Genetic Variability Studies in Genetically Diverse non-basmati Local Aromatic Genotypes of Rice (Oryza sativa (L.))

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Abstract An investigation was carried out to know the extent of genetic variability present in the local non-basmati aromatic genotypes of rice. The experiment was conducted in randomized complete block design with two replications during Kharif 2010 at Agricultural Research station Mugad, UAS Dharwad. A total of forty two genetically diverse genotypes were considered for the study. Analysis of variance was found to be significant for all the traits, indicating that there is existence of genetic variability for all the traits varying from lower to higher coefficients of variance. The results found that the higher values of genotypic and phenotypic coefficient of variability was observed for plant height, number of tillers per plant, number of productive tillers per plant, panicle weight, grain length, test weight, iron and zinc content and grain yield per plant. The moderate genotypic and phenotypic coefficients of variance were recorded for panicle length, grain breadth and L/B ratio. The days to 50 per cent flowering had recorded lower values of genotypic and phenotypic variance. High heritability with high genetic advance was observed for all traits except days to 50 per cent flowering. All traits were found to be higher values of variance and selection for such traits will be practised based on phenotypic observation.

Keywords Non-basmati aromatic genotypes; Genetic variability; Heritability; Genetic advance

1 Introduction

Rice is the world’s most important food crop and a primary source of food for more than half the world’s population. It is the predominant staple for 15 countries in Asia and the Pacific, ten countries in Latin America and the Caribbean, one country in North Africa and seven countries in sub-Saharan Africa. In developing countries, rice accounts for: 715 kcal/capita/day, 27 per cent of dietary energy supply, 20 per cent of dietary protein and 3 per cent of dietary fat. Countries in Southeast Asia are heavily reliant upon rice. India accounts for nearly one-fourth (22%) of the rice produced in the world with the first place occupied by China. World rice production now is around 597.8 million tones grown over 151 million hectares with a productivity of 3.96 tones ha-1. India has an area of 50.00 million hectares under rice cultivation with an output of 104.10 million tones, which averages to around 4.00 tones ha-1. Dietary intake surveys from China and India reveal an average adult intake of about 300 g of raw rice per day. India produces some of the best quality rices in the world. Though a high-volume commodity, a class of aromatic, superfine premium rice has evolved its own market niches, making rice trade a commercial success internationally. A class of premium rice with specific grain characteristics, traditionally grown on either side of the Indus River, is popularly known as the basmatirice and these varieties are also known as “Queen of fragrance”. The superiority of basmati cultivars over other premium rice varieties is its superfine grains which have a distinct aroma, excellent elongation ability and the soft, flaky texture of the cooked rice (Siddiq and Shobha Rani, 1998). India’s revenue from the export of 8.44 lakh tones basmati rice during 2006–2007 was Rs 2 213 crore.

Besides the much sought after basmati types which get high price in international markets, the country also abounds with hundreds of indigenous short grain aromatic cultivars and landraces grown in pockets of different states. Almost every state has its own collection of aromatic rices that perform well
The aroma of rice plays a role in its consumer acceptability. More than 100 compounds that contribute to the aroma of rice have been identified. Some of these volatile compounds contribute to consumer acceptance of certain types of rice, whereas other compounds contribute to consumer rejection. The popcorn-like smell of aromatic rice stemming primarily from its 2-acetyl-1-pyrroline (2-AP) content is preferred by many consumers. Several methods are used to detect aroma like biting kernels, smelling vegetative tissue after warming or soaking in KOH and eating cooked rice (Sood and Siddiq, 1978;). In recent years, actual quantification of 2-AP has been done using different distillation and extraction procedures. However, these methods are laborious, expensive, time consuming and require lot of sample for estimation. Keeping eye on these objectives the present investigation was carried out to know the extent of genetic variability in genetically diverse group of genotypes.

2 Results and discussion

The success of plant breeding depends on the extent of genetic variability present in a crop. The presence of genetic variability for economic traits is a key factor for improving productivity. Variability can be created by hybridization and so created variability need to be assessed in segregating populations. Therefore the present investigation was carried out to assess the extent variability in genetically diverse aromatic genotypes of rice. The results of the present investigation for various genetic parameters were as follows.

The analysis of variance was presented in table 1 and data on mean, range, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability (h²) and genetic advance as per cent mean (GAM) are character-wise presented in table 2. The figure 1 represents the entire genetic variability in the whole populations.
Table 1 Analysis of variance for yield and yield related characters in forty-two aromatic rice genotypes

| Sources of variation | DF | X₁ | X₂ | X₃ | X₄ | X₅ | X₆ | X₇ | X₈ | X₉ | X₁₀ | X₁₁ | X₁₂ | X₁₃ |
|----------------------|----|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|
| Replications         | 1  | 0.58 | 12.00 | 3.15 | 0.01 | 3.71 | 0.16 | 0.02 | 0.01 | 0.01 | 38.05 | 0.15 | 4.17 | 7.40 |
| Genotypes            | 41 | 126.88** | 950.12** | 9.15** | 9.26** | 25.32** | 1.50** | 6.43** | 3.21** | 1.43** | 89.38** | 15.10** | 33.73** | 29.37** |
| Error                | 41 | 0.68 | 0.63 | 0.25 | 0.83 | 0.28 | 0.04 | 0.02 | 0.01 | 0.01 | 7.90 | 0.74 | 1.24 | 0.75 |

Note: X₁: Days to 50 per cent flowering; X₂: Plant height (cm); X₃: Number of tillers per plant; X₄: Number of productive tillers per plant; X₅: Panicle length (cm); X₆: Panicle weight (g); X₇: Grain Length (mm); X₈: Grain Breadth (mm); X₉: L/B ratio; X₁₀: Test weight (g); X₁₁: Iron content (mg/kg); X₁₂: Zinc content (mg/kg); X₁₃: Grain yield per plant (g)

Table 2 Mean, range and genetic parameters for yield and yield related characters in forty-two aromatic rice genotypes

| Characters                        | Mean | Range | GCV (%) | PCV (%) | h² bs (%) | GA | GA as per cent of mean |
|-----------------------------------|------|-------|---------|---------|-----------|----|------------------------|
| Days to 50 per cent flowering     | 105.27 | 85.00 | 117.00 | 7.54 | 7.58 | 98.00 | 16.27 | 15.46 |
| Plant height(cm)                  | 90.36 | 60.33 | 144.00 | 24.11 | 24.13 | 99.00 | 44.85 | 49.64 |
| No of tillers per plant           | 8.77 | 4.33 | 13.33 | 24.06 | 24.74 | 94.00 | 4.22 | 48.22 |
| No of productive tillers per plant| 8.29 | 4.26 | 13.33 | 24.77 | 27.10 | 83.00 | 3.86 | 46.64 |
| Panicle length(cm)                | 26.11 | 19.17 | 32.25 | 13.55 | 13.70 | 97.00 | 7.20 | 27.60 |
| Panicle weight(g)                 | 2.78 | 1.40 | 5.16 | 30.70 | 31.57 | 94.00 | 1.71 | 61.49 |
| Grain Length (mm)                 | 7.43 | 3.00 | 10.90 | 24.11 | 24.17 | 99.00 | 3.68 | 49.55 |
| Grain Breadth (mm)                | 1.57 | 0.88 | 1.88 | 14.62 | 14.81 | 97.00 | 0.46 | 29.72 |
| L/B ratio                         | 4.72 | 3.41 | 5.80 | 17.82 | 18.02 | 97.00 | 1.71 | 36.31 |
| Test weight(g)                    | 26.46 | 13.18 | 35.65 | 24.09 | 26.32 | 83.00 | 12.03 | 45.42 |
| Iron content(mg/kg)               | 8.71 | 2.00 | 17.49 | 30.78 | 32.34 | 90.00 | 5.25 | 60.33 |
| Zinc content(mg/kg)               | 14.81 | 9.80 | 32.44 | 27.22 | 28.24 | 92.00 | 8.00 | 54.04 |
| Yield per plant (g)               | 18.17 | 10.00 | 26.00 | 20.82 | 21.36 | 95.00 | 7.59 | 41.80 |
Panicle length, grain breadth and L/B ratio recorded moderate PCV and GCV values. This indicates the existence of comparatively moderate variability for these traits, which could be exploited for improvement through selection in advanced generations. While, days to 50\% flowering recorded lower values of PCV and GCV. This indicate narrow genetic base for these traits. The moderate GCV and PCV for panicle length grain breadth and L/B ratio were reported by Gholipoore et al., 1998. For lower values of PCV and GCV for days to 50 per cent flowering was reported by Shivapriya (2002). Improvement in these characters can be brought about by hybridization or induced mutagens to widen genetic base followed by pedigree selection in advanced generations.

On the whole, co-efficient of variation indicated considerable amount of variability for most of the traits for few traits. The close correspondence between the estimates of GCV and PCV for most of the traits indicated lesser environmental influence on the expression of these traits, which is also reflected by their high heritability values.

Broad sense heritability gives an idea about portion of observed variability attributable to genetic differences. The difference between PCV and GCV estimates indicates the relative influence of environment on the character, which in turn decides the extent of their heritability. If the difference is low for a character then the influence of environment is less coupled with high heritability. Wide differences indicate considerable influence of the environment, thus resulting in low heritability estimates. According to Johnson et al. (1955), heritability estimates along with genetic gain would be more useful than the former alone in predicting the effectiveness of selecting the best individual. Therefore, it is essential to consider the predicted genetic advance along with heritability estimate as a tool in selection programme for better efficiency.

In the current study, high heritability coupled with high genetic advance as per cent of mean were recorded for plant height, number of tillers, productive tillers per plant, zinc content, iron content, test weight, L/B ratio, grain length, plant height and grain yield per plant. This indicates that there was low environmental influence on the expression of these characters and hence one can practice selection.

High heritability and genetic advance as per cent of mean was earlier for these traits were reported by Balanet al. (1999) and Bidhanet al. (2001).

The present investigation revealed high heritability coupled with high genetic advance as per cent of mean for most of the characters indicating the presence of considerable variation and additive gene effects. Hence, improvement of these characters could be effective through phenotypic selection.

3 Materials and Methods
The investigation was carried out during Kharif 2010 at Agricultural Research Station, Mugad, University of Agricultural Sciences Dharwad. A total of 42 genetically diverse aromatic genotypes of rice were taken for the study. The experiment was laid out in randomized block design with two replications. The spacing of 15 cm between the plants within row and 30 cm between the rows was maintained. All the agronomic package of practices were carried out to ensure healthy plant growth. Observations were recorded on thirteen quantitative traits viz., days to 50 per cent flowering, plant height, number of tillers for plant, number of productive tillers for plant, panicle length, panicle weight, grain length, grain breadth, L/B ratio, test weight, iron and zinc content and grain yield per plant. The analysis of variance was done as suggested by Panse and Sukhatme (1967). Variability for different characters was estimated by Burton and De Vane (1953). Heritability and expected genetic advance was calculated according to Hanson et al., 1956 and Johnson et al., 1955 respectively.

Author contributions
The author conducted the major part of this study including experimental design, data analysis and manuscript preparation.
P.I. Gangashetty and N.G. Hanamaratti participated in experimental design and preliminary analysis of data and statistical analysis. P.M. Salimath did final manuscript corrections and made valuable suggestions. All authors read and approved the final manuscript.

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