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INHERITANCE OF GRAIN SIZE AND ITS INTERRELATIONSHIP IN RICE

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ABSTRACT

Inheritance of grain size, nature of panicle, awning and plant habit was studied in two crosses. Roti, a tall variety with normal panicles having long grains was crossed with two phenotypically similar dwarf mutants with cigar shaped panicles having short and round grains. Monogenic and trigenic ratios for grain size were obtained in F_2 generation. Dwarf plant habit was associated with cigar shaped panicle possessing short and round grains, indicating pleiotropic gene action. Digenic and tetragenic ratios were obtained for awning, indicating two and four gene interactions for expression of awns in these crosses.

Key words: Inheritance study, grain size, rice.

Grain size in rice is reported to be controlled by one or two major genes. The gene for short grain is dominant over that for long grain [1–3], although the simple dominance of the gene for long grain over that for short grain has also been reported [4, 5]. Alam [3] reported complementary gene action involving two dominant genes for long grain. A polygenic system for grain inheritance was also proposed [5–8].

Compact panicle habit was reported to be controlled by a pair of recessive genes [6, 9]. Seetharaman and Srivastava [10] reported pleiotropic effect of the gene controlling short height and cigar shaped panicle in a few indica varieties. The present investigation provides additional information on the inheritance of grain size, panicle habit and plant height and relationship of genes controlling these characters.

MATERIALS AND METHODS

The material consisted of three parents: Roti, a tall variety from Madhya Pradesh with normal panicles having long grains (13.15 mm) with awns; Club mutant obtained from Sri

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Lanka, short statured with cigar shaped panicles and short, round grains; and Dwarf mutant with cigar shaped panicles and short, round grains, derived from the cross IR 8 x Basumati 370. The Dwarf mutant is phenotypically similar to the Club mutant but its grain is slightly longer. The Dwarf and Club mutants were crossed to Roti and the F_1, F_2 and F_3 generations were grown. Data were collected on grain size, nature of panicle, awning and plant habit.

RESULTS AND DISCUSSION

Roti x *Dwarf mutant*. The characters of the parents and F_1 plants are presented in Table 1, and the nature of segregation for different characters in F_2 in Table 2. Variation in grain size of the parents, F_1s, and F_2 segregates can be seen in Fig. 1. Monogenic ratios were obtained for long vs short and round grain, normal vs cigar shaped panicle, and tall vs dwarf plant. Dwarf plant height was associated with cigar shaped panicle producing short and round grain, indicating pleiotropic gene action. Seetharaman and Srivastava [10] in their studies suggested that Su-T gene acted as a suppressor for height. The gene had pleiotropic effect on other characters.

Table 1. Characters of the parents and F_1s in rice crosses

Material	Plant habit	Grain size	Nature of panicle	Awning
Roti	Tall	Long	Normal	Awned
Roti x Dwarf mutant	Tall	Long	Normal	Awned
Roti x Club mutant	Tall	Short	Normal	Awnless
Dwarf mutant	Dwarf	Short, round	Cigar shaped	Awnless
Dwarf x Club mutants	Dwarf	Short, round	Cigar shaped	Awnless
Club mutant	Dwarf	Short, round	Cigar shaped	Awnless

A 9 awned: 7 awnless ratio (Table 2) was obtained in F_2, indicating interaction of two pairs of complementary genes. The ratio was subsequently confirmed in F_3.

Table 2. Mode of segregation in F_2 generation of the cross Roti x Dwarf mutant of rice

Character (expected F_2 ratio)	F_2 plants observed	χ^2	P
Grain type (3:1)	636 long: 196 short round	0.93	0.50–0.30
Nature of panicle (3:1)	636 normal: 196 cigar shaped	0.93	0.50–0.30
Plant habit (3:1)	636 tall: 196 dwarf	0.93	0.50–0.30
Awning (9:7)	494 awned: 338 awnless	3.30	0.10–0.05

Roti x *Club mutant*. The segregation for different characters in F_2 (Table 3) showed monogenic ratio for tall plants with normal panicle vs dwarf plants with cigar shaped panicle. Association between dwarf height with cigar shaped panicle and short and round grain indicated pleiotropic gene action. Seetharaman and Srivastava [11] in the cross N 22 x Club mutant, however, reported some short statured plants in F_2 generation with normal panicle.

Unlike the first cross, the F_1 plants had short grain and segregation in the ratio of 39 short : 9 long : 16 short and round grains was obtained in F_2. The nature of segregation is due to three genes i.e., Kr_1, Kr_2 and S. The genes Kr_1 and Kr_2 are responsible for short and long grains, respectively. Gene Kr_1 is dominant over Kr_2. The third gene s, when recessive, has suppressing effect over Kr_1 and Kr_2, resulting in short and round grains. The effect of gene Kr_1 is not expressed in Club mutant due to the presence of s. The gene s has pleiotropic effect on panicle and grains. The genetic constitution of the parents thus would be:

Dwarf mutant:	kr_1	kr_1	Kr_2	Kr_2	ss
Variety Roti:	kr_1	kr_1	Kr_2	Kr_2	SS
Club mutant:	Kr_1	Kr_1	kr_2	kr_2	ss

As regards awning, the F_1 plants were awnless and a ratio of 9 awned : 247 awnless was obtained in F_2. The parents differ by four genes, out of which two are inhibitory. Cv. Roti possesses two genes An_a An_a An_b An_b (both necessary for awn development) and Club mutant carries two dominant inhibitors, I-An_a I-An_a I-An_b I-An_b, which suppress the expression of An_a and An_b.

Table 3. Mode of segregation in F_2 generation of the cross Roti x Club mutant

Character (expected F_2 ratio)	F_2 plants observed	χ^2	P
Plant habit (3:1)	620 tall: 176 dwarf	3.540	0.10–0.05
Nature of panicle (3:1)	620 tall: 176 cigar shaped	3.540	0.10–0.05
Grain type (39:9:16)	494 short: 126 long 176 short round	4.589	0.20–0.10
Awning (9:247)	22 awned: 774 awnless	1.333	0.70–0.50

Awning is generally dominant over awnless character. It has been reported earlier that the expression of awns was determined by one pair of genes [12, 13], two pairs of genes, duplicate factors An_1 An_1 An_2 An_2 [14–16], two complementary factors [17, 18] and three duplicate factors, An_1 An_1 An_2 An_2 An_3 An_3 [19, 20]. Misro et al. [21] suggested combined action of both major genes and polygenes.

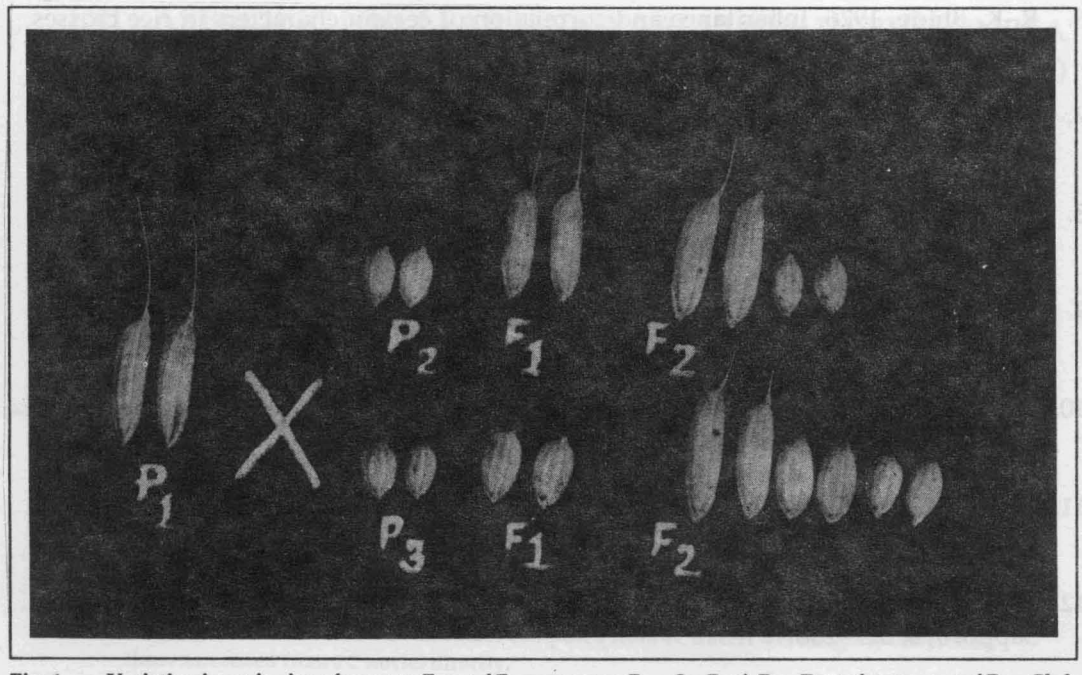

Fig. 1. Variation in grain size of parents, F_1s and F_2 segregates. P_1—Cv. Roti, P_2—Dwarf mutant, and P_3—Club mutant.

The cross between Dwarf and Club mutants did not segregate for grain size in F_2. This is due to the presence of the common recessive gene s in both the parents, which supressed the gene expression of Kr_1 of Club mutant responsible for the short grain character.

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