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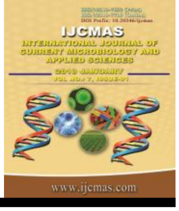

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# Assessment of Genetic Parameters for Yield and Its Related Traits in $F_2$ Populations Involving Traditional Varieties of Rice (*Oryza sativa* L.)

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## ABSTRACT

**Keywords**

Rice, $F_2$ populations, Genotypic co-efficient of variation, Phenotypic co-efficient of variation, Heritability, Genetic advance as a per cent of mean

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An investigation was carried out at ZARS, VC Farm, Mandya during 2015 to study the variability produced in two $F_2$ populations of rice *viz.*, 'Rajamudi × BR-2655' and 'Rathnachoodi × BR-2655' with 500 single plants to estimate the variability, heritability, genetic advance and genetic advance as percentage. The results showed that PCV values in general were higher than GCV for various characters studied. The high PCV and GCV values was obtained for grain yield per plant and low PCV and GCV was observed for thousand grain weight and panicle length. The small difference observed between GCV and PCV indicate the presence of high genetic variability for the traits which may facilitate selection. The traits Plant height, Spikelet fertility, harvest index and grain yield per plant had high heritability along with high genetic advance as per cent of mean indicate that these characters attributable to additive gene effects which are fixable revealing that improvement in these characters would be possible through direct selection.

## Introduction

Rice is the world's most important food crop. Rice (*Oryza sativa* L.) is the staple food for 65% of the global population and forms the cheapest source of food, energy and protein (Padmaja *et al.*, 2008).Worldwide, it is grown on an area of 166.1 million hectares with yield of 745.2 million tonnes (Anon, 2013). Traditional rice varieties or landraces have a high level of genetic heterogeneity compared to modern cultivars. Landraces comprise of the unique source for gene of high adaptability but are poor yielders. Therefore, it is an indispensable demand for varietal improvement in such situation. To formulate a sustainable breeding program precise knowledge about genetic divergence for yield components is a crucial one as varietal improvement depends mainly on the selection of parents with high genetic divergence in hybridization. Crop improvement for specific trait has been achieved through effective use of $F_2$ segregating population and fixing desirable combinations. Therefore, the present study has been undertaken to determine the estimates of variability, heritability and genetic advance as per cent of mean for grain yield and its component traits in $F_2$ segregating generation for selected two crosses.

## Materials and Methods

The present investigation was carried out during rabi/summer 2015 at Zonal Agricultural Research Station, Mandya Karnataka. Experimental material consisted of Five hundred $F_2$ population developed involving traditional varieties Rajamudi and Rantnachoodi are high yielders with superior nutritional grain quality but they are photo sensitive and susceptible to lodging because of their tall growing nature and other parent BR-2655 improved semi-dwarf high yielding variety. $F_2$ population of two crosses of rice *viz.,* 'Rajamudi × BR-2655' and 'Rathnachoodi × BR-2655' along with their three parents were planted in plots of 4m length in ten rows each maintaining a row to row distance of 20 cm and plant to plant distance of 10 cm in wet lands at 'C' block of ZARS, V. C. Farm, Mandya and recommended cultural practices and plant protection measures were taken up as per the packages of practices recommended by University of Agricultural Sciences Bangalore.. Data was recorded on 10 randomly chosen plants of parents (Rajamudi, Rathnachoodi and BR-2655) and on 500 and 492 competitive plants in the $F_2$ population of 'Rajamudi × BR-2655' and 'Rathnachoodi × BR-2655' crosses, respectively. Observations were recorded on grain yield and yield attributing traits *viz* days to 50% flowering, plant height (cm), productive tillers per plant, panicle weight (g), panicle length (cm), filled grains per paniple, total Spikelets per panicle, straw yield per plant (g), 1000-grain weight (g), spikelet fertility (%), harvest index (%) and grain yield per plant (g).

## Statistical analysis

Statistics such as mean and phenotypic and genotypic co-efficient of variation (PCV and GCV) were computed based on the method suggested by Panse and Sukhatme (1961). Heritability in the broad sense was computed with the formula suggested by Lush (1940). The genetic advance was estimated adopting the method suggested by Johnson *et al.*, (1955). All the above characters were calculated using Microsoft Excel.

## 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.

Jennings *et al.,* (1979) suggested that crosses which will realise early homozygosity are ideally suited for further breeding work. The mean, range, variability estimates i.e., Genetic co-efficient of variation (%), phenotypic co-efficient of variation (%), heritability (%) (Broad sense), genetic advance as per cent of mean are furnished in Table 1 (Figure 1 & 2). The range of variability was high for all the characters studied except panicle weight, panicle length, harvest index and 1000-grain weight, which exhibited low to moderate variability in both the crosses.

As expected, estimates of PCV values were relatively higher than GCV values in $F_2$ generation of both the crosses coupled with narrow differences which indicate less environmental influence on the expression of all the traits except productive tillers per plant, panicle weight and grain yield in both the $F_2$ populations.

Very low variability was noticed for days to 50 % flowering as evidenced by lower values of PCV (11.4% and 9.41 %) and GCV (10.65% and 8.20%) in 'Rajamudi × BR-2655' and 'Rathnachoodi × BR-2655' populations, respectively. Contrary to this, high heritability (97.44%) with moderate genetic advance as per cent of mean (30.33 %) in 'Rajamudi × BR-2655' population indicated major role of non-additive gene action while, high heritability (87.12 %) and moderate genetic advance as per cent of mean (16.88 %) in 'Rathnachoodi × BR-2655' population indicated role of additive gene action in respect of this trait. Kannan Bapu and Soundarapandian (1993) also reported similar result in respect of this trait.

PCV and GCV values (15.11 % and 14.72 %, respectively) in 'Rajamudi × BR-2655' population indicated moderate variability for plant height. Results of present study are at par with the earlier reports of Kannan Bapu and Soundarapandian (1993) and Singh and Choudhary (1996). Contrary to this, high variability was noticed for this trait as evidenced by moderate values of PCV and GCV (11.25 % and 10.59 %, respectively) in 'Rathnachoodi × BR-2655' population. These results are in agreement with earlier reports of Mohanthy and Singh (1969) and Chauhan *et al.*, (1990). This trait exhibited high heritability coupled with low to moderate genetic advance expressed as per cent of mean in both the crosses indicating role of non-additive gene action in its genetic control. Results of present study are at par with the earlier reports of Suresh and Reddy (2002) and Kumar *et al.*, (2005).

Productive tillers exhibited wide variability and high influence of environment as evidenced by wide difference between GCV and PCV as well as higher values of PCV (34.44 % and 38.43 %) and GCV (18.94% and 30.26 %) in 'Rajamudi × BR-2655' and 'Rathnachoodi × BR-2655' population, respectively. High broad sense heritability (54.99 % and 78.74 %) coupled with high genetic advance (39.01% and 62.34 %) as per cent of mean in 'Rajamudi × BR-2655' and 'Rathnachoodi × BR-2655' population, respectively revealed major role of additive gene action in the genetic control of this trait. Similar results were reported by Nayak (2008) and Nandeshwar *et al.*, (2010).

Panicle weight exhibited higher value of PCV (29.05% and 31.74%) and moderate value of GCV (13.21% and 14.65%) in 'Rajamudi × BR-2655' and 'Rathnachoodi × BR-2655' population, respectively. Difference between GCV and PCV were high indicates high magnitude of environmental influence on this character. Broad sense heritability was moderate (45.47% and 46.16%) in both the crosses, while genetic advance expressed as per cent of mean high (27.21% and 30.18%) in both the crosses. Vikaskumar *et al.*, (2014) reported high phenotypic and genotypic variability, whereas Madhusudhan (2001) reported moderate GCV and PCV values. Reliability can be placed on this important trait for selection of segregants owing to its moderate broad sense heritability coupled with high genetic advance.

Panicle length in both the crosses registered moderate values of PCV (12.36% and 11.50 %) and low value of GCV (8.05% and 7.94 %), respectively. This is in accordance with the earlier observations made by Mohanthy and Singh (1969) and Paramasivan (1986).

However, high broad sense heritability (65.13% and 69.03 %) but moderate genetic advance expressed as per cent of mean (16.58% and 16.36 %) in 'Rajamudi × BR-2655' and 'Rathnachoodi × BR-2655' population, respectively indicated predominant role of non-additive gene action in respect of this trait in both crosses. Agrawal (2003) reported similar results with respect to heritability and genetic advance for this trait.

**Fig.1** Estimation of mean and genetic parameters for yield and yield attributing traits in $F_2$ generation of the cross Rajamudi× BR-2655 in rice (*Oryza sativa* L.)

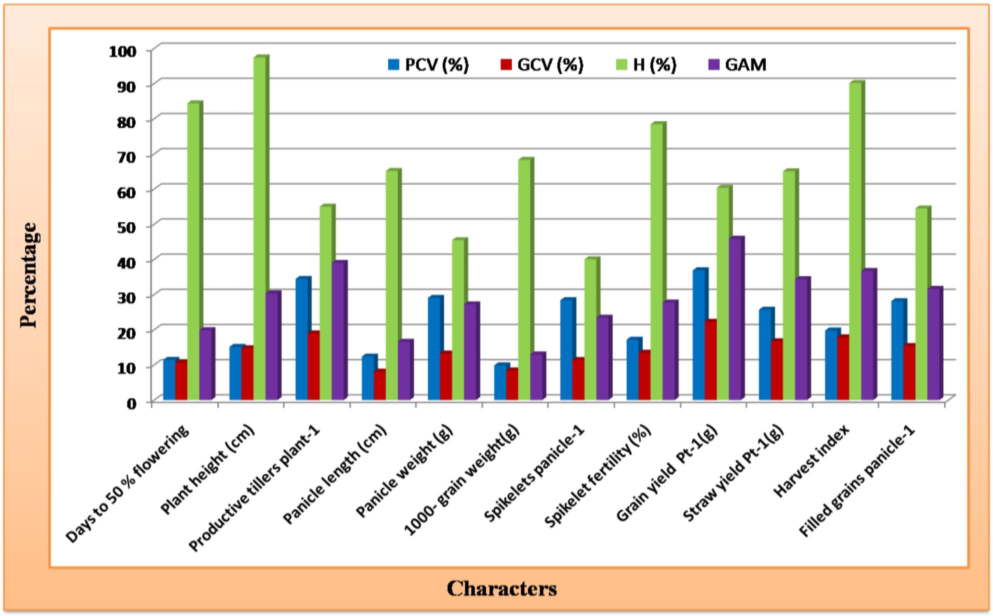

**Fig.2** Estimation of mean and genetic parameters for yield and yield attributing traits in $F_2$ generation of the cross Rathnachoodi × BR-2655 in rice (*Oryza sativa* L.)

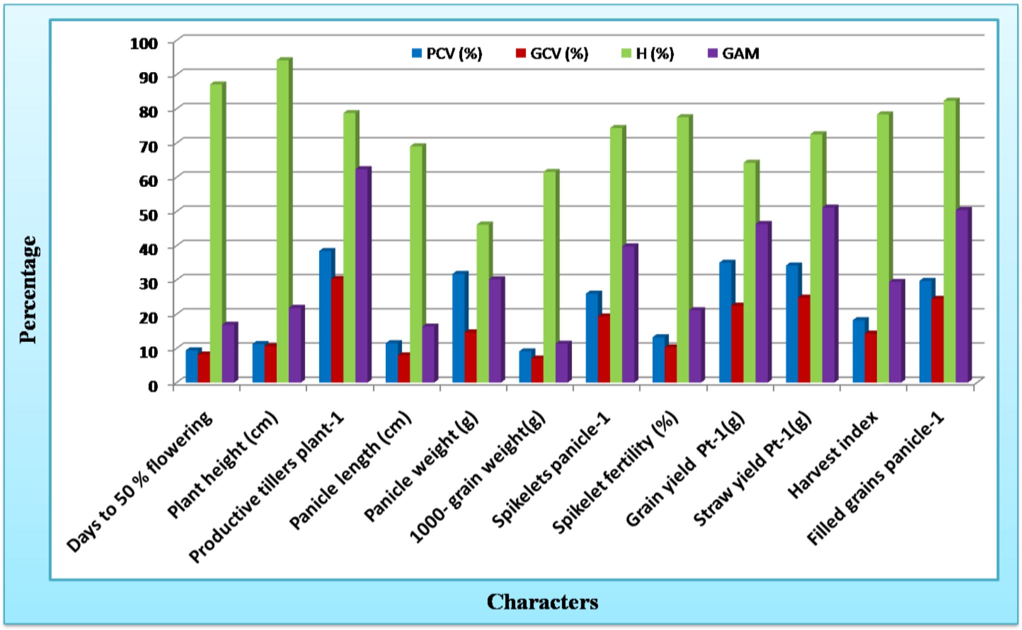

**Table.1** Variability parameters for twelve quantitative characters in $F_2$ populations of Cross 1 (Rajamudi × BR-2655) and Cross 2 (Rathnachoodi × BR-2655)

| Characters | Crosses | Mean | Range | | PCV (%) | GCV (%) | H (%) | GAM |
|---|---|---|---|---|---|---|---|---|
| | | | Minimum | Maximum | | | | |
| **Days to 50 % flowering** | Cross-1 | 87.45 | 73 | 106 | 11.44 | 10.65 | 84.37 | 19.88 |
| | Cross-2 | 104.54 | 91 | 122 | 9.41 | 8.2 | 87.12 | 16.88 |
| **Plant height (cm)** | Cross-1 | 117.51 | 63 | 185 | 15.11 | 14.72 | 97.44 | 30.33 |
| | Cross-2 | 127.44 | 65 | 174 | 11.25 | 10.59 | 94.19 | 21.83 |
| **Productive tillers per plant** | Cross-1 | 8.41 | 2 | 22 | 34.44 | 18.94 | 54.99 | 39.01 |
| | Cross-2 | 6.8 | 2 | 19 | 38.43 | 30.26 | 78.74 | 62.34 |
| **Panicle weight (g)** | Cross-1 | 3.53 | 0.8 | 6.93 | 29.05 | 13.21 | 45.47 | 27.21 |
| | Cross-2 | 3.2 | 0.97 | 6.84 | 31.74 | 14.65 | 46.16 | 30.18 |
| **Panicle length (cm)** | Cross-1 | 24.58 | 13 | 31.97 | 12.36 | 8.05 | 65.13 | 16.58 |
| | Cross-2 | 25.52 | 13.17 | 31.83 | 11.5 | 7.94 | 69.03 | 16.36 |
| **Filled grains per panicle** | Cross-1 | 134.15 | 36 | 250 | 28.14 | 15.33 | 54.49 | 31.59 |
| | Cross-2 | 118.5 | 12 | 240 | 29.71 | 24.47 | 82.35 | 50.4 |
| **Total spikeletsper panicle** | Cross-1 | 134.28 | 36 | 296 | 28.4 | 11.37 | 40.02 | 23.41 |
| | Cross-2 | 135.36 | 23 | 273 | 25.97 | 19.32 | 74.4 | 39.8 |
| **Straw yield per plant(g)** | Cross-1 | 15.9 | 9.2 | 36.1 | 25.67 | 16.69 | 65.04 | 34.39 |
| | Cross-2 | 13.7 | 7.5 | 33.7 | 34.21 | 24.82 | 72.55 | 51.13 |
| **1000- grain weight(g)** | Cross-1 | 25.23 | 15.01 | 34.97 | 9.85 | 8.41 | 68.31 | 12.97 |
| | Cross-2 | 23.46 | 14.22 | 33.14 | 9.12 | 7.02 | 61.56 | 11.34 |
| **Spikelet fertility (%)** | Cross-1 | 84.04 | 17.97 | 98.55 | 17.16 | 13.46 | 78.43 | 27.73 |
| | Cross-2 | 85.21 | 25.52 | 100 | 13.25 | 10.27 | 77.55 | 21.16 |
| **Harvest index (%)** | Cross-1 | 0.33 | 0.2 | 0.5 | 19.78 | 17.83 | 90.14 | 36.72 |
| | Cross-2 | 0.32 | 0.2 | 0.4 | 18.22 | 14.28 | 78.38 | 29.42 |
| **Grain yield per plant(g)** | Cross-1 | 24.44 | 5 | 54.4 | 36.88 | 22.26 | 60.37 | 45.86 |
| | Cross-2 | 22.57 | 5.1 | 51.4 | 35.02 | 22.49 | 64.23 | 46.34 |

Filled seeds per panicle exhibited high values of GCV (28.14% and 29.71%) and PCV (15.33% and 24.47%) in ‘Rajamudi × BR-2655’ and ‘Rathnachoodi × BR-2655’ population, respectively. In general considerable difference exists between both GCV and PCV, which indicates influence of environment. Result obtained in present study supported with earlier reports of Savitha and Ushakumari (2015). In both the crosses high (54.49% and 82.35%) broad sense heritability coupled with high (31.59% and 50.40%) amount of genetic advance expressed as per cent of mean was observed. This is in conformity with the reports of Savitha and Ushakumari (2015). High broad sense heritability with coupled with high genetic advance expressed as per cent of mean of this trait can be utilized as an index for its improvement.

Spikelet per panicle exhibited high value of PCV (28.4% and 25.97%) and moderate value of GCV (11.37% and 19.32%) in both crosses but difference between them were high indicating the high influence of environmental effect on the expression of this trait in both crosses. However, high broad sense heritability (74.40%) with high genetic advance (39.80) in the cross ‘Rathnachoodi × BR-2655’ and moderate (40.02%) broad sense heritability with high (23.41%) genetic advance in the cross ‘Rajamudi × BR-2655’was observed. The results of the present study were in total agreement with earlier reports of Thirumala *et al.,* (2014).

Straw yield per plant registered high values of GCV (25.67% and 34.21%) and PCV (16.69% and 24.82%) in both crosses, respectively. This is similar with the reports of Vikaskumar (2014). Heritability in broad sense for Straw yield per plant registered was high (65.04% and 72.55%) in both the crosses with high (34.39% and 51.13%) genetic advance expressed as per cent of mean (Rita *et al.,* 2006).

The PCV (9.85 % and 9.12 %) and GCV (8.41 % and 7.02%) values were low coupled with high (68.13 % and 61.56 %) broad sense heritability and moderate genetic advance expressed as per cent of mean (12.97 % and 11.34%) in 'Rajamudi × BR-2655' and 'Rathnachoodi × BR-2655' populations, respectively indicated moderate variability and major role of additive gene action in the control of 1000-grain weight in both the populations. Similar results were reported by Kannan Bapu and Soundarapandian (1993) and Chauhan and Chauhan (1994).

Spikelet fertility exhibited moderate variability in terms of both PCV (17.16% and 13.25%) and GCV (13.46% and 10.27%) in both the crosses, respectively. Hasib and Kole (2003) have reported moderate values for both PCV and GCV. Broad sense heritability (78.43% and 77.55%) and genetic advance expressed as per cent of mean was high in both crosses. Similar results were reported by Rita *et al.,* (2006) which they attributed to additive gene action. Thus, present situation gives scope for further improvement of this trait.

Harvest index shown moderate variability in terms of PCV (19.78% and 18.22%) and GCV (17.83% and 14.28%) 'Rajamudi × BR-2655' and 'Rathnachoodi × BR-2655' populations, respectively. In general a narrow range of difference exists between PCV and GCV, which reflect less influence of environment on the expression of this trait compared to other quantitative traits. Venkanna *et al.,* (2014) reported moderate PCV and GCV coupled with narrow difference between them.

Both the crosses registered high (90.14% and 78.38%) broad sense heritability coupled with high (36.72% and 29.42%) genetic advance. Similar results were observed by Venkanna *et al.,* (2014). Reliability can be placed on this important trait for selection of segregants owing to this high broad sense heritability coupled with high genetic advance per cent of mean.

Wide variability was noticed for grain yield per plant as evidenced by relatively higher values of PCV (36.88 % and 35.02 %) and GCV (22.26 % and 22.49%) in 'Rajamudi × BR-2655' and 'Rathnachoodi × BR-2655' populations, respectively. Estimates of broad sense heritability (60.37% and 64.23%) and genetic advance expressed as per cent of mean (45.86 % and 46.34 %) were relatively high in 'Rajamudi × BR-2655' and 'Rathnachoodi × BR-2655' populations, respectively indicating major role of additive gene action in the genetic control this trait in both the populations. Results of the present study are in conformity with the reports of Kumar *et al.,* (2005) and Nayak (2008).

The results of the present study clearly indicate that, grain yield cannot be improved by direct selection as the trait is subjected to greater environmental effect. However, yield can be improved indirectly by selecting $F_2$ plants with high total tillers per plant, productive tillers per plant, grains per panicle and 1000-grain weight as these traits showed high heritability coupled with high genetic advance as per cent of mean.

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