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Genetic Variability Studies for Qualitative and Quantitative traits in Popular Rice (Oryza sativa L.) Hybrids of India

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Abstract- The present investigation is carried out to study the genetic parameters for yield, yield attributing, quality and nutritional characters in twenty one rice hybrids. Analysis of variance revealed significant differences for all the traits under study. The characters *viz.,* number of filled grains per panicle, number of chaffy grains per panicle and iron content exhibited high Genotypic Coefficient of Variation (GCV) and Phenotypic Coefficient of Variation (PCV). Small differences between GCV and PCV were recorded for all the characters studied which indicated less influence of environment on these characters. The characters *viz.,* number of filled grains per panicle and water uptake exhibited high heritability coupled with high genetic advance indicating that simple selection could be effective for improving these characters.

Index Terms- Genetic advance, Genetic variability, Heritability and Rice

I. INTRODUCTION

Rice is one of the most important cereal crops of the world meeting the dietary requirements of the people living in the tropics and sub-tropics. Quantum jump in yield improvement has been achieved in rice with the development of high yielding heterotic hybrids under commercial cultivation. However, being the staple food of the population in India, improving its productivity has become a crucial importance (Subbaiah *et al*., 2011). Knowledge on the nature and magnitude of genetic variation governing the inheritance of quantitative characters like yield and its components is essential for effecting genetic improvement. A critical analysis of genetic variability is a pre-requisite for initiating any crop improvement programme and for adopting of appropriate selection techniques.

A paradigm shift in the rice (*Oryza sativa* L.) breeding strategies from quantity centered approach to quality oriented effort was inevitable, since India has not only become self sufficient in food grain production but also is the second largest exporter of quality rice in the world (Sreedhar *et al.*,2005). Improvement in grain quality that does not lower yield is the need of hour at present context in order to benefit all rice growers and consumers. Like grain yield, quality is not easily amenable to selection due to its complex nature. Lack of clear cut perception regarding the component traits of good quality rice is one of the important reasons for the tardy progress in breeding for quality rice varieties. With the increase in yield, there is also a need to look into the quality aspects to have a better consumer acceptance, which determines the profit margin of rice growers which in turn dictates the export quality and foreign exchange in India. Genetic enhancement is one of the important tools to improve the productivity. Hybrid technology has been widely acclaimed and accepted. High magnitude of variability in a population provides the opportunity for selection to evolve a variety having desirable characters.

Grain quality characteristics are very important in rice breeding as it is predominantly consumed as a whole grain. The milling percentage, grain appearance, cooking quality and nutritional components constitute the quality traits. Nutritional components include proteins and micronutrients like Iron and Zinc. The average percentage of protein in rice grains is 8 per cent (The amino acid profile shows that it is rich in Glutamic acid and Aspartic acid, highest quality cereal protein being rich in lysine (3.8 %), the first limiting amino acid); Fe is 1.2 mg/100 g and Zn is 0.5 mg/100 g. Malnutrition is a large and growing problem in the developing world mostly in South and S.E. Asia and Sub Sahara Africa (Reddy *et al.,* 2005). Over 3 billion people suffer micro nutrient malnutrition (Welch and Graham, 2002). Iron deficiency may affect 3 billion people worldwide (Long *et al.,* 2004). It is estimated that 49 per cent of the world's population is at risk for low zinc intake (Cichy *et al.,* 2005). In order to enhance the micronutrient concentration in the grain suitable breeding programmes should be followed. Keeping in view the above perspectives, the present investigation is carried out with the following objective of estimating the genetic variability in rice hybrids for yield, yield attributing characters, quality and nutritional traits.

II. MATERIALS AND METHODS

The present experiment is carried out at Directorate of Rice Research Farm, ICRISAT, Patancheru, Hyderabad, Andhra Pradesh, India, situated at 17.5°N latitude, 78.27°E longitude and altitude of 545 m above mean sea level. The materials comprised of twenty one rice hybrids (Table 1) obtained from Department of Plant Breeding, Crop Improvement Section, Directorate of Rice Research, Rajendranagar, Hyderabad. The experimental material was planted in a Randomized Block Design with three replications in three blocks. Each block consisted of twenty one genotypes randomized and replicated within each block. Twenty seven days old seedlings were transplanted 20cm apart between rows and 15cm within the row. All necessary precautions were taken to maintain uniform plant population in each treatment per replication. All the recommended package of practices was followed along with necessary prophylactic plant protection measures to raise a good crop. Five representative plants for each hybrid in each replication were randomly selected to record observations on the quantitative characters under study. Days to 50% flowering were computed on plot basis. Data was recorded on physico-chemical quality characters from the bulk samples. The milling characteristics were computed following the method given by Ghosh *et al*., (1971). Iron and zinc content of seed samples was estimated by Atomic Absorption Spectrophotometer as suggested by Lindsay and Novell (1978). The treatment means for all the characters *viz*., days to 50 percent flowering, plant height (cm), number of productive tillers per plant, panicle length (cm), number of filled grains per panicle, number of chaffy grain per panicle, 1000 grain weight (g), single plant yield (g), grain moisture percentage, head rice recovery (%), kernel length (mm), kernel breadth (mm), L/B ratio, volume expansion ratio, water uptake (ml), alkali spreading value, gel consistency (mm), protein content (%), Iron content (mg/100g) and Zinc content (mg/100g), except for the milling percentage were subjected to analysis of variance technique on the basis of model proposed by Panse and Sukhatme (1961). The genotypic and phenotypic variances were calculated as per the formulae proposed by Burton (1952). The genotypic (GCV) and phenotypic (PCV) coefficient of variation was calculated by the formulae given by Burton (1952). Heritability in broad sense [$h^2_{(bs)}$] was calculated by the formula given by Lush (1940) as suggested by Johnson *et al.* (1955). From the heritability estimates, the genetic advance (GA) was estimated by the following formula given by Johnson *et al.* (1955).

III. RESULTS AND DISCUSSION

a) Variability parameters

Greater variability in the initial breeding material ensures better chances of producing desired forms of a crop plant. Thus, the primary objective of germplasm conservation is to collect and preserve the genetic variability in indigenous collection of crop species to make it available to present and future generations. The analysis of variance indicated the existence of significant differences among all the hybrids for all the traits studied. The results of analysis of variance are presented in Table 2. The characters studied in the present investigation exhibited low, moderate and high PCV and GCV values. Among the yield characters, highest PCV and GCV values were recorded for number of chaffy grains per panicle, followed by number of filled grains per panicle and the lowest PCV and GCV values were recorded for grain yield per plant. Among the grain quality characters highest PCV and GCV values were recorded for iron content and lowest PCV and GCV was recorded for kernel breadth. High phenotypic variations were composed of high genotypic variations and less of environmental variations, which indicated the presence of high genetic variability for different traits and less influence of environment. Therefore, selection on the basis of phenotype alone can be effective for the improvement of these traits. Similar results were observed by Kumar *et al.* (1994), Chaudhary and Singh (1994), Pathak and Sharma (1996), Sarvanan and Senthil (1997), Rather *et al*. (1998), Satya *et al* (1999), Shivani and Reddy (2000), Iftekharudduala *et al.* (2001) and Sao (2002). Coefficients of variation studies indicated that the estimates of PCV were slightly higher than the corresponding GCV estimates for all the traits studied indicating that the characters were less influenced by the environment. Therefore, selection on the basis of phenotype alone can be effective for the improvement of these traits.

b) *Heritability*

The estimates of heritability act as predictive instrument in expressing the reliability of phenotypic value. Therefore, high heritability helps in effective selection for a particular character. Heritability is classified as low (below30%), medium (30-60%) and high (above 60%). The characters studied in the present investigation expressed low to high heritability estimates ranging from 25.5 to 98.4 percent. Among the yield characters, highest heritability was recorded by days to 50 percent flowering followed by number of chaffy grains per panicle, number of filled grains per panicle, whereas, in grain quality characters alkali spreading value recorded highest heritability and head rice recovery percentage recorded lowest heritability value. High heritability values indicate that the characters under study are less influenced by environment in their expression. The plant breeder, therefore, may make his selection safely on the basis of phenotypic expression of these characters in the individual plant by adopting simple selection methods. High heritability indicates the scope of genetic improvement of these characters through selection. Similar results have been reported by Panwar *et al.* (1997), Sarawgi *et al.*, (2000), Gannamani (2001) and Sao (2002).

c) Genetic advance

The genetic advance is a useful indicator of the progress that can be expected as result of exercising selection on the pertinent population. Heritability in conjunction with genetic advance would give a more reliable index of selection value (Johnson *et al.* 1955). Genetic advance was highest for number of filled grains per panicle followed by days to 50 percent flowering and lowest for grain yield per plant among yield characters. In case of grain quality characters, water uptake recorded highest genetic advance followed by gel consistency and the lowest for kernel breadth. The genetic advance as per cent of mean was highest in case of number of chaffy grains per panicle, while lowest recorded by grain yield per plant among yield characters, whereas, in grain quality characters, iron content recorded the highest genetic advance as per cent mean, while the lowest was recorded by head rice recovery percentage. The information on genetic variation, heritability and genetic advance helps to predict the genetic gain that could be obtained in later generations, if selection is made for improving the particular trait under study. Similar findings were also reported by Regina *et al.* (1994), Vanniarajan *et al.* (1996), Shivani and Reddy (2000), Iftekharuddaula *et al.* (2001), Gannamani (2001) and Sao (2002). In general, the characters that show high heritability with high genetic advance are controlled by additive gene action (Panse and Sukhatme, 1957) and can be improved through simple or progeny selection methods. Selection for the traits having high heritability coupled with high genetic advance is likely to accumulate more additive genes leading to further improvement of their performance. In the present study, high heritability along with high genetic advance was noticed for the traits, number of filled grains per panicle and water uptake. Other characters showed high heritability along with moderate or low genetic advance which can be improved by intermating superior genotypes of segregating population developed from combination breeding (Samadia, 2005).

Table 1. Details of twenty one popular rice hybrids of India

S.No.	Name of the hybrid	Nominating Agency
1	DRRH – 2	Directorate of Rice Research, Hyderabad
2	PA 6129	Bayer Bio-Science
3	Sahyadri – 2	Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli
4	Sahyadri –4	Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli
5	Pusa RH -10	Indian Agricultural Research Institute, New Delhi
6	Indirasona	Indira Gandhi Krishi Vishwa Vidyalaya, Raipur
7	GK 5003	Ganga Kaveri Seeds
8	PSD-3	G. B. Pant University of Agriculture and Technology, Pantnagar
9	Sahyadri – 3	Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli
10	PA 6201	Bayer Bio-Science
11	HSD-1(HKRH-1)	Chaudhary Charan Singh Haryana Agricultural University, Karnal
12	PA 6444	Bayer Bio-science
13	Suruchi (MPH 5401)	Mahyco seeds, Hyderabad
14	JKRH- 2000	JK Agri. Genetics
15	US - 312	US Agri Seeds
16	CORH- 3	Tamil Nadu Agricultural University, Coimbatore
17	KRH-2	University of Agricultural Sciences, Mandya
18	Sahyadri -1	Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli
19	PHB – 71	Pioneer Overseas Corporation
20	CRHR - 5	Central Rice Research Institute, Cuttack
21	CRHR - 7	Central Rice Research Institute, Cuttack

Table 2: ANOVA for yield and quality characters in rice hybrids

S. No.	Character	Mean sum of squares		
		Replications (d.f. = 2)	Treatments (d.f. = 20)	Error (d.f. = 40)
1	Days to 50 per cent flowering	3.09	253.45**	3.16
2	Plant height (cm)	2.11	224.14**	30.56
3	Panicle length (cm)	1.89	4.66**	0.61
4	No. of productive tillers/plant	0.56	4.46**	1.46
5	No. of filled grains/panicle	1.11	2146.95**	37.46
6	No. chaffy grain/panicle	0.02	235.49**	3.85
7	Grain yield/plant (g)	0.43	2.07*	1.02
8	1000-grain weight (g)	0.13	15.24**	0.31
9	Grain moisture (%)	0.01	1.25**	0.01
10	Milling percentage (%)	0.01	3.01	26.25
11	Head rice recovery (%)	13.21	43.62*	20.38
12	Kernel Length (mm)	0.002	1.17**	0.014
13	Kernel breath (mm)	0.002	0.016**	0.001
14	L/B ratio	0.01	0.42**	0.006
15	Volume expansion ratio	0.01	0.81**	0.01
16	Water uptake (ml)	0.02	1506.78**	26.25
17	Alkali spreading value	0.02	2.98**	0.016
18	Amylose content (%)	0.1	8.20**	0.20

19	Gel consistency (mm)	0.57	271.64**	4.17
20	Protein content (%)	0.01	2.52**	1.05
21	Iron (mg/100g)	0.42	16.02**	3.83
22	Zinc (mg/100g)	0.017	0.57**	0.027
* Significant at 5 per cent level				
** Significant at 1 per cent level				

Table 3: Estimates of variability, heritability, genetic advance and genetic advance as per cent of mean in rice hybrids

S. No.	Character	Phenotypic variance	Genotypic variance	PCV (%)	GCV (%)	Heritability (h^2) (%)	GA (5%)	GA as per cent mean (5%)
1.	Days to 50 per cent flowering	86.59	83.43	9.62	9.44	96.3	18.47	19.10
2.	Plant height (cm)	95.09	64.53	10.02	8.26	67.9	13.63	14.01
3.	Panicle length (cm)	1.96	1.35	5.37	4.45	68.9	1.99	7.61
4.	No. of productive tillers/plant	2.46	1.00	16.91	10.77	40.6	1.31	14.14
5.	No. of filled grains/panicle	740.63	703.16	23.87	23.26	94.9	53.23	46.68
6.	No. chaffy grain/panicle	81.07	77.21	44.67	43.60	95.2	17.67	87.66
7.	Grain yield/plant (g)	1.37	0.35	5.10	2.58	25.5	0.62	2.68
8.	1000-grain weight (g)	5.29	4.98	9.54	9.25	94.1	4.46	18.49
9.	Grain moisture (%)	0.42	0.41	5.59	5.52	97.5	1.31	11.23
10.	Milling percentage (%)	18.51	-7.74	5.98	3.87	-41.9	-3.71	-5.16
11.	Head rice recovery (%)	28.13	7.75	8.02	4.21	27.5	3.01	4.55
12.	Kernel Length (mm)	0.40	0.39	9.80	9.63	96.5	1.26	19.48
13.	Kernel breath (mm)	0.01	0.01	3.72	3.34	80.6	0.13	6.18
14.	L/B ratio	0.14	0.14	12.16	11.92	96.0	0.75	24.05
15.	Volume expansion ratio	0.28	0.27	11.41	11.19	96.2	1.04	22.61
16.	Water uptake (ml)	519.76	493.51	7.37	7.18	94.9	44.59	14.41
17.	Alkali spreading value	1.01	0.99	17.65	17.51	98.4	2.03	35.77
18.	Amylose content (%)	2.87	2.67	7.65	7.38	93.0	3.24	14.65
19.	Gel consistency (mm)	93.33	89.16	17.44	17.05	95.5	19.01	34.33
20.	Protein content (%)	1.55	0.49	15.63	8.80	31.7	0.81	10.21
21.	Iron (mg/100g)	7.89	4.06	41.10	29.49	51.5	2.98	43.59
22.	Zinc (mg/100g)	0.19	0.16	11.74	10.88	85.8	0.77	20.75

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