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

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

The present investigation was carried out at the Department of Vegetable Crops, Horticultural College and Research Institute (HC&RI), Tamil Nadu Agricultural University, Periyakulam during 2016 -2017. Twenty genotypes used to study the genetic diversity for different yield attributing characters of moringa by principal component analysis. In this study, out of twelve principal components, five components exhibited eigen value and revealed about 99.54% variability among the traits. The PC1 accounted for the highest variability (62.20%), followed by PC5 (28.86%) , PC (10 6.25%), PC7 (1.01%) and PC4 (0.75%). The results of the Principal Component Analysis revealed that wide genetic variability exists in these moringa genotypes.

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Keywords: Moringa (Moringa oleifera L.); Genotypes; PCA; variability; traits; eigen values.

1. INTRODUCTION

Moringa (*Moringa oleifera* L.), which belongs to the family Moringaceae, is a highly useful vegetable crop and native to India. In India, it is grown all over the region for its tender pods, leaves and flowers. Plants have always been vital to mankind irrespective of era and area, all over the world since the beginning of life. Popularly known as ''Drumstick'' tree, horseradish tree, or Ben oil tree. *M. oleifera* is a deciduous-to-evergreen shrub or small tree with a height of 5 to 10 m [1]. To carry out breeding to increase the pod yield, information on genetic variability is the prerequisite since it is the source of variation and raw material for yield improvement. Assessment of genetic variability is also needed for efficient parent selection in a breeding program [2] long-term selection gain and exploitation of heterosis [3]. Moreover, the evaluation of genetic diversity is important to know the source of genes for a particular trait within the available germplasm [4]. Principal component analysis (PCA) involves a mathematical procedure that transforms several possibly correlated variables into a (smaller) number of uncorrelated variables called Principal Component [5]. 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 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. The present investigation was carried out to understand the variability through principal components in Moringa (*Moringa oleifera* L.) germplasms cultivated in Telangana State.

2. MATERIALS AND METHODS

The present investigation was carried out to understand the variability through principal components in Moringa (*Moringa oleifera* L.) germplasms cultivated in Telangana State at Department of Vegetable Crops, Horticultural College and Research Institute (HC&RI), Tamil Nadu Agricultural University, Periyakulam (PKM) during 2016 -2017. Twenty moringa genotypes (MO 1, MO 2, MO 3, MO 4, MO 5, MO 6, MO 7, MO 8, MO 9, MO 10, MO 11, MO 12, MO 13, MO 14, MO 15, MO 16, MO 17, MO 18, MO 19 & MO 20) were collected from different regions of Telangana and the details of the plant materials used in the present study are listed in Table 1.

Twenty 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, a 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 twelve different traits *viz*. plant height stem girth (cm), leaf length (cm), number of leaves per rachis, length of leaf rachis, number of flowers per inflorescence, length of 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 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 [6,7].

3. RESULTS AND DISCUSSION

Twenty genotypes of moringa collected from various parts of Telangana were evaluated for different morphological 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 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.

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

Table 1. List of Moringa genotypes used in this study

S.No.	Name of the genotype	Name of the Type	Place of collection & District	Latitude & Longitude
1.	MO 1	Long poded perennial type	Warangal, Warangal	18^{0} 0' 38.60N, 79^{0} 36'0 .10 E
2.	MO 2	Long poded perennial type	Malyal, Warangal	18^{0} 21' 48.80 N, 80^{0} 18' 23.66 E
3.	MO 3	Medium poded perennial type	Ghanpur, Warangal	17^{0} 49' 58.89 N, 78^{0} 59' 57.35 E
4.	MO 4	Short poded perennial type	Regonda, Warangal	18^{0} 23' 77.70 N, 79^{0} 77' 50.80 E
5.	MO 5	Long podedperennial type	Jagithyala, Karimnagar	18^{0} 46'0.66 N, 78^{0} 54'42 .83 E
6.	MO 6	Short poded perennial type	Peddapally, Karimnagar	18^{0} 37' 24.72 N, 79^{0} 22' 47.59 E
7.	MO 7	Short poded perennial type	Armor, Nizamabad	18^{0} 48' 37.14 N, 78^{0} 17' 7.00 E
8.	MO 8	Short poded perennial type	Nandipeta, Nizamabad	18^{0} 52' 34.06 N, 78^{0} 31' 14.68 E
9.	MO 9	Medium Poded perennial type	Rudrur, Nizamabad	18^{0} 34' 45.48 N, 77^{0} 52' 31.27 E
10.	MO 10	Short poded perennial type	Satyanarayanapuram,Nizamabad	18^{0} 32' 40.61 N, 77^{0} 53' 31.39 E
11.	MO 11	Medium poded perennial type	Basara, Nirmal	18^{0} 52' 40.63 N, 77^{0} 56' 57.01 E
12.	MO 12	Short poded perennial type	Mudhol, Nirmal	18^{0} 98' 26.81 N, 77^{0} 92' 05.10 E
13.	MO 13	Short poded perennial type	Ichoda, Adilabad	19^{0} 26' 1.02 N, 78^{0} 27' 14.82 E
14.	MO 14	Short poded perennial type	Adilabad, Adilabad	19^{0} 38' 53.14 N, 78^{0} 31' 14.68 E
15.	MO 15	Medium poded perennial type	Amaravathi,Manchiriyal	18^{0} 54' 15.05 N, 79^{0} 28' 58.30 E
16.	MO 16	Short poded perennial type	Doragaripalli, Manchiriyal	18^{0} 53' 59.5 N, 79^{0} 27' 41.2 E
17.	MO 17	Medium poded perennial type	Kyathanpalli, Manchiriyal	18^{0} 55'18.8 N, 79^{0} 28' 13.4 E
18.	MO 18	Short poded perennial type	Suryapeta, Nalgonda	17^{0} 14' 8.70 N, 79^{0} 36' 34.07 E
19.	MO 19	Medium poded perennial type	Gollapally, Nalgonda	17^{0} 31' 23.59 N, 80^{0}52' 19.91 E
20.	MO 20	Short poded perennial type	Narayanapuram,Nalgonda	17^{0} 10' 36.74 N, 80^{0} 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 [6,7]. The result of the PCA revealed 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 genotypes (Table 2) indicated that out of 12 principal components, 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%), PC (10 6.25%), PC7 (1.01%) and PC4 (0.75%).

3.1 PC scores of Genotypes

The PC scores of each component (PC1, PC2, PC3, PC4, PC5, PC6, PC7, PC8, PC9, PC 10, 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. These score can be utilized to propose precise selection indices 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.

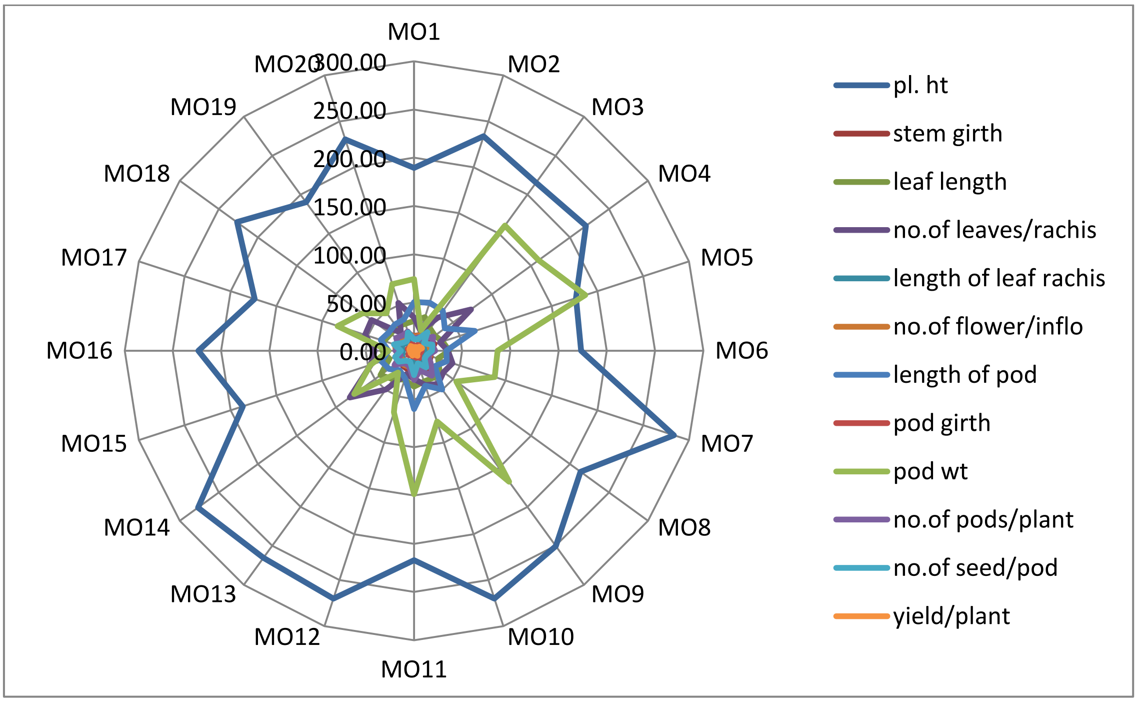

Fig. 1. Radar diagram showing mean performance of 20 moringa germplasm lines for different yield traits

Table 2. Traits, Eigen values, PC, variance and cumulative Eigen values of moringa germplasm

Traits	PC	Eigenvalue	Percentage of variation	Cumulative %
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
No.of leaves per rachis	PC4	32.08	0.75	63.34
Length of leaf rachis	PC5	1229.48	28.86	92.20
No of flower/infloresence	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(gr)	PC9	1.63	0.03	93.28
No of pods per plant	PC10	266.54	6.25	99.54
No of seeds per pod	PC11	15.42	0.36	99.90
Yield per plant(kg)	PC12	4.10	0.09	100.00

Table 3. PC scores of moringa genotypes

Genotype	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12
MO 1	5.926	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	70.445	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
MO 6	6.659	30.529	18.274	15.736	11.862	45.098	12.324	187.533	29.975	6.144	3.20	54.240
MO 7	8.143	18.603	19.994	17.591	13.014	52.620	14.964	295.488	22.169	6.807	4.133	33.407
MO 8	10.77	25.938	21.089	16.651	10.852	45.965	13.885	220.035	26.577	2.626	3.766	13.585
MO 9	9.632	27.914	18.995	18.321	12.683	53.608	15.095	279.457	39.805	3.322	6.50	119.361
MO 10	8.672	25.480	15.366	18.440	16.001	55.598	15.494	279.878	26.749	3.207	4.70	25.655
MO 11	10.231	28.840	3.475	15.021	13.360	60.951	13.869	242.304	40.651	6.729	4.00	108.928
MO 12	11.179	25.470	6.403	16.205	13.250	45.772	13.110	277.670	22.096	4.220	5.10	14.253
MO 13	10.644	27.503	30.404	18.695	13.424	55.442	14.855	265.256	21.835	5.374	4.20	-22.496
MO 14	6.480	31.126	59.697	20.097	9.358	67.293	15.221	287.228	32.739	5.766	4.30	23.743
MO 15	11.851	18.335	27.406	15.339	11.940	54.348	16.691	192.465	25.169	12.323	2.20	14.728
MO 16	7.074	23.847	22.790	16.196	14.461	51.379	11.644	223.917	24.986	4.091	4.466	-15.621
MO 17	8.910	24.832	34.332	17.474	14.919	52.565	14.570	187.257	28.143	12.501	4.966	51.645
MO 18	12.008	21.309	34.444	17.440	14.400	54.497	15.835	235.756	28.390	2.742	5.233	23.593
MO 19	10.281	23.868	5.321	14.849	11.004	46.524	13.201	195.610	24.460	2.084	6.066	13.202
MO 20	7.809	20.815	31.522	16.653	13.863	54.345	15.510	240.507	30.160	8.476	4.10	29.349

Plate 1. Morphological variation in leaves of moringa genotypes

Plate 2. Morphological variation in leaves of moringa genotypes

Plate 3. Morphological variation in pods of moringa genotypes

Plate 4. Morphological variation in pods of moringa genotypes

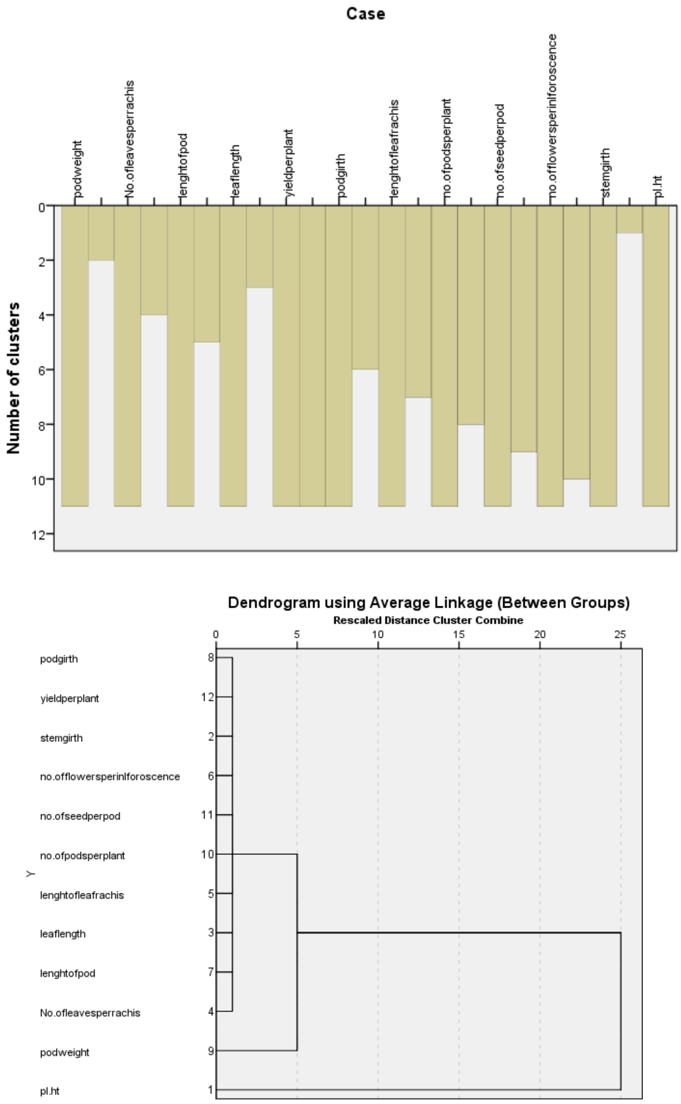

Fig. 2. Dendrogram for twenty germplasm genotypes of moringa for different traits

4. 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 and yield per plant are the chief contributors towards genetic divergence in moringa genotypes. Therefore, the prominent characters coming together in different principal components and the contribution in explaining the variability has revealed the need to adeopt these characters or traits while carrying out a breeding programme.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Morton JF. The horseradish tree, Moringa pterigosperma (*Moringaceae*): A boon to arid lands? Economic Botany. 1991;45: 318–333.
2. Rahman MM, Rasul MG, Bashar MK, Syed MA, Islam MR. Parent selection for transplanted Aman rice breeding by morphological, physiological and molecular diversity analysis. Journal International of the Libyan Agriculture Research Center. 2011;2(1):29-35.
3. Rahman MM, Bashar MK, Rasul MG. Molecular characterization and genetic variation in rice. LAP Lambert Academic Publishing GmbH & Co. KG, Saarbrucken, Germany. 2012;1-45.
4. Tomooka N. Genetic diversity and landrace differentiation of mung bean the (*Vigna radiata L*.) Wilc Zek and evaluation of its wild relatives (The subgenus Ceratotropics) as breeding materials. Tech. Bull. Trop. Res. Centre, Japan. Ministry of Agriculture, Forestry and Fisheries. Japan. 1991;28:1.
5. Chatfield C, Collis A. Introduction to Multivariate Analysis. CRC Press, Boca Raton. 1980;246.
6. Massay WF. Principal component regression in exploratory statistical research. Journal of the American Statistics Association. 1965;60:234-246.
7. Jolliffie IT. Principal Component Analysis. Springer, New York; 1986.

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