INHERITANCE OF RESISTANCE TO LEAF BLAST IN SOMACLONES OF RICE CULTIVAR "ARAGUAIA"

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ABSTRACT

The inheritance of resistance to leaf blast [*Pyricularia grisea* (Cooke) Sacc.] in three somaclones of the upland rice cultivar "Araguaia" was studied. Artificial inoculations were made with spore suspension of race IB-45 of *P. grisea* on 21-day old plants of F_1, F_2, BC_1 and $F_{2:3}$ generations of crosses between three resistant somaclones and the susceptible cultivars "Araguaia" and "IAC 201". Disease evaluations were made nine days after inoculation based on the compatible and incompatible reactions. The F_2 populations from the crosses between "Araguaia" as well as "IAC 201"and somaclones segregated in a ratio of three resistant to one susceptible plant, indicating that the trait is controlled by a single gene with dominance of the allele that conditions resistance to race IB-45 in these somaclones. These results were confirmed by segregation ratios of the BC_1 and $F_{2:3}$ progenies. No segregation for susceptibility was observed in the F_2 progenies of crosses between somaclones, showing thereby that the same gene controls resistance in the somaclones. The dominant gene that conferred resistance to the race IB-45 in these somaclones was designated as *Pi-ar*.

Key words: *Pyricularia grisea*, tissue culture, *Oryza sativa*, inheritance of resistance.

RESUMO

Análise genética da resistência à brusone nas folhas em somaclones da cultivar de arroz "Araguaia"

Foi estudada a herança da resistência à brusone (*Pyricularia grisea*) nas folhas em somaclones da cultivar de arroz de sequeiro "Araguaia". Inoculações artificiais foram feitas com suspensão de esporos da raça IB-45 de *P. grisea* em plantas de 21 dias de idade nas gerações F_1, F_2, RC_1 e $F_{2:3}$ provenientes de cruzamentos de três somaclones com as cultivares suscetíveis "Araguaia" e "IAC 201". As avaliações foram feitas aos nove dias após a inoculação, baseando-se em reações compatíveis e não compatíveis. As populações F_2 dos cruzamentos entre os somaclones e as cultivares "Araguaia" e "IAC 201" segregaram na proporção de três plantas resistentes para uma suscetível, indicando que o caráter é controlado por um gene com dominância do alelo que condiciona a resistência para a raça IB-45, sendo confirmado pelas segregações dos retrocruzamentos e famílias $F_{2:3}$. Os cruzamentos entre os somaclones não mostraram segregação, indicando, possivelmente, que o mesmo gene controla a resistência à brusone. O gene dominante que condiciona resistência para raça IB-45 nestes somaclones foi designado como *Pi-ar*.

One of the major objectives of the rice improvement program of Embrapa Arroz e Feijão (National Rice and Bean Research Center) is to obtain cultivars resistant to rice blast. Several rice cultivars and breeding lines with a moderate to high degree of blast resistance have been developed. "Araguaia" was one of the first widely cultivated rice cultivars bred for blast resistance. It was derived from a cross between IAC 47 and a blast-resistant line TOS 2578/7-4-2-3-B2, introduced from Nigeria. The resistance of this cultivar was broken two years after its release, resulting in considerable grain yield losses.

Tissue culture has been widely employed as an alternative to the conventional breeding procedure for the development of disease resistant lines in several crops (Araújo *et al.*, 1997; Cai *et al.*, 1990; Fukui, 1983). The genetic variation in tissue culture-derived plants for disease resistance has been extensively reviewed (Daub, 1986; Zapata et al., 1995). Induction and selection of mutants at the cellular level are probably the most useful applications of tissue and cell culture techniques (Swaminathan, 1982). Both recessive and dominant gene mutations have been reported in somaclones for different traits including disease resistance (Fukui, 1983; Cai *et al.*, 1990). The analysis of the inheritance of two sheathblight-resistant somaclones derived from the susceptible rice cultivar Labelle has shown that resistance, in the somaclones, was controlled by major genes (Xie *et al.*, 1990). Both recessive and dominant gene mutations at one, two or three loci were reported to occur in somaclones of wheat (Cheng *et al.*, 1992). Somaclonal variation in rice has not always been random and those specific loci had higher mutation rates during the somaclonal procedure (Xie *et al.*, 1995).

Somaclones highly resistant to rice blast have been successfully developed from the susceptible rice cultivar "Araguaia" (Araújo *et al.*, 1997). The somaclones of "Araguaia" differ from the parent cultivar in fanshaped plant type and blast resistance. However, there is very little information about the inheritance of resistance in these somaclones. Such knowledge is a prerequisite for adopting an adequate breeding strategy employing somaclonal variants as useful sources of resistance. Earlier genetic investigations on the mode of leaf blast resistance with different races of the pathogen have revealed that resistance is controlled by independent dominant genes in the near-isogenic lines of C039 (Mackill & Bonmann, 1992). In Brazil, the inheritance studies of blast resistance, in rice, to two predominant races IB-1 and IB-9 of *P. grisea* have shown that resistance is controlled by three genes which segregate independently (Filippi & Prabhu, 1996). The mode of inheritance of leaf blast resistance in three somaclones SC9, SC10 and SC23 of "Araguaia" is herein reported.

An isolate identified as race IB-45 was used for inoculations in the present study. Crosses were made between susceptible cultivars, employing "Araguaia" and "IAC 201" as female parents, and three somaclones derived from "Araguaia" as male parents. The F_1, F_2, $F_{2:3}$, and backcross proge-

TABLE 1 - Segregation of F_1, F_2, BC_1 and F_3 populations involving susceptible (S) and resistant (R) parents to race IB-45 of *Pyricularia grisea*.

Parentage	Parent reaction	Generation	Observed data		Expected ratio*	χ^2	Probability
			R	S			
"Araguaia" x SC9	S x R	F_1	20	0	R	–	–
		F_2	290	105	3:1	0.42	0.50-0.25
		BC_1**	17	13	1:1	0.53	0.50-0.25
		F_3	26	15	3:1	2.93	0.10-0.05
"Araguaia" x SC10	S x R	F_1	20	0	R	–	–
		F_2	302	105	3:1	0.13	0.75-0.50
		BC_1	19	16	1:1	0.24	0.75-0.50
		F_3	26	13	3:1	1.92	0.25-0.10
"Araguaia" x SC23	S x R	F_1	20	0	R	–	–
		F_2	290	102	3:1	0.21	0.75-0.50
		BC_1	19	15	1:1	0.46	0.50-0.25
		F_3	30	12	3:1	0.28	0.50-0.75
SC9 x SC10	R x R	F_1	20	0	R	–	–
		F_2	100	0	R	–	–
		F_3	40	0	R	–	–
SC9 x SC23	R x R	F_1	20	0	R	–	–
		F_2	100	0	R	–	–
		F_3	40	0	R	–	–
SC10 x SC23	R x R	F_1	20	0	R	–	–
		F_2	100	0	R	–	–
		F_3	40	0	R	–	–
"IAC 201" x SC9	S x R	F_1	20	0	R	–	–
		F_2	55	25	3:1	0.82	0.90-0.75
		BC_1	14	13	1:1	0.07	0.90-0.75
		F_3	28	14	3:1	0.75	0.50-0.25
"IAC 201" x SC10	S x R	F_1	20	0	R	–	–
		F_2	62	21	3:1	0.004	0.99-0.90
		BC_1	16	13	1:1	0.31	0.75-0.50
		F_3	29	13	3:1	0.75	0.50-0.25
"IAC 201" x SC23	S x R	F_1	20	0	R	–	–
		F_2	56	26	3:1	1.92	0.25-0.10
		BC_1	16	14	1:1	0.13	0.75-0.50
		F_3	29	13	3:1	0.75	0.50-0.25

* Ratio = Resistant to susceptible
** BC_1 = Backcrossed to susceptible parent

nies (BC_1) of three crosses were tested for their reaction to race IB-45, under controlled conditions of inoculation, in the greenhouse.

Plants were grown in plastic trays (30x10x15cm) containing 6Kg of soil fertilized with 5.0g of NPK (4-30-16), 1.0g of zinc sulfate and 2.0g of ammonium sulfate at planting. Top dressing was done with 2g of ammonium sulfate per tray. Inoculations were made on 21-day-old plants with 30 ml of spore suspension per tray (10^5 spores/ml). Spore suspension was prepared as described by Prabhu *et al.* (1992). Each tray had ten rows with about 80 plants of segregating populations. Following inoculation, the trays were incubated for 24 hr in humid chambers and later they were maintained at high humidity (70-90%) with an average temperature ranging from 26-30 °C. The reaction of parents, F_1 and $F_{2:3}$ families was determined on a row basis, while F_2 and BC_1 generations were assessed on an individual plant basis. Disease reaction was evaluated 7 to 9 days after inoculation based on a 0 to 9 scale. The disease severity ratings 0 to 1 represented incompatible reactions (resistant), and 3 to 9, compatible reactions (susceptible). All plants or families $F_{2:3}$ exhibiting 0 to 1 reaction were considered resistant.

The reactions of F_1, F_2 and $F_{2:3}$ progenies from the cross of "Araguaia" and "IAC 201" with three resistant somaclones are presented in Table 1. The progenies from the crosses of "Araguaia" with SC9, SC10 and SC23 were resistant to race IB-45, thereby indicating the dominant nature of resistance in those somaclones. The F_2 population from the crosses of "Araguaia" with somaclones segregated in the ratio of three resistant to one susceptible plant, indicating that this characteristic is controlled by a single gene with the allele that conditions resistance being dominant. Backcrosses to the susceptible parent segregated as expected in a 1:1 ratio of resistant and susceptible. The $F_{2:3}$ families from these crosses also segregated in a 3:1 ratio, confirming the dominant monogenic nature of resistance. Similar results were obtained from inoculation tests of the progenies of crosses of "IAC 201" with the three resistant somaclones (Table 1).

There was no segregation in the F_2 populations of crosses among resistant somaclones (Table 1). It can be concluded that these three somaclones may carry the same dominant gene for resistance to isolate IB-45, and is designated as *Pi-ar*. This constitutes the first report of the induction of gene mutation in a susceptible rice cultivar for race-specific resistance to *P. grisea,* through tissue culture. This novel resistance gene can be incorporated into commercial susceptible cultivar "Araguaia", either by a conventional backcross breeding procedure, or molecular mediated selection.

LITERATURE CITED

ARAÚJO, L.G., PRABHU, A.S. & FREIRE, A.B. Variação somaclonal na cultivar de arroz IAC-47 para resistência à brusone. Fitopatologia Brasileira 22:125-130. 1997.

CAI, T., EJETA, G., AXTELL, J.D. & BUTLER, L.G. Somaclonal variation in high tannin sorghums. Theoretical and Applied Genetics 79:737-747. 1990.

CHENG, X.Y., GAO, M.W., LIANG, Z.Q., LIU, G.Z. & HU, T.C. Somaclonal variation in winter wheat: frequency, occurrence and inheritance. Euphytica 64:1-10. 1992.

DAUB, M.E. Tissue culture and the selection of resistance to pathogens. Annual Review of Phytopathology 24:159-186. 1986.

FILIPPI, M.C. & PRABHU, A.S. Inheritance of blast resistance in rice to two *Pyricularia grisea* races, IB-1 and IB-9. Revista Brasileira de Genética 19:599-604. 1996.

FUKUI, K. Sequential occurrence of mutation in a growing rice callus. Theoretical and Applied Genetics 65:225-230. 1983.

MACKILL, D.J. & BONMANN, J.M. Inheritance of blast resistance in near-isogenic lines of rice. Phytopathology 82:746-749. 1992.

PRABHU, A.S., FILIPPI, M.C. & CASTRO, N. Pathogenic variation among isolates of *Pyricularia oryzae* affecting rice, wheat and grasses in Brazil. International Journal of Pest Management 38:367-371. 1992.

SWAMINATHAN, M.S. Biotechnology research and third world agriculture. Science 218:967-974. 1982.

XIE, Q.J., RUSH, M.C. & CAO, J. Somaclonal variation for disease resistance in rice (*Oryza sativa* L.). *In*: Grayson, B.T., Green, M.B. & Copping, L.G. (ed.). Pest Management on Rice. London, Elsevier, 1990. pp.491-509.

XIE, Q.J., RUSH, M.C. & OARD, J.H. Homozygous variation in rice somaclones: nonrandom variation instead of mitotic recombination. Crop Science 35:954-957. 1995.

ZAPATA, F.J., TORRIZO, L.B. & ANDO, A. Current developments in plant biotechnology for genetic improvement: the case of rice (*Oryza sativa* L.). World Journal of Microbiology & Biotechnology 11:393-399. 1995.

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