IJPS INTERNATIONAL JOURNAL OF PLANT SCIENCES
Volume 7 | Issue 1 | January, 2012 | 85-89

RESEARCH ARTICLE

Genetic diversity in mango (*Mangifera indica* L.) genotypic and phenotypic characterization

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SUMMARY

The highest number of fruits per tree and yield of fruits (kg/tree) was recorded in Pottalma and the lowest number of fruits per tree and yield of fruits (kg/tree) were observed in Kalepad and Mulgoa, respectively. In respect of biochemical characters, the highest TSS was recorded in Himayuddin and the lowest TSS was recorded in Neelum. The highest acidity and ascorbic acid content were recorded in Kalepad and the lowest in Baneshan and Mulgoa, respectively. By the application of clustering technique, the twelve genotypes were grouped into four clusters. Among the four clusters, cluster I was the biggest one, consisting of six genotypes and cluster II contained four genotypes, while cluster three and four had one genotype each. Among sixteen traits studied, number of fruits per tree and yield in kg showed higher degree of phenotypic and genotypic coefficient of variation. In correlation studies, yield per tree, plant height, tree spread and tree girth had high correlation with yield.

Key Words **:** Genetic diversity, D^2 anlysis, Genotypic and phenotypic coefficient of variation, Mango

How to cite this article **:** Barhate, S.G., Balasubramanyan, S., Bhalerao, R. R. and Bhalerao, P. P. (2012). Genetic diversity in mango (*Mangifera indica* L.) genotypic and phenotypic characterization. *Internat. J. Plant Sci.*, **7** (1) : 85-89.

Article chronicle **: Received :** *24.08.2011;* **Sent for revision :** *10.09.2011;* **Accepted :** *22.11.2011*

Mango (*Mangifera indica* L.) is the most important fruit crop of India and it has been cultivated in India for over 4000 years. There are at least 1000 named cultivars in India. Mango is considered as the national fruit of India. In South India alone, over 350 varieties are being cultivated (Naik, 1963). Urbanization and industrialization paved way to large scale destruction of mango germplasm. Moreover, there was a shift in the preference of people towards new varieties and grafts. This has resulted in genetic erosion of traditional mango germplasm of state Tamilnadu. Many of our traditional varieties have become extinct. Therefore, there is an urgent need to catalogue and conserve at least the available traditional genetic resources, which are on the verge of extinction. Proper assessment of existing genetic diversity is important in view of emerging patent rules. The excessive preference among the growers for collection of large number of varieties in their mixed orchards is another potent cause for the present chaotic nomenclature and classification. Very little information is available with cultivars of Tamil Nadu based on correlation and characterization. So the present study was taken up to assist phenotypic and genotypic variances characterization of mango cultivar of Tamil Nadu.

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MATERIALS AND METHODS

The experiment was conducted on central block of Horticultural College and Research Institute, Periyakulam. Twelve genotypes such as Senduram, Alphonso, Himayuddin, Baneshan, Neelum, PKM 1, Panchavaranam, Swarnarekha, Mulgoa, Pottalma, Kalepad and Rumani were maintained in the germplasm collection of department of fruit crops in periyakulam with three replications and five plants per

replication in Randomized Block Design (RBD). The genetic variability and diversity analysis for yield characters (Number of fruits per tree and yield), Fruit quality characters (TSS, acidity and ascorbic acid), genetic divergence (D^2 analysis, clustering, intra and inter cluster average distance, cluster mean value of characters and contribution of characters towards divergence) were studied in present investigation.

RESULTS AND DISCUSSION

The results obtained from the present investigation are presented below:

Yield characters :

Fruit yield characters such as number of fruits per tree, fruit yield studied in this investigation and result are depicted in Table 1. The highest number of fruits per tree (1144) was recorded in Pottalma and the lowest number of fruits per tree (126) was observed in Mulgoa however, fruit yield in kg ranged between 30.76 to 314.6 kg per tree. The highest yield of fruits (314.6kg/tree) was recorded in Pottalma and the lowest yield of fruits (30.76 kg/tree) was recorded in Kalepad. Yield in mango is a multiplicatory factor of fruit size and number of fruits per tree. In the present investigation, apart from fruit size, number of fruits per tree and yield per tree were also found to vary significantly with cultivars. Such wide variation in the yield potential of different cultivars is expected as varieties were selected from seedling population long before by our ancestors and maintained as clones. The very poor number of fruits obtained in Mulgoa is due to its inherent shy bearing nature. Similarly poor yield observed with LOCAL type Kalepad showed that it may not be suitable for commercial scale exploitation. But in view its dwarf character, it is recommended for homestead cultivation or may be exploited for rootstock purpose.

Fruit quality characters :

Fruit quality in mango is generally judged by sweetness of the flesh. In the present study, the TSS which is a direct indicator of sweetness, ranged from 17.0 to 25.3°brix exhibiting considerable variation, the highest total soluble solid (24.6°brix) was recorded in Himayuddin and Pottalma and the lowest total soluble solids (17°brix) was recorded in Neelum (Table 1). On the other hand, acidity of fruit which is supposed to be minimum in climacteric fruits like mango. The highest acidity content was recorded in Kalepad (0.55 %) and the lowest acid (0.170 %) content was recorded in Baneshan (Table 1).

Mango fruit is an important source of vitamin C (Manay and Shadaksharaswamy, 1995). Ascorbic acid content varied drastically from 4.3 mg/100 g (Mulgoa) to 55.30 mg /100g (Kalepad) (Table 1). Small fruits were observed to possess higher content of ascorbic acid. The ascorbic acid content of LOCAL varieties of Kerala, as reported by Satyavati (1972), ranged from 19.84 to 54.72 mg per 100 g of fruit. Ascorbic acid content of varieties and hybrids grown under Kerala conditions, investigated by Anila (2002) ranged from 1.50 to 53.00 mg per 100 g. Such knowledge is helpful to screen varieties for blending purposes especially with product needing the supplementation of vitamin C and this finding is in agreement with those other workers (Siddapa and Bhatia, 1954). Although fruit quality is a genetical parameter, the environmental factors such as stage of maturity, sampling

Table 1 : Mean performance of mango genotypes for number of fruits per tree, yield of fruits per tree (kg/tree), TSS (^{0}brix), acidity (%) and ascorbic acid (mg/100g)

Sr. No.	Name of genotype	Number of fruit per tree	Yield (kg/tree)	TSS	Acidity	Ascorbic acid
1.	Senduram	288	67.8	21.4	0.34	20
2.	Alphonso	393	83.23	20.4	0.204	14.34
3.	Himayuddin	401	146.3	24.6	0.19	4.5
4.	Baneshan	169	41.5	21.7	0.17	7.5
5.	Neelum	239	96.99	17.0	0.28	8.96
6.	PKM 1	352	79.8	22.4	0.26	21.2
7.	Panchavarnam	789	249.3	17.6	0.204	5.5
8.	Swarnarekha	988	305	18.3	0.204	4.3
9.	Mulgoa	126	110.7	22.4	0.272	12.0
10.	Pottlma	1144	314.6	24.66	0.30	25.6
11.	Kalepad	183	30.76	25.3	0.544	55.3
12.	Rumani	722	188.23	20.7	0.206	11.0
	Grand mean	519.4	159	21.3889	0.2658	22.5503
	SE(d)	63.17	77.21	0.2788	0.0103	1.1195
	CD(0.05%)	131	160	0.5781	0.0213	2.3216

Table 2 : Constitution of D^2 clusters of twelve genotypes of (*Mangifera indica* L.)

Cluster number	Number of genotype	Name of genotype
1	6	Senduram
		Alphonso
		Himayuddin
		Baneshan
		Neelum
		PKM 1
2	4	Panchavarnam
		Swarnarekha
		Mulgoa
		Pottlma
3	1	Kalepad
4	1	Rumani

Table 3 : Average of intra (in bold) and inter cluster D^2

clusters	1	2	3	4
1.	33.792	43.061	53.881	42.909
2.	43.061	34.392	72.159	44.536
3.	53.881	72.159	0	66.195
4.	42.909	44.536	66.195	0

Table 4 : Clusters mean values of the characters

characters	Plant height	Tree girth	Tree spread	No of branches	Length of inflorescence	Fruit length	Fruit diameter	Fruit wt. (g)	Fruit volume (ml)	TSS (^{o}brix)	Acidity (%)	Ascorbic acid (mg/ 100g)	Yield in kg. Per tree
cluster 1	6.078	0.681	7.094	25.389	25.622	10.528	8.039	294.667	293.078	21.278	0.238	24.15	297.944
cluster 2	11.458	1.825	11.958	39.583	25.875	10.233	8.992	368	366.483	20.708	0.248	14.501	879
cluster 3	3.6	0.7	5.9	47.667	25.367	8.333	5.767	151.333	149.9	25.467	0.565	55.4	196
cluster 4	4.667	2.067	6.867	24	23.367	6.3	7.333	252.333	250.533	20.7	0.206	12.3	733.333

Table 5: Estimates of variability and genetic parameters of mango genotypes

Sr. No.	Characters	PCV (%)	GCV (%)
1.	Tree height	44.9024	44.0532
2.	Tree girth	55.1645	53.9523
3.	Tree spread	40.3811	40.0928
4.	Number of branches	33.1264	32.2235
5.	Leaf length	9.7134	9.7028
6.	Length of inflorescence	13.876	13.5713
7.	Spread of inflorescence	16.328	15.8805
8.	Fruit length	18.9174	18.7542
9.	Fruit diameter	19.8523	19.6025
10.	Fruit weight	49.1406	44.3037
11.	Fruit volume	49.3957	44.524
12.	TSS	12.9391	12.8402
13.	Acidity	39.7303	39.4482
14.	Ascorbic acid	68.0524	67.7803
15.	Number of fuit per tree	79.5073	78.0996
16.	Yield (kg)	81.7785	56.0138

Table 6 : Genotypic correlation among yield and yield influencing traits of 12 genotypes of (*Mangifera indica* L.)

Genotypic correlation coefficient matrix

	TH	TG	TS	NOB	LL	LOI	SOI	FL	FD	FW	FV	TSS	ACD	ASCA	NOF	YIK
TH	1	0.584*	0.909**	0.483	0.344	-0.028	-0.368	0.236	0.255	0.174	0.174	-0.315	-0.332	-0.489	0.7	0.722**
TG		1	0.516	0.433	0.353	-0.004	-0.481	-0.131	0.383	0.386	0.386	-0.37	-0.26	-0.546	0.567	0.582*
TS			1	0.386	0.439	-0.319	-0.585*	0.148	0.191	0.13	0.13	-0.214	-0.158	-0.312	0.598*	0.619*
NOB				1	0.215	0.38	-0.349	0.134	-0.091	-0.049	-0.049	-0.039	0.331	-0.084	0.372	0.281
LL					1	0.206	-0.228	0.437	0.437	0.587*	0.587*	-0.071	-0.21	-0.253	0.081	0.307
LOI						1	0.433	0.26	-0.011	0.054	0.055	-0.055	-0.152	-0.202	0.168	0.226
SOI							1	-0.112	-0.305	-0.323	-0.323	-0.099	-0.273	0.097	-0.14	-0.327
FL								1	0.668*	0.707*	0.707*	-0.084	-0.255	-0.358	-0.394	-0.269
FD									1	1.011	1.011	-0.156	-0.347	-0.493	-0.251	-0.085
FW										1	1	-0.056	-0.261	-0.42	-0.335	-0.127
FV											1	-0.055	-0.26	-0.421	-0.335	-0.127
TSS												1	0.447	0.298	-0.162	-0.197
ACD													1	0.806**	-0.233	-0.418
ASCA														1	-0.336	-0.336
NOF															1	0.975**
YIK																1

*and ** indicate significance of values at p=0.05 and 0.01, respectively G – Genotypic correlation

TH= Tree height, TG= Tree girth, TS= Tree spread, NOB= Number of branches, LL= Leaf length, LOI= Length of inflorescence, SOI= Spread of inflorescence, FL= Fruit length, FD= Fruit diameter, FW= Fruit weight, FV= Fruit volume, TSS= TSS, ACD= Acidity, ASCD= Ascorbic acid, NOF= Number of fruit, YIK= Yield in kg/tree.

Table 7: Phenotypic correlation among yield and yield influencing traits of 12 genotypes of (*Mangifera indica* L.)

	TH	TG	TS	NOB	LL	LOI	SOI	FL	FD	FW	FV	TSS	ACD	ASCA	NOF	YIK
TH	1	0.566	0.886	0.463	0.336	-0.031	-0.359	0.228	0.252	0.139	0.14	-0.304	-0.321	-0.478	0.689	0.476
TG		1	0.498	0.392	0.345	-0.001	-0.441	-0.131	0.381	0.296	0.296	-0.356	-0.249	-0.533	0.538	0.407
TS			1	0.372	0.435	-0.309	-0.564	0.144	0.184	0.11	0.111	-0.207	-0.152	-0.31	0.589	0.449
NOB				1	0.208	0.362	-0.347	0.131	-0.097	-0.03	-0.03	-0.046	0.318	-0.079	0.368	0.141
LL					1	0.199	-0.221	0.431	0.433	0.531	0.531	-0.072	-0.207	-0.25	0.078	0.202
LOI						1	0.412	0.244	-0.009	0.074	0.075	-0.06	-0.149	-0.198	0.155	0.134
SOI							1	-0.109	-0.297	-0.289	-0.289	-0.097	-0.258	0.099	-0.14	-0.149
FL								1	0.645	0.625	0.625	-0.082	-0.254	-0.356	-0.378	-0.185
FD									1	0.894	0.894	-0.147	-0.339	-0.487	-0.248	-0.107
FW										1	1	-0.051	-0.234	-0.368	-0.3	-0.098
FV											1	-0.051	-0.233	-0.368	-0.3	-0.098
TSS												1	0.443	0.293	-0.155	-0.133
ACD													1	0.796	-0.229	-0.281
ASCA														1	-0.329	-0.231
NOF															1	0.65
YIK																

* and * indicate significance of values at p= 0.05 and 0.01, respectively G – Genotypic correlation

TH= Tree height, TG= Tree girth, TS= Tree spread, NOB= Number of branches, LL= Leaf length, LOI= Length of inflorescence, SOI= Spread of inflorescence, FL= Fruit length, FD= Fruit diameter, FW= Fruit weight, FV= Fruit volume, TSS= TSS, ACD= Acidity, ASCD= Ascorbic acid, NOF= Number of fruit, YIK= Yield in kg/tree.

stage and postharvest stage of fruit life are also known to influence fruit quality substantially. Thus, the morphological and fruit quality traits helped to bring out the genetic diversity in the selected cultivars.

Less research has been dedicated in fruit crops especially woody trees as compared to other vegetable crops in respect of variability analysis through D^2 statistic. The variability of the genetic stock could be increased by increasing the collection from diversified origin and geographical distribution. Mode of origin and subsequent adaptation to varied environments are the primary causes for the heritable variation found among genotypes (Anshebo, 2002). The phenotypic and genotypic variances, estimated from total variances were used to assess the variability among the genotypes. The genotypic coefficient of variation along with phenotypic coefficient of variation was used to ascertain the value of diversity among the genotypes.

In the present study, the characters such as fruit yield / tree, ascorbic acid, acidity, TSS, tree height, length of inflorescence, leaf length, fruit length and fruit diameter have close value for GCV and PCV indicating lesser influence of environmental variances for these characters. This indicates that scope for selection based on this component would be much valuable in *M. Indica* (Table 5)

Association or correlation reveals that what extent yield is dependent upon the yield component and this is helpful in embarking selection. The correlation analysis made in this study (Table 6, 7) revealed positive and significant association of yield per tree with number of fruit per tree, plant height, tree spread, tree girth which supported to previous finding of Iyer *et al*. (1988) that plant height had a positive correlation with yield and former was correlated spread of the tree. This indicates the possibility of having only less yield with less tree height and spread and therefore, genotype which had less of this attributes are to be planted closely to compensate for the total yield per unit area. The interrelationship of component characters of yield provides the information about the likely consequences of selection for simultaneous improvement of desirable characters under selection. Regarding interrelation of the yield component, plant girth and tree spread showed positive and significant correlation with yield through tree plant height.

Mahalanobis (1936) generalized distance to measure the genetic divergence which has been used in the present study to measure the genetic divergence available in the *M .indica* genotypes. The analysis of variance revealed significant differences among the genotypes for all sixteen characters observed, indicating the existence of considerable genetic variability among genotypes. Based on this analysis, genotypes were grouped into four clusters, cluster I had maximum number of six genotypes which indicates the genotype from Tamil Nadu, Andhra Pradesh and western part of India. While the cluster II which composed of four types from Tamil Nadu alone. The distinct clustering of Kalepad and Rumani into different groups further supports the theory that they should be genetically and geographically distinct also.

Summary :

The highest number of fruits per tree and highest yield was recorded in Pottalma, while the lowest number of fruits per tree was registered in Mulgoa and lowest yield was registered in Kalepad. With respect to biochemical characters, the highest TSS was recorded in Himayuddin, while the lowest TSS in Neelum. Among the 12 mango cultivars, the highest acidity and highest ascorbic acid content was recorded in Kalepad and the lowest acidity in Baneshan and lowest ascorbic acid was registered in Mulgoa. Genetic diversity analysis resulted in grouping of genotypes in four clusters which revealed considerable diversity for number of fruits per plant and TSS contributed more towards diversity. Among sixteen traits studied, number of fruits per tree and yield in kg showed higher degree of phenotypic and genotypic coefficient of variation. In correlation studies, yield per tree, plant height, tree spread and tree girth had high correlation with yield.

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