SELECTION OF RICE CULTIVARS RESISTANT TO SOME PATHOGENS USING SEED HEALTH TESTING[1]

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ABSTRACT - Thirty-six lowland rice (*Oryza sativa* L.) progenies have been tested in yield trials aiming at determining the most important seed-borne fungi and the progeny performance as to each of the pathogens found in seeds, with special emphasis on seed discoloration and consequent seed weight loss. Significant progeny differences as to seven seed-born fungi have been found; however, as far as seed discoloration and consequent seed weight loss are concerned, *Rhynchosporium oryzae*, *Phoma* spp., *Trichoconis padwickii* and *Helminthosporium oryzae* have been the most important pathogens. Seven progenies outperformed IAC-899 (commercial variety used as control) regarding all the parameters analysed. It is concluded that seed health testing is an effective complementary tool in selecting rice germplasms with lower seed-borne fungal incidence.

Index terms: seed pathology, resistance, *Oryza sativa*.

SELEÇÃO DE CULTIVARES DE ARROZ RESISTENTES A ALGUNS PATÓGENOS, MEDIANTE TESTE DE SANIDADE

RESUMO - Trinta e seis progênies de arroz (*Oryza sativa* L.) irrigado foram testadas, em campo, objetivando-se determinar os fungos mais importantes de sementes e o desempenho das progênies com relação a esses patógenos, dando-se ênfase especial à descoloração e conseqüente perda de peso de sementes. Observaram-se diferenças significativas entre progênies quanto à presença de sete fungos de sementes. Entretanto, considerando-se a descoloração e a conseqüente perda de peso de sementes, *Rhynchosporium oryzae*, *Phoma* spp., *Trichoconis padwickii* e *Helminthosporium oryzae* se apresentaram como patógenos mais nocivos. Em todos os parâmetros analisados, sete progênies suplantaram a cultivar comercial IAC-899, usada como controle. Conclui-se que, apesar de trabalhoso, o teste de sanidade de sementes é um instrumento muito eficaz na seleção de novos germoplasmas de arroz com baixa incidência de fungos de sementes.

Termos para indexação: patologia de sementes, resistência, *Oryza sativa*.

INTRODUCTION

The use of seed health testing as an effective tool in rice breeding programs has not been reported on before. The IAC long-term lowland rice breeding program has had several aims throughout the years, but none of tem has dealt with seed discoloration problems.

According to reports coming from southeastern, south and central parts of Brazil (Lasca et al. 1979, Ribeiro 1979 and Urben & Wetzel 1980), there has been a significant increase in the percentage of incidence of discolored seeds in commercial rice crops.

Up to now all IAC-released lowland rice varieties: IAC-120, IAC-435, IAC-841 and IAC-899 have shown moderate to high susceptibility levls to seed-borne fungi. Therefore the search for new genetic material tolerant to several types of kernel spot has recently received renewed attention.

Rice panicles are attacked by several fungi from flowering to maturity causing failure of grain formation or discolored grains. Severely affected light weight kernels are lost in harvesting operations and can significantly reduce rice yields. On the other hand, high incidence of discolored seeds in rice seed lots reduces the price received by rice growers.

Many fungi such as *Alternaria* sp., *Aspergillus flavus*, *Botrytis* sp., *Cladosporium miyakei*, *Curvularia lunata*, *C. geniculata*, *Diplodia oryzae*, *Epicoccum purpurascens*, *Fusarium graminearum*, *Fusarium* spp., *Helminthosporium oryzae*, *Nigros-*

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pora oryzae, *N. sphaerica*, *Penicillium* sp., *Phoma glumarum*, *Phoma* sp., *Pyricularia oryzae*, *Pythium* sp. and *Septoria* sp. have been isolated from rice discolored grains (Ou 1972, Atkins 1974, Ribeiro 1979 and Richardson 1979).

Although a large number of seed-discolorating fungi have been detected so far, very little is known about the symptoms they cause and the resultant yield losses in different varieties.

The main objectives of this research have been to determine the most frequent seed-discolorating fungi occuring in IAC-high performance progenies, as well as to check out the feasibility of using seed health testing in the selection scheme of new lowland rice cultivars.

MATERIAL AND METHODS

Yield trials were carried out at two sites (Tremembé and Pindamonhangaba, State of São Paulo), during 1980/81, aiming at testing the performance of 36 lowland rice progenies. The experimental design was a lattice 6 x 6 + 1, with three replications per site, the cultivar IAC-899 being used as a control. Experimental plots had five rows with 5 m length each, spaced 30 cm apart. Normal NPK fertilization was applied according to soil analysis.

At harvest, 200 g seed samples were drawn from the three inner lines of each experimental plot. Afterwards each sample was further subdivided in four 25-seed subsamples for seed health testing.

Seeds were analysed by the standard blotter test, following the methodology reported by the International Seed Testing Association (1966), Mathur & Neergaard (1972), Neergaard & Saad (1973) and Neergaard (1977). Twenty-five untreated seeds were placed in a plastic petri dish and then exposed, for a week, to an alternate light regimen (12 hours at NUV and 12 hours at darkness). A binocular stereoscopic microscope (6 to 50X) and and optical microscope were used for seed examination.

Additional 5 g sub-samples were drawn from the original 200 g samples in order to determine the discolored seed and the weight loss (due to discoloration) percentages. To do so, spotless and spotted seeds were counted separately. The following formula were applied for those calculations:

$$DS\ (\%) = \frac{D}{T} \times 100 \text{ where}$$

DS (%) = discolored seed percentage.
T = sample total weigh (5 grams).
D = discolored seed weight.

$$WL\ (\%) = \frac{SLW - SDW}{SLW} \times 100 \text{ where}$$

WL (%) = weight loss (due to discoloration) percentage.
SLW = weight of 100 spotless seeds.
SDW = weight of 100 spotted seeds.

The data obtained for DS (%) and WL (%) were transformed into arc sin $\sqrt{\%}$ and a statistical analysis performed on the transformed data. In the same way the data obtained for number of seeds with each fungus were transformed into $\sqrt{x + 0,5}$ and a statistical analysis performed on the transformed data. Correlation coefficientes between DS (%), WL (%) and the number of seeds infected with each fungus were also calculated.

RESULTS AND DISCUSSION

The results of discolored seed percentages, weight loss percentages and the number of seeds infected with each fungus for each progeny are shown in Tables 1 and 2 for Tremembé and Pindamonhangaba, respectively.

Epicoccum spp., *Trichoconis padwickii*, *Phoma* spp., *Helminthosporium oryzae*, *Pyricularia oryzae*, *Curvularia* spp. and *Rhynchosporium oryzae* have been the most frequent pathogenic agents found in the seed samples drawn from the 36 lowland rice progenies studied. Of those pathogens only *Rhynchosporium oryzae* had not been reported in Brazil up to 1982, although it has previously been found in rice seeds in Costa Rica by De Gutierrez (1960).

A significant correlation coefficient ($r = 0.37$; $t = 2.37^{*}$) between discolored seed percentage and number of seeds infected with *Rhynchosporium oryzae* was revealed at Tremembé. Similarly a highly significant correlation between weight loss percentage and number of *Phoma* spp. infected seeds ($r = 0.45$; $t = 0.31^{**}$) was detected at the same site. Additionally, *Trichoconis padwickii* infected seed frequencies correlated well with weight loss percentage ($r = 0.47$; $t = 3.12^{**}$) whereas a highly significant correlation coefficient was found between *Helminthosporium oryzae* infected seeds and weight loss percentage ($r = 0.43$; $t = 2.82^{**}$), at Pindamonhangaba.

In this way, *Rhynchosporium oryzae* and *Phoma* spp. can be considered as the most important

TABLE 1. Discolored seed, weight loss percentage, mean results and average number of seeds infected with *Epicoccum* spp., *Trichoconis padwickii, Rhynchosporium oryzae, Phoma* spp., *Helminthosporium oryzae, Pyricularia oryzae* and *Curvularia* spp. in 36 lowland rice progenies tested in yield trials carried out at Tremembé, SP, during 1980/81. (Seed sample size = 100 seeds).

Progeny	DS %	WL %	*Epicoc.* spp.	*T. padwickii*	*R. oryzae*	*Phoma* spp.	*H. oryzae*	*P. oryzae*	*Curvul.* spp.
CICA-8	46.1 b	5.4 a	23.1 b	2.6 b	11.6 c	1.5 a	8.1 a	0.7 a	0.2 a
IR-3518	68.0 c	2.6 a	21.4 a	0.6 b	6.7 a	4.1 a	10.9 c	1.3 a	1.1 b
IET-6503	41.2 a	32.4 c	24.4 c	3.7 b	6.0 a	9.1 c	6.0 a	0.9 a	5.1 c
IET-4094	44.76	12.9 b	24.6 c	4.3 c	7.9 b	8.3 c	6.8 a	0.2 a	2.4 b
IET-2881	47.2 b	24.3 c	23.1 b	1.1 b	6.8 a	9.5 c	3.4 a	3.9 b	2.6 b
BR-541	45.8 b	15.4 b	23.1 b	1.5 b	10.7	8.9 c	9.9 c	0.0 a	2.7 b
IR-9129	27.8 a	15.5 b	24.6 c	0.9 b	5.1 a	3.2 a	8.5 b	0.4 a	0.2 a
IET-6507	49.6 b	16.7 b	22.8 b	1.5 b	7.1 a	10.5 c	3.7 a	1.3 a	1.5 b
IR-2070	44.1 b	10.7 a	24.1 c	1.9 b	5.3 a	1.5 a	5.4 a	0.2 a	1.1 b
PI-1278	53.2 b	6.3 a	23.4 b	3.0 b	11.3 c	1.1 a	8.4 b	0.3 a	0.2 a
PI-1291	73.7 c	3.6 a	24.9 c	0.6 b	7.5 b	4.0 a	7.5 a	0.2 a	0.4 b
PI-1332	77.9 c	6.2 a	24.9 c	1.1 b	12.7 c	2.7 a	13.2 c	0.6 c	0.4 b
PI-1356	66.7 c	6.2 a	24.4 c	0.9 b	13.1 c	1.8 a	11.3 c	0.2 a	0.3 a
PI-1377	52.7 b	7.0 a	24.9 c	1.7 b	9.4 b	2.1 a	10.3 c	0.9 a	0.4 b
IR-1544	56.7 b	6.1 a	24.4 c	0.7 b	9.9 b	3.1 a	8.5 b	0.0 a	1.0 b
IRGA-409	43.9 b	17.1 c	24.4 c	0.4 a	7.7 b	14.1 c	2.2 a	0.2 a	5.2 c
L-8-38	57.9 b	13.2 b	24.6 c	1.1 b	11.3 c	10.9 c	11.9 c	0.0 a	1.1 b
L-7-33	57.0 b	17.8 c	24.6 c	3.0 b	9.4 b	3.2 a	10.1 c	0.0 a	1.3 b
L-8-36	60.3 b	12.4 b	24.9 c	1.3 b	8.6 b	5.3 c	11.1 c	0.4 a	1.2 b
MAI-F3-3	66.7 c	13.1 b	24.9 c	2.6 b	12.1 c	7.4 c	5.7 a	0.2 a	1.9 b
L-1-43	62.4 b	15.1 b	24.6 c	2.2 b	8.6 b	3.4 a	13.8 c	0.2 a	3.3 b
PI-2-48	56.1 b	8.1 a	24.9 c	2.2 b	9.9 b	4.6 b	9.9 c	0.0 a	0.7 b
PI-1-40	43.1 b	22.9 c	24.4 c	4.8 c	11.8 c	12.4 c	13.8 c	0.0 a	2.1 b
PI-1-39	41.9 a	21.6 c	24.9 c	1.5 b	9.4 b	3.0 a	3.9 a	0.4 a	1.9 b
P-2-S-2	80.1 c	7.3 a	24.9 c	2.1 b	11.0 c	0.0 a	10.6 c	0.8 a	0.6 b
H-73-1-53	61.9 b	12.8 b	24.6 c	2.2 b	8.6 b	2.4 a	8.6 b	0.0 a	1.7 b
75-500	68.2 c	17.6 c	23.6 b	2.4 b	15.4 c	3.1 a	12.1 c	1.3 a	1.7 b
P-2-S-1-78	67.4 c	2.8 a	24.1 c	3.2 b	5.1 a	4.2 b	10.9 c	0.4 a	0.3 a
L-17-72	54.0 b	8.7 a	24.9 c	0.9 b	7.8 b	2.2 a	4.2 a	0.7 a	0.8 b
GI-6902-76	74.2 c	14.4 b	24.6 c	1.7 b	7.3 a	3.5 a	4.6 a	0.2 a	1.5 b
GI-6904-4	50.5 b	9.3 a	24.9 c	1.5 b	9.0 b	6.3 c	11.8 c	0.2 a	0.9 b
GI-7004-3	70.2 c	16.8 b	24.9 c	1.9 b	5.0 a	7.5 c	3.3 a	0.2 a	1.9 b
GI-74-27	50.9 b	5.3 a	24.9 c	1.7 b	8.1 b	9.2 c	14.9 c	8.7 c	0.4 b
GI-76-70	47.9 b	7.4 a	24.1 c	0.6 b	3.0 a	1.3 a	11.1 a	1.1 a	1.5 b
GI-74-29	47.3 b	13.1 b	24.9 c	0.2 a	3.0 a	0.2 a	8.1 a	0.8 a	1.1 b
GI-6904-2	59.9 b	6.8 a	24.9 c	0.2 b	7.9 b	3.5 a	8.9 b	2.2 a	4.1 b
IAC-899-(Control)	74.5 c	9.1 a	24.6 c	2.5 b	17.6 c	7.1 c	19.1 c	0.2 a	0.2 a
CV (%)	5.0	14.5	1.7	27.1	15.1	23.9	15.6	31.6	34.4

DS (%) = discolored seed percentage
WL (%) = weight loss (due to discoloration) percentage
CV (%) = coefficient of variability
Data followed by the same letter, in the same column are not significantly different according to Tukey test at. 01 significance level.

TABLE 2. Discolored seed, weight loss percentage, mean results and average number of seeds infected with *Epicoccum* spp., *Trichoconis padwickii, Rhynchosporium oryzae, Phoma* spp., *Helminthosporium oryzae,* and *Pyricularia oryzae* in 36 lowland rice progenies tested in yield trials carried out at Tremembé, SP, during 1980/81. (Seed sample size = 100 seeds).

Progeny	DS %	WL %	*Epicoc.* spp.	*T. padwickii*	*R. oryzae*	*Phoma* spp.	*H. oryzae*	*P. oryzae*
CICA-8	72.4 b	6.0 b	0.6 a	5.6 b	10.7 b	1.7 a	18.5 b	0.0 a
IR-3518	46.3 b	2.6 a	1.5 a	2.7 a	5.4 a	2.0 a	15.6 b	1.5 b
IET-6503	51.5 b	10.6 c	0.2 a	5.6 b	5.0 a	4.7 a	16.3 b	0.2 a
IET-4094	54.5 b	8.7 b	0.4 a	12.0 c	4.8 a	9.7 c	19.4 c	0.0 a
IET-2881	51.4 b	13.3 c	6.1 b	6.6 b	8.4 b	6.3 b	15.6 b	0.3 a
BR-541	51.6 b	11.7 c	3.4 a	5.9 b	7.2 b	4.2 a	22.2 c	1.3 b
IR-9129	32.7 a	8.0 b	3.1 a	5.2 b	9.4 b	11.2 c	17.1 b	0.2 a
IET-6507	75.6 b	6.1 b	1.0 a	6.6 b	8.3 b	11.8 c	17.3 b	0.4 a
IR-2070	53.5 b	8.4 b	3.0 a	3.5 a	10.8 b	5.9 a	12.0 a	0.6 a
PI-1278	71.4 b	6.3 b	0.9 a	5.0 b	13.7 c	5.8 a	16.1 b	0.4 a
PI-1291	78.1 c	3.1 a	4.5 a	1.8 a	5.5 a	9.2 c	10.2 a	0.4 a
PI-1332	87.3 c	4.7 a	3.1 a	3.7 a	7.9 b	4.7 a	14.8 b	2.5 b
PI-1356	78.3 c	8.6 b	0.9 a	3.0 a	11.1 b	15.5 c	19.8 c	0.2 a
PI-1377	67.3 b	6.1 b	1.8 a	1.8 a	7.3 b	14.3 c	13.6 a	1.3 b
IR-1544	67.6 b	12.0 c	21.3 c	6.5 b	8.2 b	9.8 c	20.8 c	0.0 a
IRGA-409	52.7 b	6.0 b	3.5 a	4.5 a	5.7 a	15.6 c	17.3 b	0.0 a
L-8-38	59.5 b	11.0 c	10.0 c	10.7 c	6.6 b	9.0 c	17.6 b	1.1 b
L-7-33	57.3 b	9.1 b	8.1 b	10.4 c	7.6 b	6.5 b	16.3 b	0.6 a
L-8-36	62.6 b	8.3 b	11.6 c	5.9 b	6.7 b	6.1 a	17.9 b	0.4 a
MAI-F3-3	68.0 b	8.7 b	9.4 c	9.0 b	9.9 b	8.4 c	18.6 b	0.6 a
L-1-43	68.4 b	8.3 b	4.0 a	16.4 c	7.1 b	5.2 a	19.9 c	0.6 a
P-2-48	53.9 b	7.1 b	1.5 a	12.4 c	11.4 b	3.6 a	20.1 c	0.2 a
P-1-40	44.0 a	13.6 c	4.7 a	13.6 c	8.7 b	8.3 c	18.9 b	0.3 a
P-1-39	43.6 a	12.3 c	2.6 a	16.8 c	7.6 b	9.3 c	18.9 b	0.5 a
P-2-S-2	76.3 b	9.3 b	3.4 a	12.3 c	14.9 c	3.4 a	17.6 b	0.2 a
H-73-1-53	60.4 b	8.2 b	4.9 a	9.1 b	12,1 b	2.8 a	21.6 c	0.0 a
75-500	74.4 b	11.4 c	8.9 c	14.6 c	12.6 b	6.9 b	20.2 c	0.0 a
P-2-S-1-78	76.5 b	5.9 b	6.6 b	13.0 c	7.3 b	7.3 b	17.4 b	1.7 b
L-17-72	49.7 b	6.4 b	20.3 c	1.3 a	5.6 a	3.2 a	11.8 a	0.3 a
GI-6902-76	82.3 c	11.8 c	9.9 c	10.0 c	10.5 b	12.2 c	18.2 b	0.0 a
GI-6904-4	69.1 b	9.4 b	12.8 c	7.8 b	8.9 b	7.4 b	16.4 b	1.1 b
GI-7004-3	68.7 b	11.8 c	14.6 c	6.5 b	8.4 b	12.6 c	11.5 a	0.0 a
GI-74-27	42.4 a	9.3 b	10.3 c	4.7 b	6.4 b	4.6 a	23.9 c	5.2 c
GI-76-70	36.9 a	12.4 c	6.9 b	5.7 b	11.2 b	12.8 c	22.6 c	1.2 b
GI-74-29	32.6 a	14.4 c	6.4 b	8.2 b	10.5 b	5.1 a	22.8 c	0.7 a
GI-6904-2	62.8 b	8.7 b	5.2 a	12.7 c	7.9 b	9.2 c	19.7 c	1.5 b
IAC-899-(Control)	78.8 c	5.3 b	7.6 b	8.0 b	9.7 b	6.2 b	19.4 c	0.0 a
CV (%)	4.0	15.3	21.6	21.6	14.6	16.4	8.7	35.2

DS (%) = discolored seed percentage
WL (%) = weight loss (due to discoloration) percentage
CV (%) = coefficient of variability
Data followed by the same letter, in the same column are not significantly different according to Tukey at .01 significance level.

fungi causing seed discoloration and seed weight loss at Tremembé, whereas *Trichoconis padwickii* and *Helminthosporium oryzae* can be considered as the most important fungi at Pindamonhangaba. It is noteworthy that rice seed discoloration can be caused by one or more seed-borne fungi, depending on the rice-growing region studied.

As seed pathogen incidence can show variations according to the year (Lasca et al. 1979), the selection scheme to obtain rice germplasms more tolerant to seed pathogens should take into account seed health testing carried out for more than one year at several sites.

No single rice progeny has presented the best results for all fungi and parameters analysed; however, CICA-8, IR-3518, IR-9129, IET-6507, IR-2070, PI-1278 and L-17-72 performed quite well, as compared to IAC-899 (commercial variety used as control), regarding the majority of the parameters studied.

These results confirm the high performance of CICA-8 and PI-1278, released by IAC as new lowland rice varieties in 1982. Both of them possess high yielding potential, good milling and cooking characteristics and other desirable agronomic features, associated to relatively low seed-borne fungi incidence, seed discoloration and weight loss due to seed discoloration.

Finally seed health testing can help breeders in selecting rice cultivars which present lower incidence of seed-borne fungi.

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