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Inheritance Studies in Panicle Characters of Rice (*Oryza sativa* L.)

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Abstract

The present study was to investigate the genetic basis of three panicle characters *viz.*, double grain, clustered spikelet and dense panicle and their utilization in plant breeding. The experimental material consisted of five segregating F_2 populations for different characters. The segregating ratio revealed that the double grain trait was governed by single recessive gene in both the indigenous varieties Ram-laxman and Dodana. Likewise single recessive gene was responsible for the dense panicle in the variety Keraghul. However, clustered spikelets character in both the varieties Kaudidhul and Amaruthi governed by trigenically involving two dominant genes either of them complement with one other dominant gene.

Keywords: Inheritance, rice, germplasm, panicle characters

Introduction

Rice (*Oryza sativa* L.) is the world's most important food crop and a primary source of food for more than half of the world's population and account for more than 50% of their daily calorie intake. During the course of organic evolution, rice originated much earlier than most of the other cereal crops. As a result, vast genetic variability, not only in quantitative but also in qualitative traits has been created and accumulated in this crop leading evolution of over hundred thousand genotypes possessing wide array of variation in almost all the traits. This variability has always fascinated every one including farmers, traders, evolutionists and geneticists. In order to safeguard genetic variability of rice, over 20,000 indigenous accessions of rice germplasm are being maintained at IGKV, Raipur. Of these, some accessions have unique type of morphological characters such as double grain (Multiple pistil), clustered spikelet and dense panicle (compact panicle). Normally only one grain is set in each of the spikelet. However, a tendency is seen in some of the cultivars to set two or more grains per spikelet because of more than one pistil within the spikelet. Likewise, rare forms of cultivars have 2-7 spikelets in cluster. It appears to result mainly from reduction in pedicle length. Dense panicle also has advantage over lax type panicle in offering resistance to infection (Futsuhara *et al.,* 1979). Grain number per unit length is higher in the compact panicle cultivar than the loosed panicle cultivar (Panda *et al.,* 2009). Therefore compact panicle trait may be useful for the enhancement of grain number for higher exploitation of yield potential of the cultivars. Understanding the genetic basis of panicle architecture will contribute to not only elucidating the crop evolutionary mechanism but also improving crop grain yield (Zhu *et al.,* 2013). These traits directly or indirectly affect the yield. Further, such traits provide for uniqueness to the genotype identification, which is much needed in the present era of plant variety protection (Roy *et al.*, 2004). Considering the above view, an attempt has been made to study the inheritance of these unique characters (double grain, clustered spikelets and dense panicle) using a set of cultivars.

Materials and Methods

The materials used in the present study are mainly five crosses in rice involving eight parents studied up to F_2 generation for inheritance of double grain, clustered spikelet and dense panicle. Parents were collected from different places of Chhattisgarh (India). The list of parents with their attributing traits is given in Table 1. The present investigation was carried out at the Rice Research Farm, in the Department of Genetics and Plant Breeding, IGKV, Raipur. The observations on the parents and F_1's were recorded on the row basis, while F_2 population on individual plant basis. The data were analyzed independently for each trait to determine the mode of inheritance by χ^2 (Chi-square) test as suggested by Fisher (1936).

Results and Discussion

a) Inheritance of double grain (multiple pistil)

Mode of inheritance of multiple pistil trait was studied in the crosses of R 710-4-37-1-1-1-1 (single grain) x Ram-laxaman (double grain) and R710-4-37-1-1-1-1(single grain) x Dodana (double grain). This is a special trait present in the indigenous rice germplasm. Occasionally rice varieties are found with multiple pistils ranging from 2-7 pistils in each

spikelet. The F_1s of the crosses Ram-laxman and Dodana with R710-4-37-1-1-1-1 were found to have only single grained spikelets, indicating dominance of single grain over double grain character (Table 2 and Fig. 1a). The proportion of plants possessing tendency to have double grains to those having single grains plants in the F_2 populations of these crosses were closely fitted in the ratio of 1 double grain: 3 single grained types, indicated that single recessive gene was responsible for expression of the double grain trait. Multiple pistils have been found to be simple recessive to single pistil by Parthasarthy (1935) in a number of crosses. Tomar *et al.* (2000) also reported that unipistillate ovary was dominant over the multipistillate ovary.

b) Inheritance of clustered spikelets

Mode of inheritance of Clustered spikelet trait was studied in the crosses of R714-3-103-1-3-2 (Solitary spikelets) x Kaudidhul (clustered spikelets) and R714-3-103-1-3-2 (Solitary spikelets) x Amaruthi (clustered spikelets). Segregation analysis of this character was done using two crosses representing solitary spikelet × clustered spikelet parent. In both the crosses F_1 plants have clustered spikelets, indicating clustered spikelets traits to be dominant over normal spikelets. The F_2 population in both crosses were closely fitted to be in the ratio of 45:19 (clustered to solitary spikelets), indicating trigenically involving two dominant genes either of them capable of complementing with one another dominant gene, being responsible for expression of this character in both varieties Kaudidhul and Amaruthi (Table 2, Fig.1b)

c) Inheritance of Dense panicle

Mode of inheritance of dense panicle trait was studied in the cross of Keraghul (compact panicle) with Dokara-dokari (lax panicle). The F_1 plants possessed lax panicle, indicating that dense spikelet was due to recessive gene (Table 2, Fig. 1c). The proportion of plants with compact and lax panicles in the F_2 population of this cross closely fitted in to the ratio of 1: 3, suggesting that dense panicle trait was governed by single recessive gene in the variety Keraghul. Similar results were reported by Dhulappanavar, (1977) and Futsuhara *et al.*, (1979). Mitra and Ganguli (1935) reported that lax panicle was controlled by two dominant complementary genes. On the other hand Chakravorty (1948) reported dense panicle being governed by two complementary genes. Pavithran *et al.* (1995) reported duplicate recessive gene responsible for expression of compact panicle.

The results revealed that the double grain trait was governed by single recessive gene in both the indigenous varieties Ram-laxman and Dodana. Likewise single recessive gene was responsible for the compact panicle in the variety Keraghul. However, clustered spikelet character in both the varieties Kaudidhul and Amaruthi governed by trigenically involving two dominant genes either of them complement with one other dominant gene. These characteristics of indigenous rice may increase grain-yield potential of cultivated varieties through crop improvement programme.

Table 1: Details of genotypes undertaken in the present study

S. No.	Name of the genotypes/ Acc. Nos.	Panicle character	Place of origin	Place of collection Dist. / Block
1	Ram-laxaman (R:358)	Double grain	India	Raigarh/ Gharghoda
2	Dodana (D:612)	Double grain	India	Bilaspur/Bilaspur
3	Kaudidhul (K:1849)	Clustered spikelets	India	Raigarh/ Dharamjaigarh
4	Amaruthi (A:643)	Clustered spikelets	India	Bastar/Antagarh
5	Dokra-dokri (D:520)	Lax panicle	India	Raipur/Fingeshwar
6	Keraghul (K:2034)	compact panicle	India	Raigarh/Gharghoda
7	R 710-4-37-1-1-1-1 (semi dwarf)	Single grain	India	IGKV, Raipur
8	R 714-3-103-1-3-2 (semi dwarf)	Solitary spikelets	India	IGKV, Raipur

Table 2: Segregation for three qualitative characters in F_2 population in rice

S. No	Cross combination	Panicle trait	F_1 Phenotype	F_2 observations		χ^2 ratio	χ^2 Value	P value
1.	**Double grain (multiple pistil)**			Double grain	Single grain			
	R710-4-37-1-1-1-1/ Ram-laxaman	Single grain / double grain	Single grain	139	473	1:3	1.70	0.20-0.10
	R710-4-37-1-1-1-1/ Dodana	Single grain / double grain	Single grain	177	515	1:3	0.12	0.80-0.70

2.	**Clustered spikelet**			Clustered	Solitary			
	R714-3-103-1-3-2/ Kaudidhul	Solitary spikelets / clustered spikelets	clustered spikelets	535	243	45:19	0.886	0.50-0.30
	R714-3-103-1-3-2/ Amaruthi	Solitary spikelets / clustered spikelets	clustered spikelets	536	220	45:19	0.125	0.80-0.70
3.	**Dense panicle**			Compact	Lax			
	Dokra-dokari / Keraghul	Lax panicle / compact panicle	Lax panicle	228	597	1:3	3.05	0.10-0.05

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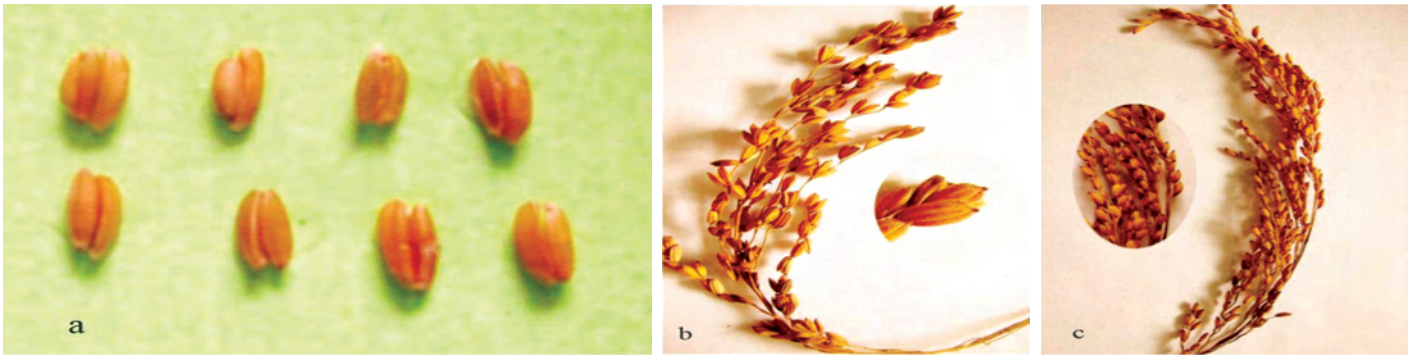

Fig. 1. Photograph of rice cultivars showing different panicle characters:
(a) double grain in Ram-Laxman; (b) clustered spikelets in Amaruthi and (c) dense panicle in Keraghul