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# Genetic Variability, Heritability and Genetic Advance for Grain Yield, its Components and Quality Traits in Rice (*Oryza sativa* L.)

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**ABSTRACT**

An investigation was carried out to assess the variability, heritability and genetic advance for twenty four characters. High PCV and GCV for alkali spreading value was recorded, while number of grains per panicle, test weight, leaf area index at maximum tillering stage, kernel breadth after cooking, water uptake, gel consistency recorded moderate variability (*i.e.,* moderate PCV and GCV). High heritability accompanied with high genetic advance had shown by the characters *viz.,* number of ear bearing tillers per plant, number of grains per panicle, test weight, leaf area index at maximum tillering stage, water uptake, gel consistency and alkali spreading value indicating the preponderance of additive gene action which may be exploited through pedigree method, mass selection, ear-to-row method, etc. are to be followed to improve these traits.

**Key words:** *Genetic advance, Heritability, Rice, Variability*

Rice (*Oryza sativa* L.) was one of the staple cereal food crops of India. About 90% of the world's rice is grown and consumed in Asia. According to the projections made by the Population Foundation of India, the country's population will be 1546 million by the end of 2030 and 1824 million by the end of 2050. It is estimated that the demand for rice will be 121.2 million tonnes by the year 2030 and 137.3 million tonnes by the year 2050. (CRRI -VISION 2050). Due to various socio-economic constraints, a chance of bringing more area under rice cultivation is very remote. In view of the current situation of food insecurity, a number of limiting factors such as population growth in most of the Asian countries continues to be around 2% per year. Hence to achieve the target of increased rice production, it requires raising the production per unit area by creating the high yielding varieties, which requires a thorough knowledge of genetic variation in yield contributing characters. Observed variability is a combined estimate of genetic and environmental causes whereas genetic variability alone is heritable. Moreover, estimates of genetic variability across different environments helps to exploit complete genetic variability to exercise selection for development of yield contributing traits. However, the success of any breeding programme depends upon the quantum of genetic variability present in the population. Wider range of genetic variability helps in selecting desired genotypes. In addition to the genetic variability, knowledge on heritability and genetic advance helps the breeder to employ the suitable breeding strategy. Therefore, it is necessary to have knowledge of genetic variability, heritability and genetic advance present in the available genetic material.

## MATERIAL AND METHODS

Twenty varieties were grown during *kharif*, 2014 at Andhra Pradesh Rice Research Institute (APRRI) and Regional Agricultural Research Institute (RARS) in a Randomized Complete Block Design (RCBD) with three replications. Observations were recorded on ten randomly chosen plants for twenty four quantitative characters viz., twenty four characters of consisting of 10 yield attributing characters *viz.,* days to 50% flowering, days to maturity, plant height (cm), total number of tillers per plant, number of ear bearing tillers per plant, panicle length per plant (cm), number of grains per panicle, test weight (gm), leaf area index at maximum tillering stage, grain yield per plant; 6 physical traits such as hulling per cent, milling per cent, head rice recovery per cent, kernel length (mm), kernel breadth (mm), L/B ratio; and 8 cooking quality traits such as kernel length after cooking (mm), kernel breadth after cooking (mm), kernel elongation ratio, volume expansion ratio, water uptake value (ml), gel consistency, alkali digestion value (mm) and amylose. The data were subjected to statistical analysis and various genetic parameters such as PCV, GCV, heritability and genetic advance were worked out as per Johnson *et al.* (1955) and Hanson (1963).

## RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among all the 20 varieties for all the characters studied, indicating a high degree of variability in the material (Table 1). In the present study, the variation among genotypes was estimated as coefficient of variation (Table 2). The phenotypic coefficient of variance (PCV) was slightly higher in magnitude than genotypic coefficient of variance (GCV) for all the characters studied indicating the influence of environment on expression of these traits. Highest PCV and GCV (32.342 and 32.079) were exhibited by akali spreading value, whereas Moderate PCV and GCV was recorded for total number of tillers per plant, number of ear bearing tillers per plant, number of grains per panicle, test weight, leaf area index at maximum tillering stage, kernel breadth after cooking, water uptake and gel consistency. While grain yield per plant exhibited moderate PCV and low GCV. Low PCV and GCV was recorded by days to 50% flowering, days to maturity, plant height, panicle length per plant, hulling per cent, milling per cent, head rice recovery, kernel length, kernel breadth, L/B ratio, kernel length after cooking, kernel elongation ratio, volume expansion ratio, and amylose content. The results are in accordance with by Allam *et al.* (2015), Navin Kumar *et al.* (2015), Sameera *et al.* (2015), Arpita *et al.* (2014), Lingaiah *et al.* (2014), Thirumala Rao *et al.* (2014), Aditya Kumar *et al.* (2013), Paikhomba *et al.* (2013) and Shiva Prasad *et al.* (2013).

Heritability estimates along with genetic advance are more helpful in predicting the gain under selection than heritability estimates alone. The estimates of heritability and genetic advance as per cent of mean were high for number of ear bearing tillers per plant, number of grains per panicle, test weight, LAI at maximum tillering stage, water uptake, gel consistency and alkali spreading value indicating that these characters were less influenced by environment and governed by additive gene action which may be exploited through breeding methods involving simple selection like pedigree method, mass selection, ear-to-row method, etc. These findings were in agreement with Keya *et al.* (2015), Sameera *et al.* (2015), Gokulakrishnan *et al.* (2014), Atif and Khalid (2013), Awaneet Kumar and Senapati (2013) and Gangashetty *et al.* (2013)

High heritability coupled with moderate genetic advance as per cent of mean was observed for days to 50% flowering, days to maturity, plant height, total number of tillers per plant, panicle length per plant, head rice recovery, kernel length, kernel breadth, L/B ratio, kernel length after cooking, kernel breadth after cooking, kernel elongation ratio and volume expansion ratio. Whereas hulling per cent , milling per cent and amylose content expressed high heritability accompanied with low genetic advance indicating the role of both additive and non-additive gene actions in the inheritance of these traits and can be improved either by population improvement methods or even heterosis breeding methods like production of hybrids and synthetics. While moderate heritability coupled with low genetic advance as per cent of mean was observed for milling per cent, whereas grain yield per plant exhibited moderate PCV and GCV indicating the role of non-additive gene action and can be improved by population improvement methods involving selection, intermating among selected ones and reselection may help to improve these traits besides exploiting the methods of heterosis breeding. These findings are corroborated by Vijay Kumar *et al.* (2015) and Mulugeta *et al.* (2012).

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**Table: 1. Analysis of variance of parents for grain yield, yield components and quality traits of 20 varieties in rice (*Oryza sativa* L.)**

| Source of variations | d.f. | Days to 50% flowering | Days to maturity | Plant height (cm) | Total number of tillers per plant | Number of ear tillers per plant | Panicle length per plant (cm) | Number of grains per panicle | Test weight (gm) | Leaf area index at maximum tillering stage | Hulling percentage | Milling | Head rice recovery |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean sum of squares | | | | | | | | | | | |
| Replications | 2 | 0.267 | 0.467 | 0.247 | 0.067 | 0.067 | 0.006 | 3.200 | 0.031 | 0.000 | 0.050 | 0.119 | 0.462 |
| Treatments | 19 | 173.470** | 177.105** | 191.121** | 5.210** | 5.154** | 7.576** | 2367.435** | 20.254** | 0.487** | 4.961** | 13.988** | 40.960** |
| Error | 38 | 5.986 | 7.274 | 11.277 | 0.839 | 0.575 | 0.789 | 97.288 | 0.214 | 0.003 | 0.877 | 2.690 | 1.807 |
| Total | 59 | 179.723 | 184.846 | 202.645 | 6.115 | 5.796 | 8.371 | 2467.923 | 20.500 | 0.490 | 5.887 | 16.798 | 43.230 |

| Source of variations | d.f. | Kernel length (mm) | Kernel breadth | Kernel L/B ratio | Kernel lenth after cooking (mm) | Kernel breadth after cooking (mm) | Kernel elongation ratio | Volume expansion ratio | Water uptake (ml) | Gel consistency (mm) | Alkali spreading value (mm) | Amylose content (%) | Grain yield per plant (gm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean sum of squares | | | | | | | | | | | |
| Replications | 2 | 0.000 | 0.001 | 0.001 | 0.003 | 0.012 | 0.000 | 0.016 | 25.350 | 0.284 | 0.005 | 0.034 | 0.530 |
| Treatments | 19 | 0.272** | 0.087** | 0.088** | 1.654** | 0.282** | 0.031** | 0.411** | 2875.448** | 191.629** | 5.493** | 5.939** | 12.056** |
| Error | 38 | 0.002 | 0.001 | 0.001 | 0.029 | 0.040 | 0.001 | 0.039 | 50.648 | 2.071 | 0.030 | 0.611 | 2.769 |
| Total | 59 | 0.275 | 0.089 | 0.091 | 1.686 | 0.334 | 0.032 | 0.466 | 2951.446 | 193.985 | 5.528 | 6.584 | 15.354 |

** Significant at 1% level

* Significant at 5% level

**Table: 2. Estimates of variability, heritability and genetic advance as per cent of mean for grain yield, yield components and quality traits of 20 varieties in rice (*Oryza sativa* L.)**

| S.No | Characters | Mean | Range | | Coefficient of varition | | Heritability (broad sense) | Genetic advancement | Genetic advance as percent of mean |
|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | PCV (%) | GCV (%) | | | |
| 1 | Days to 50% flowering | 112.37 | 96.33 | 122.33 | 6.997 | 6.649 | 90.30 | 14.628 | 13.018 |
| 2 | Days to maturity | 142.83 | 126.00 | 152.33 | 5.596 | 5.268 | 88.60 | 14.590 | 10.215 |
| 3 | Plant height (cm) | 109.48 | 94.88 | 119.34 | 7.709 | 7.072 | 84.20 | 14.633 | 13.365 |
| 4 | Total number of tillers plant$^{-1}$ | 11.82 | 8.67 | 14.00 | 12.822 | 10.215 | 63.50 | 1.981 | 16.764 |
| 5 | Number of ear bearing tillers plant$^{-1}$ | 7.97 | 5.67 | 11.33 | 18.198 | 15.508 | 72.60 | 2.169 | 27.224 |
| 6 | Panicle length per plant (cm) | 25.10 | 21.34 | 28.14 | 6.958 | 5.991 | 74.10 | 2.668 | 10.626 |
| 7 | Number of grains per panicle | 199.30 | 158.00 | 242.00 | 14.663 | 13.803 | 88.60 | 53.342 | 26.765 |
| 8 | Test weight (g) | 19.26 | 15.07 | 25.54 | 13.635 | 13.422 | 96.90 | 5.241 | 27.216 |
| 9 | LAI at max tillering tillering stage | 2.84 | 2.30 | 3.47 | 14.242 | 14.123 | 98.30 | 0.821 | 28.848 |
| 10 | Grain yield plant$^{-1}$ (g) | 21.51 | 18.12 | 25.66 | 11.261 | 8.181 | 52.80 | 2.633 | 12.245 |
| 11 | Hulling (%) | 80.29 | 77.46 | 82.24 | 1.863 | 1.453 | 60.80 | 1.875 | 2.335 |
| 12 | Milling (%) | 73.29 | 68.09 | 76.60 | 3.467 | 2.648 | 58.30 | 3.053 | 4.166 |
| 13 | Head rice recovery (%) | 65.05 | 57.78 | 71.03 | 5.925 | 5.553 | 87.80 | 6.975 | 10.722 |
| 14 | Kernel length (mm) | 5.60 | 4.98 | 6.11 | 5.421 | 5.355 | 97.60 | 0.611 | 10.899 |
| 15 | Kernel breadth (mm) | 2.04 | 1.64 | 2.30 | 8.439 | 8.313 | 97.00 | 0.345 | 16.869 |
| 16 | Length/Breadth Ratio | 2.75 | 2.53 | 3.04 | 6.341 | 6.188 | 95.30 | 0.342 | 12.442 |
| 17 | Kernel length after cooking (mm) | 9.35 | 7.91 | 10.45 | 8.081 | 7.870 | 94.90 | 1.477 | 15.79 |
| 18 | Kernel breadth after cooking (mm) | 2.78 | 2.15 | 3.47 | 12.488 | 10.208 | 66.80 | 0.478 | 17.19 |
| 19 | Kernel Elongation Ratio | 1.70 | 1.50 | 1.88 | 6.167 | 5.885 | 91.10 | 0.197 | 11.57 |
| 20 | Volume expansion ratio | 4.45 | 3.70 | 5.06 | 9.079 | 7.906 | 75.80 | 0.631 | 14.183 |
| 21 | Water uptake (ml) | 200.05 | 145.00 | 285.00 | 15.746 | 15.339 | 94.90 | 61.578 | 30.781 |
| 22 | Gel consistency (mm) | 55.84 | 40.23 | 68.08 | 14.467 | 14.236 | 96.80 | 16.113 | 28.856 |
| 23 | Alkali spreading value (mm) | 4.21 | 2.06 | 6.72 | 32.342 | 32.079 | 98.40 | 2.757 | 65.544 |
| 24 | Amylose content (%) | 23.77 | 21.34 | 26.86 | 6.501 | 5.607 | 74.40 | 2.368 | 9.964 |

PCV = Phenotypic coefficient of variation GCV = Genotypic coefficient of variation

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