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GENETICS OF PHENOL COLOUR REACTION IN UPLAND RICE (*ORYZA SATIVA* L.) CULTIVARS

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ABSTRACT

Genetics of phenol colour reaction was investigated in five intervarietal crosses. The segregation pattern of F_2 and F_3 generations indicated that single dominant gene confered phenol colour reaction in the crosses : UPR 103-30-6 × ITA 257, ITA 257 × RR 215-2; ITA 257 × RR 203-2 and RR 215-2 × Khaolo 33. But in the cross, Khaolo 33 × Kalinga III, two genes, one basic (ph) and other inhibitory (I) governed this character.

Keywords : *Oryza sativa L.*, upland rice, phenol reaction, genetics

Rice grain exhibiting browning or blackening when subjected to aqueous solution of phenol (C_6 H_5 OH) has been used as one of the criteria for ascertaining genetic purity of a variety, cultivar identification and characterization of rice germplasm [1-4]. Activity of polyphenol oxidase and similar enzymes, responsible for browning/blackening of rice grain are mainly localized in the rice husk as brown rice showed little change in colour. The phenol colour reaction provides an index of activities of such enzymes. Prasada Rao and Misro [5] reported that this trait is governed by a single dominant gene in *javanica* rice. The present investigation attempts to elucidate the inheritance of this character in some upland cultivars.

MATERIALS AND METHODS

The experimental materials comprised five intervarietal crosses derived by hybridizing two exotic rice cultivars, ITA 257 (an improved upland cultivar from IITA, Nigeria) and Khaolo 33 (a traditional upland cultivar from Thailand) having negative phenol reaction with UPR 103-30-6, RR 203-2, RR 215-2 and Kalinga III showing positive phenol reaction. The parents, F_1, F_2 and F_3 generation of these

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crosses (Table 1) were grown during 1994 wet season. Twenty one-day-old seedlings were transplanted, 15 X 15 cm apart, cone seedling per hill in 3.2 m long rows. The crop was raised as transplanted rainfed at 60 N : 13 P : 17 K (Kg/ha). Standard agronomic practices were followed to raise a good crop.

Observations were recorded on five plants for each P_1, P_2 and F_1 of the cross. The F_2 sample size ranged from 100 to 254. There were 71-100 F_3 families. In each F_3 family 10 plants were studied to judge the segregation pattern. Twenty seeds from each plant were soaked in 0.25% aqueous solution of phenol (C_6H_5OH, AR grade, F. P. 40.5-41°C, Mol. wt. 94.11 and purity 99.9%) for 48 h. at room temperature. The phenol reaction was rated as no colour development, designated as (–), or colour development (browning or blackening of grains), designated as positive (+). In the segregating populations the colour development was recorded using parents of the respective cross as checks. The χ^2 test was applied to test for the goodness of fit for the genetic ratios.

RESULTS AND DISCUSSION

The phenol reactions of the parents, F_1 and F_2 of the five crosses have been presented in Table 1. Except the cross RR 215-2 X Khaolo 33, where the intensity of colour development in F_1 was slightly less than that of the phenol +ve parent (RR 215-2), in the other crosses, F_1's showed either similar or higher intensity of coloration than the parents indicating the dominance/overdominance of positive phenol reaction.

Table 1. Phenol colour reaction of parental, F_1 and F_2 generations of five upland rice crosses.

Cross	P_1	P_2	F_1	F_2		Expected ratio	χ^2	P-value
				(+)	(–)			
UPR 103-30-6 × ITA 257	++	–	+++	77	23	3:1	0.32	0.75-0.50
ITA 257 × RR 215-2	–	+++	+++	159	42	3:1	1.81	0.25-0.10
Khaolo 33 × Kalinga III	–	+	++	177	51	13:3	1.96	0.25-0.10
RR 215-2 × Khaolo 33	+++	–	++	190	64	3:1	0.01	0.95-0.90
ITA 257 × RR 203-2	–	+	+++	105	31	3:1	0.35	0.75-0.50

The F_2 populations from the crosses, UPR 103-30-6 × ITA 257; ITA 257 × RR 215-2; Khaola 33 × Kalinga; RR215-2 × Khaolo 33 and ITA 257 × RR 203-2

(Table 1) segregated in to 3 (phenol positive) : 1 (phenol negative) ratio. The F_3 progenies (Table 2) of these crosses gave a good fit to the ratio 1 (positive) : 2 (segregating) : 1 (negative). The results indicated that positive phenol reaction in these crosses was conditioned by a pair of dominant genes. Prasada Rao and Misro [5] and Choi [6] also reported monogenic inheritance for this trait.

Table 2. Segregation pattern of F_3 families for phenol colour reaction in five upland rice crosses

Cross	Number of F_3 families with phenol colour reaction			Expected ratio	χ^2	P- value
	(+)	(+/-)	(-)			
UPR 103-30-6 × ITA 257	21	34	16	1:2:1	0.84	0.75-0.50
ITA 257 × RR 215-2	19	50	22	1:2:1	1.06	0.75-0.50
Khaolo 33 × Kalinga III	38	51	11	7:8:1	4.29	0.25-0.10
RR 215-2 × Khaolo 33	22	47	25	1:2:1	0.29	0.90-0.75
ITA 257 × RR 203-2	26	57	17	1:2:1	3.58	0.25-0.10

In the F_2 population of the cross Khaolo 33 × Kalinga III, 177 plants gave positive and 51 negative phenol reaction. The data gave a good fit to a digenic ratio of 13 positive : 3 negative thereby indicating that one dominant basic gene (ph) for phenol negative reaction in association with one inhibitory gene (I) governed the expression of phenol reaction in this cross. The segregation of F_3 families (7 positive : 8 segregating : 1 negative) confirmed the validity of F_2 segregation ratio (Table 2).

The findings of the present investigation suggest that phenol reaction in rice is a simply inherited trait and governed by one to two pairs of major genes.

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