Original Research Article

Multivariate Analysis Through Principal Components for Yield Attributing Traits in Indigenous Moringa (Moringa oleifera L.) Germplasm Lines

Abstract:

The present investigation entitled was carried out at the Department of Vegetable Crops, Horticultural College and Research Institute (HC&RI), Tamil Nadu Agricultural University, Periyakulam during from 2016 -2017. With twenty genotypes in order to study the genetic diversity for different yield attributing characters of moringa by principal component analysis. In this study, out of twelve principal components, only five components exhibited eigenvalue and showed about 99.54% variability among the traits within the axes exhibited great influence on the phenotype of genotypes. The PC1 accounted for the highest variability (62.20%), followed by 28.86% (PC5), 6.25% (PC10), 1.01% (PC7) and 0.75% (PC4). Thus the results of the Principal Component Analysis revealed a wide range of genetic variability among the existing moringa genotype accessions.

Key words: Moringa (Moringa oleifera L.), Genotypes or Accessions, PCA, Variability, Traits analysis, EigenValues.
Introduction:

Moringa (*Moringa oleifera* L.), belonging to the family Moringaceae, is a highly useful vegetable crop and native of India. In India, it is grown all over the subcontinent for its tender pods and also for its leaves and flowers. The plants have always been vital for mankind irrespective of the era and area, all over the globe since the beginning of life. Popularly known as the “Drumstick” tree, horseradish tree, or Ben tree, *M. oleifera* is a deciduous-to-evergreen shrub or small tree with a height of 5 to 10 m (Morton, 1991). Unfortunately, limited work has been carried out on the understanding of its detailed germplasm characterization. Detailed studies on the distribution and genetic variability of moringa species are limited. However, substantial variations in quantitatively inherited traits have been documented in the natural population from India. In order to carry out breeding for to increase the yield, genetic variability must be initially considered as the prerequisite since it is the source of variation and raw material for yield improvement. Work. Assessment of genetic variability is also needed for efficient parent selection in a breeding program (Rahman et al., 2011), long term selection gain and exploitation of heterosis (Rahman et al., 2012). Moreover, the evaluation of genetic diversity is important to know the source of genes for a particular trait within the available germplasm (Tomooka, 1991). Principal Component Analysis (PCA) involves a mathematical procedure that transforms several possibly correlated variables into a (smaller) number of uncorrelated variables called Principal Components (Chatfield and Collis, 1980). PCA is an important statistical method through which we can easily identify important polygenic characters which are of great importance in a plant breeding programme. PCA provides an idea on how to reduce a complex data set to a lower dimension to reveal the sometimes hidden, simplified structures that often underlie it. The eigenvalue of a particular Principal Component depicts the amount of variation present in traits and is explained by that Principal Component which is very useful for the further breeding programme.

Materials and Methods:

This present investigation was carried out to know the variability through principal component analysis in *Moringa* (*Moringa oleifera* L.) germplasms cultivated in Telangana State.
Twenty moringa accessions were collected from different regions of Telangana and the details of the plant accessions investigated are listed in Table 1.

| S/No. | Accessions | Traits                  | Location                | Latitude & Longitude          |
|-------|------------|-------------------------|-------------------------|-------------------------------|
| 1.    | MO 1       | Long poded perennial type | Warangal, Warangal      | 18° 0' 38.60N, 79° 36' 0.10 E |
| 2.    | MO 2       | Long poded perennial type | Malyal, Warangal        | 18° 21' 48.80 N, 80° 18' 23.66 E |
| 3.    | MO 3       | Medium poded perennial type | Ghanpur, Warangal       | 17° 49' 58.89 N, 78° 59' 57.35 E |
| 4.    | MO 4       | Short poded perennial type | Regonda, Warangal       | 18° 23' 77.70 N, 79° 77' 50.80 E |
| 5.    | MO 5       | Long poded perennial type | Jagithyala, Karimnagar  | 18° 46' 0.66 N, 78° 54' 42.83 E |
| 6.    | MO 6       | Short poded perennial type | Peddapally, Karimnagar  | 18° 37' 24.72 N, 79° 22' 47.59 E |
| 7.    | MO 7       | Short poded perennial type | Armor, Nizamabad        | 18° 48' 37.14 N, 78° 17' 7.00 E |
| 8.    | MO 8       | Short poded perennial type | Nandipeta, Nizamabad    | 18° 52' 34.06 N, 78° 31' 14.68 E |
| 9.    | MO 9       | Medium poded perennial type | Rudrur, Nizamabad       | 18° 34' 45.48 N, 77° 52' 31.27 E |
| 10.   | MO 10      | Short poded perennial type | Sathyarayanapuram,Nizamabad | 18° 32' 40.61 N, 77° 53' 31.39 E |
| 11.   | MO 11      | Medium poded perennial type | Basara, Nirmal          | 18° 52' 40.63 N, 77° 56' 57.01 E |
| 12.   | MO 12      | Short poded perennial type | Mudhol, Nirmal          | 18° 98' 26.81 N, 77° 92' 05.10 E |
| 13.   | MO 13      | Short poded perennial type | Ichoda, Adilabad        | 19° 26' 1.02 N, 78° 27' 14.82 E |
| 14.   | MO 14      | Short poded perennial type | Adilabad, Adilabad      | 19° 38' 53.14 N, 78° 31' 14.68 E |
| 15.   | MO 15      | Medium poded perennial type | Amaravathi, Manchiriyal | 18° 54' 15.05 N, 79° 28' 58.30 E |
| 16.   | MO 16      | Short poded perennial type | Doragaripalli, Manchiriyal | 18° 53' 59.5 N, 79° 27' 41.2 E |
| 17.   | MO 17      | Medium poded perennial type | Kyathanpalli, Manchiriyal | 18° 55' 18.8 N, 79° 28' 13.4 E |
| 18.   | MO 18      | Short poded perennial type | Suryapeta, Nalgonda     | 17° 14' 8.70 N, 79° 36' 34.07 E |
The moringa genotypes were evaluated by using IPGRI minimal descriptors. The recommended agronomic practices were followed. Observations were recorded for 12 morphological characters. Principal Component Analysis (PCA) is an important multivariate method in modern data analysis because it is a simple, non-parametric method for extracting relevant information from confusing data sets and it was applied for the assessment of genetic diversity within moringa genotypes. Data were recorded on ten different traits viz., plant height (cm), stem girth (cm), leaf length (cm), number of leaves per rachis, length of leaf rachis, number of flowers per inflorescence, length of the pod (cm), pod girth (cm), pod weight (g), number of pods per plant, number of seeds per pod, yield per plant (kg). The data on yield traits were statistically analyzed based on the basis of a randomized complete block design. The PCA analysis reduces the dimensions of a multivariate data to a few principal axes, generates an eigenvector for each axis and produces component scores for the characters (Massay, 1965; Jolliffe, 1986).

**Results and Discussion:**

Twenty accessions of moringa collected from various parts of Telangana were evaluated for different morphological and biochemical traits. Observations on morphological characters viz., plant height (cm), stem girth (cm), leaf length (cm), number of leaves per rachis, length of leaf rachis, number of flowers per inflorescence, length of the pod (cm), pod girth (cm), pod weight (g), number of pods per plant, number of seeds per pod, yield per plant (kg) and yield per plot were recorded.

The accessions exhibited wide variability for morphological characters such as tree shape, tree nature, the colour of bark, young shoot colour, foliage density, nature of branchlets, branchlets, leaflet shape, leaflet apex, the colour of calyx and pod maturity. Four morphological descriptors viz., duration of plant, type of planting material, the shape of corolla and shape of calyx did not reveal any variation among the 20 genotypes. The traits that were showing variations revealed that most of the accessions possessed phenotypic variation among them.

|   |   | Medium poded perennial type | Gollapally, Nalgonda | 17° 31’ 23.59 N, 80° 52’ 19.91 E |
|---|---|-----------------------------|---------------------|----------------------------------|
| 19. | MO 19 | Short poded perennial type | Narayananapuram, Nalgonda | 17° 10’ 36.74 N, 80° 52’ 19.91 E |
PCA is a well-known method of dimension reduction that can be used to reduce a large set of variables to a small set that still contains most of the information in the large set (Massay, 1965; Jolliffe, 1986). Principal Component Analysis has shown the genetic diversity among the investigated accessions of the germplasm lines. In Table 2, it indicated that out of 12 principal components, only five components exhibited high eigenvalues and showed about 99.54% variability among the traits studied. The PC1 accounted for the highest variability (62.20%), followed by PC5 (28.86%), (PC10) (6.25%), PC7 (1.01%) and PC4 (0.75%). The results of the PCA explained the genetic diversity among the moringa genotypes. There are no standard tests to prove the significance of proper values and coefficients. The results of the PCA revealed the genetic diversity among the moringa genotypes. There are no standard tests to prove the significance of proper values and coefficients. Principal Component Analysis has shown the genetic diversity among the investigated accessions of the germplasm lines. The PC1 accounted for the highest variability (62.20%), followed by PC5 (28.86%), (PC10) (6.25%), PC7 (1.01%) and PC4 (0.75%). The PC1 had the highest variability (62.20%), followed by 28.86% (PC5), 6.25% (PC10), 1.01% (PC7) and 0.75% (PC4).

Table 2: Traits, Eigen values, PC, % percentage variance and cumulative Eigen values of moringa germplasm accessions

| Traits                        | PC  | Eigen values | Percentage of variation | Cumulative percentage |
|-------------------------------|-----|--------------|-------------------------|-----------------------|
| Plant height (cm)             | PC1 | 2649.61      | 62.20                   | 62.20                 |
| Stem girth (cm)               | PC2 | 2.25         | 0.053                   | 62.25                 |
| Leaf length (mm)              | PC3 | 14.12        | 0.33                    | 62.58                 |
| Number of leaves per rachis   | PC4 | 32.08        | 0.75                    | 63.34                 |
| Length of leaf rachis         | PC5 | 1229.48      | 28.86                   | 92.20                 |
| Number of flower/inflorescence| PC6 | -2.08        | -0.049                  | 92.15                 |
| Length of pod (cm)            | PC7 | 43.36        | 1.01                    | 93.17                 |
| Pod girth (cm)                | PC8 | 3.11         | 0.07                    | 93.24                 |
| Pod weight (g)                | PC9 | 1.63         | 0.03                    | 93.28                 |
| Number of pods per plant      | PC10| 266.54       | 6.25                    | 99.54                 |
| Number of seeds per pod       | PC11| 15.42        | 0.36                    | 99.90                 |
| Yield per plant (kg)          | PC12| 4.10         | 0.09                    | 100.00                |

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Figure 1: Radar diagram showing mean performance of 20 moringa accessions with germplasm lines for different yield traits

PC scores of genotypes

The PC scores of each component (PC1, PC2, PC3, PC4, PC5, PC6, PC7, PC8, PC9, PC10, PC11, and PC12) had positive and negative values (Table 3). In this PC score PC1, PC5, PC10, PC7 and PC4 or given high PC score values. These scores can be utilized to propose precise selection indices based on genetic variability, which is whose intensity can be decided by variability explained by each principal component. A high PC score for a particular genotype in a particular component denotes high values for the variables in that particular genotype.

**Table 3: PCA scores of moringa genotypes**

| Genotype | PC1  | PC2  | PC3  | PC4  | PC5  | PC6  | PC7  | PC8  | PC9  | PC10 | PC11 | PC12 |
|----------|------|------|------|------|------|------|------|------|------|------|------|------|
| MO 1     | 6.926| 20.841| 11.157| 16.129| 10.557| 61.487| 14.830| 200.187| 18.472| 6.201| 3.466| 41.701|
| MO 2     | 8.826| 24.421| -4.302| 17.494| 12.464| 50.445| 15.679| 231.834| 20.405| 5.828| 4.10 | -17.818|
| MO 3     | 9.801| 22.129| 19.591| 17.334| 11.383| 52.714| 13.755| 243.949| 27.398| 14.740| 3.50 | 119.532|
| MO 4     | 9.0280| 19.058| 51.668| 14.773| 10.750| 52.310| 14.964| 249.686| 28.665| -0.255| 7.066| 116.888|
| MO 5     | 9.438| 24.090| 2.652| 16.157| 11.771| 56.790| 14.522| 211.174| 29.096| 8.777| 8.866| 155.363|
Conclusion:

The phenotypic value of each trait measures the importance and contribution of each component to the total variance. The component contributed the maximum for phenological traits, plant height, number of pods per plant, yield per plant are the chief contributors towards genetic divergence in moringa genotypes. Therefore, Thus, the prominent characters coming together in different principal components and the contribution in explaining the variability has revealed and have the need to adopt these characters or traits while carrying out a breeding programme. tendency to remain together this may be kept into consideration during the utilization of these characters in the breeding program.

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Plate 1. Morphological variation in leaves of moringa genotypes

Plate 2. Morphological variation in leaves of moringa genotypes

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