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Research Article

Genetic variability and character association for earliness, yield and its contributing traits in F_2 population of rice (*Oryza sativa* L.)

E.[1] Nezam Ali, S. Rajeswari[2], R. Saraswathi[1] and P. Jeyaprakash[1]
[1]Dept. of Rice, CPBG, TNAU, Coimbatore - 641 003
[2]UG Education Unit, CPBG, TNAU, Coimbatore – 641 003
E-Mail: nezam2525@gmail.com

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Abstract

Variability studies revealed that considerable amount of variability exist in the F_2 population of rice cross CB 08504 × Prasanna through high values of PCV and GCV for characters like number of filled grains per panicle, spikelet fertility percentage and single plant yield. High PCV and moderate GCV was observed for number of productive tillers per plant while moderate PCV and GCV was recorded for days to first flowering and harvest index. High heritability coupled with high genetic advance as percent of mean was observed for the characters namely number of filled grains per panicle, number of productive tillers per plant, spikelet fertility percentage and single plant yield in the F_2 population. The traits days to first flowering, number of productive tillers per plant, panicle length, number of filled grains per panicle, spikelet fertility percentage and harvest index were showing significant and positive correlation with single plant yield. The F_2 population of CB 08504 × Prasanna performed better for earliness, yield and yield associated traits and could be utilised in future breeding programs to meet the increasing demand of rice.

Keywords

Rice, F_2 population, heritability, genetic advance, correlation

Introduction

Rice (*Oryza sativa* L.) is a crop belongs to Poaceae family, serve as a major carbohydrate source for many nations all over the world. Over the years there has been a gradual increase in the rice consuming population along with a decline in the growth rate of world rice production. Gain in the global annual yield of rice by 1% remains far from the required 2% increase to meet the demand in coming decades (Ray *et al*., 2013). In order to retain a balance between the increase in population growth and food necessity, rice production must be increased to at least match the rate of increase in population. Under the existing scenario, earliness is an important trait acceptable to sustain the rice production and to meet the upcoming demands. Growing early high yielding varieties will enhance the rice productivity, resource and input use efficiency and profitability per unit area and per unit time. New challenging research methods are essential in fulfilling the demand for rice. The breeders are involved in the mission of developing short duration (around 90 days and below) varieties with the positive association of economically important yield contributing characters, so as to increase its production and to meet the ever-growing demand for food grains. Early maturing crops are comparatively low yielding in any season but it may be balanced by less standing duration in the field (Shahriar *et al*., 2014). So, it is crucial to select short duration lines of rice without much sacrificing yield.

Yield is a complex trait, composed of numerous components, some of which affect the yield directly while others contribute indirectly. Therefore, for the improvement of grain yield we need to identify characters playing direct or indirect role in the enhancement of the grain yield. In such conditions a comprehensive study on the genetic architecture of a population, character association, heritability and genetic advance for the grain yield and its contributing traits play a vintage role in improving the productivity of a crop (Jan *et al*., 2017). An assortment of parents having high variability determines the success of a hybridization programme for varietal development, as a result the desired character combination may be selected to enhance grain quality and higher grain yield. Furthermore, data of heritability is significant for determination based advancement as it demonstrates the transmissibility of a quality into forthcoming ages.

The present study was formulated with a vision to develop short duration and high yielding rice varieties in future by quantifying the extent of genetic variation and character association available for earliness, grain yield and its components in the segregating generations of rice. To achieve this goal, the breeder has the option of selecting desirable genotypes in early generations or delaying intense selection until advanced generations, when progenies are nearly homozygous.

Materials and Methods

The experiment was conducted at the research field of Department of Rice, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore during *kharif* 2017. The experimental materials consisted of 500 F_2 plants developed from the cross CB 08504 × Prasanna and their respective parental genotypes, the details of which are presented in Table 1. The F_1 seeds were obtained from Department of Rice, Tamil Nadu Agricultural University, Coimbatore to raise F_2 population and were planted in plots of 5m. length in twenty rows each maintaining a row to row distance and plant to plant distance of 20 cm. Transplanting was done at twenty eighth day after sowing, all the recommended agronomic practices and plant protection measures were taken up to raise a healthy crop. Observations were recorded for the traits such as days to first flowering, number of productive tillers per plant, panicle length (cm.), number of filled grains per panicle, spikelet fertility percentage (%), hundred grain weight (g.), single plant yield (g.) and harvest index. The traits panicle length, number of filled grains per panicle and spikelet fertility percentage were recorded in three samples per plant and averaged.

Genotypic and phenotypic coefficient of variation (GCV and PCV) were calculated by the formula suggested by Burton (1952). Heritability in the broad sense was computed with the formula suggested by Lush (1949). The genetic advance was estimated by adopting the method suggested by Johnson *et al*. (1955).The correlation between yield and its component traits and among themselves as well as between characters were performed using the software OPSTAT.

Results and Discussion

The potentiality of a cross is measured not only by mean performance but also on the extent of variability. Knowledge on nature and magnitude of genotypic and phenotypic variability present in any crop species plays an important role in formulating successful breeding programmes (Allard, 1960). Siva Subramanian and Mathavamenon (1973) also highlighted the importance of variability in early segregating generations and suggested that magnitude of genotypic co-efficient of variability and phenotypic co-efficient of variability should be given importance.

The mean, range, variability estimates *i.e*., genotypic co-efficient of variation (%), phenotypic co-efficient of variation (%), heritability (%) (Broad sense), genetic advance as per cent of mean are presented in Table 2. Range of variation, a simple measure of variability was quite high for all the characters studied except harvest index and hundred grain weight. Minimum days to first flowering was 53 days and maximum single plant yield recorded was 84.81 g. These results suggested that these experimental materials might contain segregants exhibiting earliness coupled with yield.

The phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) provide an idea about the magnitude of variability. Number of filled grains per panicle, spikelet fertility percentage and single plant yield recorded high PCV and GCV values. Similar findings was also observed by Rani *et al*. (2016) for single plant yield and number of filled grains per panicle and Singh *et al*. (2015) for spikelet fertility percentage. One of the focussed trait of the cross CB 08504 x Prasanna is to identify segregants with early duration of less than 100 days. The parent Prasanna is the donor for this trait. In variability studies, moderate PCV and GCV was recorded for days to first flowering as also observed by Shivashankar and Kumar (2015). Ranjith *et al*. (2018) also noted moderate PCV and GCV for harvest index, which is in accordance with the present result. Low PCV and GCV was reported for hundred grain weight are in accordance with Tripathi *et al*. (2018). High PCV and moderate GCV observed for number of productive tillers per plant, agrees that of Kahani and Hittalmani (2016). It indicated that the possibility of improving and fixing these characters through effective selection. Panicle length recorded moderate PCV and low GCV, similar results were reported by Jan *et al*. (2017). The small differences observed between genotypic and phenotypic coefficients of variation on most of the characters indicate the presence of sufficient genetic variability for the traits which may facilitate selection

All the important yield contributing traits like number of productive tillers per plant, panicle length, number of filled grains per panicle, spikelet fertility percentage, harvest index, single plant yield including days to first flowering recorded high heritability and genetic advance as percent of mean. So the heritability is due to additive gene effects and selection may be effective for such trait. Previous findings of Ram *et al*. (2017) for number of productive tillers per plant, number of filled grains per panicle and single plant yield, the traits Kalyan *et al.* (2008) for spikelet fertility percentage, Tiwari *et al.* (2011) for harvest index and days to first flowering also are in line with the results. Hundred grain weight recorded high heritability and moderate genetic advance as percent of mean as that reported by Ranjith *et al*. (2018). Thus simple selection of desired segregants with earliness and high yield or contributing traits may result in breeding lines combining these traits in later generation. High heritability and moderate genetic advance as per cent of mean was observed for hundred grain weight which indicated presence of both additive and non-additive gene action and improvement in this population through cyclic selection method is possible.

In F_2 population of the cross CB 08504 × Prasanna, the characters, days to first flowering, number of productive tillers per plant, panicle length, number of filled grains per panicle, spikelet fertility percentage and harvest index showed significant and positive correlation with single plant yield (Table 3). The present findings were in accordance with the previous results of Rahman *et al*. (2014) and Jan *et al*. (2017). Strong positive association of these traits with single plant yield indicated that the selection for these traits will be useful in improving single plant yield.

Positive and significant correlation was observed between number of productive tillers and panicle length, number of filled grains per panicle, spikelet fertility percentage and harvest index. Similar findings have been reported by Ramesh *et al*. (2018) . Positive and significant correlation was observed between number of filled grains per panicle, spikelet fertility and harvest index. Panicle length showed significant and positive correlation with number of filled grains per panicle, spikelet fertility, hundred grain weight and harvest index. This was in accordance with Rahman *et al*. (2014) and Ramesh *et al*. (2018). Hence, intensive selection for these characters in the positive direction would ensure simultaneous improvement of grain yield in rice.

The results of the present study clearly indicated that yield can be improved indirectly by selecting F_2 plants with high number of productive tillers per plant, number of filled grains per panicle and high spikelet fertility percentage as these traits showed high heritability coupled with high genetic advance as per cent of mean and were holding a strong positive association. Even though early maturing crops are low yielding, selecting a line for shorter growth duration with comparatively higher yield would be possible from these F_2 plants.

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Table 1. Details of parents involved in the crosses

Sl. No.	Parents	Characters	Average grain yield
1.	CB 08 504 (Rascadam /IR 50)	113 days duration and moderately resistant to stem borer, blast and sheath blight.	6.05 (t/ha)
2.	Prasanna (IRAT-8/N-22)	90-95 days duration, Semi dwarf (100 -105 cm) and grains long slender	3.5 – 4.1 (t/ha)

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Table 2. Variability parameters for morphological traits in rice in F_2 generation of CB 08504 x Prasanna

Traits	Mean	Range		PCV (%)	GCV (%)	h^2 (%)	GAM
		Minimum	Maximum				
DFF	77.44	53	106	13.11	12.67	96.69	26.11
NPTP	17.29	10	27	20.41	16.36	80.16	33.70
PL	23.32	17.50	30.00	11.37	9.90	87.09	20.40
NFGP	108.05	23	242	46.21	38.82	84.01	79.97
SFP	63.94	17.02	92.61	28.03	25.30	90.26	52.12
HGW	1.79	1.40	2.10	8.86	7.08	79.95	14.59
HI	0.42	0.20	0.51	16.38	13.56	82.81	27.94
SPY	24.28	3.92	84.81	58.14	53.16	91.43	109.51

DFF- Days to First Flowering, NPTP- Number of Productive Tillers per Plant, PL- Panicle Length (cm), NFGP- Number of Filled Grains per Panicle, SFP- Spikelet Fertility Percentage (%), HGW- Hundred Grain Weight (g), SPY- Single Plant Yield (g), HI- Harvest Index, PCV- Phenotypic Coefficient of Variation, GCV- Genotypic Coefficient of Variation, h^2- Heritability (broad sense), GAM- Genetic Advance as per cent of Mean.

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Table 3. Correlation coefficients among morphological traits in F_2 generation of CB 08504 x Prasanna

Traits	DFF	NPTP	PL	NFGP	SFP	HGW	HI	SPY
DFF	1	0.173	0.489**	0.153	-0.074	-0.013	0.002	0.256*
NPTP		1	0.488**	0.530**	0.439**	0.174	0.265**	0.844**
PL			1	0.461**	0.331**	0.248*	0.252*	0.547**
NFGP				1	0.779**	0.123	0.455**	0.783**
SFP					1	0.262**	0.573**	0.658**
HGW						1	0.278**	0.181
HI							1	0.426**
SPY								1

*** Significant at 5 % level, ** Significant at 1 % level**
DFF- Days to First Flowering, NPTP- Number of Productive Tillers per Plant, PL- Panicle Length (cm), NFGP- Number of Filled Grains per Panicle, SFP- Spikelet Fertility Percentage (%), HGW- Hundred Grain Weight (g), SPY- Single Plant Yield (g), HI- Harvest Index