Original Research Article

Genetic Variability Studies in Tamarind (Tamarindus indica L.)

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A B S T R A C T

Introduction

Tamarind (Tamarindus indica L.) is a monotypic genus tree belonging to the family Leguminosae, sub-family caesalpiniaceae with somatic chromosome number of 2n=24 (Purseglove et al., 1987). It is indigenious to tropical Africa and southern India (Nas, 1979). It is estimated that India produces an annual production of pulp over 1.99 lakh tones and exported the tamarind products worth of rupees 57 crores per annum during 2017-18 (Anon., 2017). The sticky pulp is often eaten fresh but has many other culinary uses viz., in pickles, jam, candy, juices, curries, sauces, chutneys and certain drinks (Archana et al., 2013). Tamarind is a highly cross pollinated and seed propagated crop; hence wide variability is common in this species. The individual variation between the
trees within a population is of paramount importance and it may be worthwhile concentrating only on best trees with respect to neighbouring ones and plus trees may be selected within ecological zones for increasing their frequencies. The magnitude of variability and its quantitative estimation for each character would indicate the potential of each tree and scope for improving the desirable and economic characters through selection (Feungchan et al., 1996a).

Therefore, a field investigation was carried out with a view to study the genetic variability, heritability and genetic advance in tamarind by assessing the tamarind genotypes at K. R. C. College of Horticulture, Arabhavi (Karnataka).

**Materials and Methods**

The experimental material comprised of 231 randomly selected elite tamarind genotypes from six districts with different locations (viz., Belagavi, Dharwad, Gadag, Bellary, Chitradurga and Gulbarga) which is away from K. R. C. College of Horticulture, Arabhavi, Karnataka, India. The observation on twenty quantitative and qualitative parameters like tree height (m), trunk diameter (m), spread of the tree east to west (m), spread of the tree north to south (m), crown size (m), pod length (cm), pod width (cm), pod thickness (cm), pod weight (g), pulp weight (g), number of seeds per pod, seed weight per pod (g), shell weight per pod (g), vein weight per pod (g), pulp per cent (%), seed per cent (%), shell per cent (%), vein per cent (%), tamarind pod yield (kg/tree) and tartaric acid content (%) were recorded 10 representative samples of ripe pods (fruits) from all the directions of the tree and were analysed statistically (Sundarraj et al., 1972). The biometrical analyses were carried out according to estimation of genotypic and phenotypic coefficients of variation (Burton and Devane, 1953), heritability in broad sense (Hanson et al., 1956), genetic advance and genetic advance over per cent mean (Johnson et al., 1955).

**Results and Discussion**

The analysis of variance was conducted to test significance difference among genotype studied. The mean sums of squares due to various sources for different characters are presented in table 1. The genotypic and phenotypic coefficient of variability, heritability, and genetic advance as per cent over mean for each of the characters are presented in table 2 and 3. A range of variation was observed for all the characters. It was maximum in case of tamarind pod yield (280-1200) and minimum for the vein weight per pod (0.25-2.76). The difference between the genotypic (GCV) and phenotypic coefficient of variation (PCV) were found to be narrow for trunk diameter, spread of the east to west and spread of the tree north to south, crown size, pod thickness, pulp per cent, seed per cent and shell per cent. The results suggest that these traits are least affected by environment and selection for these traits on phenotypic would be rewarding. For the rest of the character the estimates of PCV were greater than GCV. This indicates that the variation for these traits is not only by genotypes but also due to environment. Selection based on phenotypes may miss lead as their expression depends more on genetical factors. Similar observations were reported in tamarind by Hanamashetti (1996), Mastan et al., (1997), Biradar (2001), Patil (2004), Ganachary (2005), Divakara (2008), Divakara (2009) and Singh and Nandini (2014).

In the present study, most of the characters exhibited high estimates of heritability except for pod width. The high estimates of heritability for tree height (65.26 %), trunk diameter (76.74 %), spread of the tree east to
west (75.04 %), spread of the tree north to south (71.74 %), crown size (86.46 %), pod length (96.01 %), pod thickness (68.79 %), pod weight (89.13 %), pulp weight (92.49 %), number of seeds per pod (87.61 %), seed weight per pod (89.21 %), shell weight per pod (75.78 %), vein weight per pod (67.06 %), pulp per cent (99.09 %), seed per cent (99.93 %), shell per cent (99.85 %), vein per cent (99.32 %), tamarind pod yield (99.80 %) and tartaric acid content (98.64 %). Suggest that selection will be effective for these characters. These results are in accordance with Keskar et al., (1989), Jambulingam et al., (1997), Karale et al., (1999), Biradar (2001), Patil (2004), Singh et al., (2008), Prasad et al., (2009) in tamarind crop.

High heritability along with high genetic advance as a per cent over mean is an important factor for predicting the resultant effect for selecting the best individuals.

**Table.1 Analysis of variance (ANOVA) for growth, yield and quality attributes in tamarind genotypes**

| Sl. No. | Source of variance        | Replication | Treatment (Genotypes) | Error | CD @ 5% | CD @ 1% |
|---------|---------------------------|-------------|-----------------------|-------|---------|---------|
| 1       | Tree height (m)           | 730.52      | 36.26**               | 7.62  | 5.44    | 7.17    |
| 2       | Trunk diameter (m)        | 2099.96     | 4.91**                | 0.64  | 1.58    | 2.08    |
| 3       | Spread of the tree EW (m) | 1920.41     | 4.01**                | 0.57  | 1.49    | 1.96    |
| 4       | Spread of the tree NS (m) | 2048.73     | 4.36**                | 0.71  | 1.67    | 2.20    |
| 5       | Crown size (m)           | 51.87       | 3.90**                | 0.28  | 1.05    | 1.38    |
| 6       | Pod length (cm)          | 1140.16     | 30.71**               | 0.62  | 1.56    | 2.05    |
| 7       | Pod width (cm)           | 2533.05     | 2.34**                | 1.64  | 2.53    | 3.32    |
| 8       | Pod thickness (cm)       | 1710.65     | 10.98**               | 2.03  | 0.28    | 0.63    |
| 9       | Pod weight (g)           | 1377.96     | 89.44**               | 5.14  | 4.47    | 5.89    |
| 10      | Pulp weight (g)          | 1970.65     | 17.82**               | 0.69  | 1.64    | 2.16    |
| 11      | Number of seeds per pod  | 1390.75     | 10.66**               | 0.70  | 1.65    | 2.17    |
| 12      | Seed weight per pod (g)  | 1424.06     | 11.69**               | 0.66  | 1.61    | 2.12    |
| 13      | Shell weight per pod (g) | 1246.73     | 5.44**                | 0.74  | 1.71    | 2.24    |
| 14      | Fiber or Vein weight per pod (g) | 30.46 | 0.58** | 0.11 | 0.67 | 0.88 |
| 15      | Pulp per cent            | 7.63        | 56.29**               | 0.25  | 1.00    | 1.31    |
| 16      | Seed per cent            | 8.80        | 56.01**               | 0.02  | 0.27    | 0.35    |
| 17      | Shell per cent           | 7.24        | 24.77**               | 0.01  | 0.26    | 0.34    |
| 18      | Vein per cent            | 7.89        | 5.19**                | 0.01  | 0.26    | 0.39    |
| 19      | Tamarind pod yield (tree/kg) | 1575.62 | 7.24** | 0.02 | 0.24 | 0.37 |
| 20      | Tartaric acid content (%) | 1045.93     | 81.81**               | 0.56  | 1.47    | 1.94    |
Table 2 Estimates of mean, range, co-efficient of variability, heritability and genetic advance for growth parameters of tamarind genotypes

| Sl. No. | Characters                     | Mean   | Range            | Variance | Co-efficient of variability | $h^2$ | GA  | GAM |
|--------|-------------------------------|--------|------------------|----------|-----------------------------|-------|-----|-----|
|        |                               |        |                  |          | PV                          | GV    | EV  | PCV | GCV |       |       |
| 1      | Tree height (m)               | 21.36  | 13.22-36.95      | 21.94    | 14.32                       | 7.62  | 21.92 | 17.71 | 65.26 | 6.29  | 29.48 |
| 2      | Trunk diameter (m)            | 8.84   | 4.46-11.87       | 2.78     | 2.13                        | 0.64  | 18.85 | 16.51 | 76.74 | 2.63  | 29.81 |
| 3      | Spread of the tree EW (m)     | 9.50   | 5.12-12.07       | 2.29     | 1.72                        | 0.57  | 15.94 | 13.81 | 75.04 | 2.34  | 24.64 |
| 4      | Spread of the tree NS (m)     | 8.83   | 4.41-11.48       | 2.54     | 1.82                        | 0.71  | 18.05 | 15.29 | 71.74 | 2.35  | 26.68 |
| 5      | Crown Size (m)                | 9.16   | 5.14-11.65       | 2.09     | 1.81                        | 0.28  | 15.79 | 14.68 | 86.46 | 2.57  | 28.12 |

GV- Genotypic variance  
$h^2$- Broad sense heritability  
GA- Genetic advance  
GAM- Genetic advance as per cent of mean  
PV- Phenotypic variance  
EV- Environmental variance  
GCV- Genotypic co-efficient of variation  
PCV- Phenotypic co-efficient of variation
**Table 3** Estimates of mean, range, co-efficient of variability, heritability and genetic advance for yield and quality parameters of tamarind genotypes

| Sl. No. | Characters                        | Mean   | Range          | Variance | Co-efficient of variability | $h^2$ | GA  | GAM  |
|--------|----------------------------------|--------|----------------|----------|-----------------------------|-------|-----|------|
|        |                                  |        |                |          | PV  | GV  | EV  | PCV | GCV |       |      |     |      |
| 1      | Pod length (cm)                  | 16.00  | 9.34-27.72     | 15.67    | 15.04 | 0.62 | 24.74 | 24.24 | 96.01 | 7.82 | 48.93 |
| 2      | Pod width (cm)                   | 6.31   | 3.99-9.38      | 1.99     | 0.34  | 1.64 | 22.38 | 9.38  | 17.57 | 0.51 | 8.10  |
| 3      | Pod thickness (cm)               | 1.72   | 1.17-2.34      | 6.50     | 4.47  | 2.03 | 14.83 | 12.30 | 68.79 | 3.61 | 21.02 |
| 4      | Pod weight (g)                   | 22.02  | 9.11-45.84     | 47.29    | 42.15 | 5.14 | 31.23 | 29.48 | 89.13 | 12.62 | 57.34 |
| 5      | Pulp weight (g)                  | 8.68   | 3.11-18.86     | 9.26     | 8.56  | 0.69 | 35.05 | 33.71 | 92.49 | 5.79 | 66.79 |
| 6      | Number of seeds per pod          | 8.09   | 3.90-14.91     | 5.68     | 4.98  | 0.70 | 29.46 | 27.57 | 87.61 | 4.30 | 53.17 |
| 7      | Seed weight per pod (g)          | 6.99   | 2.52-14.89     | 6.18     | 5.51  | 0.66 | 35.58 | 33.60 | 89.21 | 4.56 | 65.39 |
| 8      | Shell weight per pod (g)         | 5.57   | 1.82-10.22     | 3.09     | 2.34  | 0.75 | 31.58 | 27.49 | 75.78 | 2.74 | 49.30 |
| 9      | Fiber or Vein weight per pod (g) | 0.85   | 0.25-2.76      | 0.34     | 0.23  | 0.11 | 69.14 | 56.62 | 67.06 | 0.81 | 95.52 |
| 10     | Pulp per cent                    | 39.49  | 25.52-51.39    | 28.27    | 28.01 | 0.25 | 13.46 | 13.40 | 99.09 | 10.85 | 27.48 |
| 11     | Seed per cent                    | 31.84  | 17.96-46.69    | 28.01    | 27.99 | 0.02 | 16.63 | 16.62 | 99.93 | 10.89 | 34.22 |
| 12     | Shell per cent                   | 25.66  | 16.80-37.68    | 12.39    | 12.37 | 0.01 | 13.72 | 13.71 | 99.85 | 7.24 | 28.22 |
| 13     | Vein per cent                    | 3.90   | 0.97-9.83      | 2.60     | 2.58  | 0.01 | 41.38 | 41.24 | 99.32 | 3.30 | 84.86 |
| 14     | Tamarind yield (tree/kg)         | 643.38 | 280-1200       | 36200.24 | 36198.22 | 0.01 | 29.44 | 29.41 | 99.80 | 391.94 | 60.64 |
| 15     | Tartaric acid content (%)        | 16.39  | 3.82-33.92     | 41.18    | 40.62 | 0.56 | 39.14 | 38.88 | 98.64 | 13.04 | 79.55 |

GV- Genotypic variance  
$h^2$- Broad sense heritability  
GA- Genetic advance  
GAM- Genetic advance as per cent of mean  
PCV- Phenotypic co-efficient of variation  
PV- Phenotypic variance  
EV- Environmental variance  
GCV- Genotypic co-efficient of variation
Table 4 Top 20 ranking genotypes of tamarind with respect to yield and quality characters

| Sl No. | Characters                      | Top ranking genotypes                  |
|--------|---------------------------------|---------------------------------------|
| 1      | Pod length                      | BGK-12, CLK-10, BGK-18, GRG-10, KDL-10 |
| 2      | Pod weight                      | GRG-10, UDP-08, KDL-18, KOL-08, UDP-10 |
| 3      | Pulp weight                     | BGK-13, GRG-15, UDP-08, KNU-06, GRG-16 |
| 4      | Number of seeds per pod         | GRG-10, UDP-08, BCM-06, GRG-07, UDP-04 |
| 5      | Seed weight per pod             | GRG-10, UDP-08, CLK-10, GRG-07, GRG-11 |
| 6      | Shell weight per pod            | GRG-11, GRT-14, UDP-18, CLK-10, BGK-13 |
| 7      | Pulp per cent                   | KOL-08, GRG-10, GRG-11, BGK-12, BGK-13 |
| 8      | Seed per cent                   | UDP-10, GRT-14, BGK-08, BCM-06, KDL-10 |
| 9      | Tartaric acid content           | BGK-12, KNU-06, TKD-12, KNU-15, GRG-11 |
| 10     | Pod yield per tree              | GRG-11, BGK-11, UDP-15, CLK-10, UDP-08 |

In the present study, high heritability was accompanied with high values of genetic advance as a per cent over mean for tree height, trunk diameter, spread of the tree east to west, spread of the tree north to south, crown size, pod length, pod thickness, pod weight, pulp weight, number of seeds per pod, seed weight per pod, shell weight per pod, vein weight per pod, pulp per cent, seed per cent, shell per cent, vein per cent, tamarind pod yield and tartaric acid content indicating predominance of additive gene component. Thus, there is ample scope for improving these characters based on direct selection.

The present study revealed the identification of top 20 genotypes based on the different characters as given in the table 4. These genotypes may be further utilized for selecting superior genotype having major plus characters and also further crop improvement programmes.

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