 33	3	5	2
Faro 48	1	3	2
Faro 43	5	7	2
Faro 13	3	5	2
Faro 20	3	5	2
TOS 7730	3	5	2
TOS 14519	1	3	2
Faro 31	0	3	3

The infestations at 40 DAS (Fig. 2) showed that none of the entries scored 0, that is, none was highly resistant. 57.14% of the landraces had a score of 1 (resistant reaction) compared to 6.6% and 1.8% for the improved and the local varieties respectively. At the rate of 3 the percentages were 28.57% (landraces), 22.2% (improved) and 25.5% (local varieties). Looking at the score rate of 5 it was 14.3%, 24.4% and 33.92% for the landraces, improved and the local varieties respectively. At susceptible rate of 7, the improved varieties had a higher percentage of 37.78% compared to 14.3% (landraces) and 21.43% (locals). None of the landraces had a score of 9 at 40 DAS; 12.7% and 11.1% of the local and the improved varieties showed high susceptibility. Fig. 3 is the reaction at 60 DAS and represents the period in which selection for resistant cultivars could be made. Fig. 4 shows percent line infested based on the days of scoring. At 20 DAS, entries reacted to blast between rates of 0 – 7 and at 40 and 60 DAS, it was 1 – 9 and 3 – 9 respectively. The distribution of the varieties based on their reaction to the disease and varietal names is presented in Table 3. None of the entries was highly resistant or resistant (score 0 or 1) to the disease. This shows that none of the materials possessed major gene resistance (McCouch *et al.,* 1994) to blast. 12 entries had a score of 3 (moderately resistant). Higher percentage of the improved and local varieties had a score of 7 (susceptible reaction), Table 4 shows the development of the disease from 20 DAS to 60 DAS. Forty-seven of the entries were selected based on low development of the disease on the test materials. Danboto was the only entry in which the spread of the disease could not increase from 20 DAS to 60 DAS. FAROS 18, 48 and TOS 14519 had initial score of 1 at 20 DAS and score of 3 at 60 DAS. FARO 31 had 0 score at 20 DAS and 3 at 60 DAS. These materials provided a good horizontal resistance and could show stability over time (Anonymous, 1997; 1999).

DISCUSSION

The reaction of these experimental materials to blast is an indication of genes available to be used for the Control of the disease. At 60 DAS, none of the varieties appeared to possess highly resistant or resistant reaction, that is, a score rate of 0 or 1. This indicates that major gene resistance for blast, which has a high habitability value, is absent in this population (Anonymous, 1999). For hybridization programs, cultivars that are completely immune or highly resistant provide easy transfer of gene than cultivars with the value of 3 and above (Anonymous, 1999). At score rate of 3 cultivars have resistant reactions that are durable since they contribute multiple genes that confer partial resistance to the host plant (Bonman *et al.*, 1992). The varieties with a score rate of 3 could be used in hybridization programs. More varieties are at the rate of susceptible reaction, that is, at a score of 7. A zero yield could occur at infestation levels of 7 and 9. The implication of this result is that during outbreak of blast it was expected that 64.28% (score 7 and 9) of the rice cultivated in farmers' fields would be severely affected by blast. For the improved varieties the percentage is 61.6%. Entries with the score of 5 (moderately susceptible) are 29%, they could be used for commercial cultivation but with improved management practices such as good planting time, balanced fertilizer application and good weeding regimes (AAS, 1999).

The rate at which disease developed from the initial infestation is also used as indices for selecting cultivars with resistant genes (Anonymous, 1997). Some varieties slowed down disease severity. For example in this study, Danboto, a local variety has initial score of 3 and final score of 3, suggesting that outbreak of the disease on such a variety may not require any Control measures since the disease will not spread to an economic injury level. Those cultivars with initial score of 7 have already reached a susceptible level when Control measures could have amounted to a waste of resources at that time. Such varieties include Saganuwungi, Landanchi, Ebaangichi (Ku), Nasara , Dubbu 2, Faro 32, Faro 2, (Table 4). Cultivars with initial score of 3 at 20 DAS and final score of 5 at 60 DAS could be adopted for blast Control. According to Anonymous (1997), a delay in outbreak linked to vertical resistance could reduce severity of the disease from 62.5% to 7.5%. In their work they showed that two varieties IET 8113 and Moroberakan started outbreak at the same time but the disease progression was faster on IET 8113 (r-0.27% per day) than Moroberakan (r-0.11% per day) and that IET 8113 had a greater horizontal resistance. They also stated that severity difference between cultivars might be derived from different resistant mechanisms. Fomba (1986), reported that, out of 493 accessions screened for blast resistance in the major agro-climatic zones of Sierra Leone in 1991-1992, only 64 showed good resistance in all locations. Over 70% of these are of African origin including Ngeyemo, Yakei, ITA 120, IRAT 147 and ROK 16. Similarly in this study only 12 out of the 109 varieties representing 11.30% of the materials were moderately resistant (Table 3).

REFERENCES

AAS (Academy of Agricultural Sciences) (1999). Manual for the international training of the rice breeding experts for the effective use of rice genetic resources in developing countries: Pyangyang D.P.R. of Korea Pp3-6

Anonymous, (1997). West Africa Rice Development Association Program Reports Bouake Coted'lvoire pp 46-56

Anonymous, (1999). Rice Interspecific Hybridization Project: West Africa Rice Development Association: Research Highlights pp34.

Awoderu, V.A. (1990). Yield loss attributable to neck-rot of rice caused by *Pyricularia* o*ryzae* Cav.in Coted'lvoire *Tropical Pest Management*, 36,394-396.

Bonman, J.M., Khush G.S. and Nelson R.J. (1992). Breeding rice for resistance to pest. *Ann. Rev. Phytopathos.,* 30, 507-528.

Carpenter, A.J. (1977). Crop losses affecting Rice in Liberia. Plant protection for the rice crop, *Seminar proceedings No 4*. West Africa Rice development Association, Monrovia, Liberia. pp 160-173.

Fomba, S.N. (1986). Grain yield losses caused by neck blast disease. *Pyricularia oryzae* Cav. in unprotected tidal mangrove swamp rice in Sierra Leone *WARDA Technical Newsletter,* 6: 24-25.

Fomba, S.N. and Taylor D.R. (1994). Rice blast in West Africa. It's nature and Control. .
In *rice blast disease* edited by R.S. Zeigler, S.A. leong and P.S. Teng. IRRI pp343-356.

IRRI, (1996). Standard Evaluation system for Rice IRRI, Los Banos Philippines pp52.

OU, S. H (1985). *Rice diseases.* 2nd edition common wealth mycological institute, Kew, UK 380 pp.

Raymoundo, S.A. (1975). Importance of rice diseases in Sierra Leon: Paper presented at the seminar on rice improvement in West Africa. Rice Research Station. Rokup, Sierra Leon.

Reckhaus, P.M and Adamou 1. (1986) Rice diseases and their economic importance in Niger. FAO *Plant Protection Bulletin,* 34,77-82