



## Genetic correlation and cluster analysis in sapota (*Manilkara zapota*)

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### ABSTRACT

Sapota is classified into two main types based on fruit shape as 'round' and 'oval'. However, there are several intermediates, as, it is a heterozygous tree crop. In this study, an effort was made to group available variability in sapota based on fruit characters and to analyze it. This helps in selection of parents for use in further breeding programmes. Cluster analysis revealed four definite clusters. High variability was observed for fresh-fruit weight, fruit length, fruit girth, fruit weight at ripening, pulp weight, peel weight, number of seeds and TSS. Correlation studies among fruit parameters indicated positive relationship between all the parameters studied, except TSS which had negative relationship with the rest of the fruit parameters. Selection of distantly placed cultivars in breeding programs stands to result in better progeny for further evaluation.

**Key words:** Sapota, fruit parameters, variability, correlation, clusters

### INTRODUCTION

Sapota (*Manilkara zapota* (Roxb.) commonly known as "chikku", is one of the delicious tropical fruits. It was introduced into India in the 1800's from Mexico via Sri Lanka. This climacteric fruit is well-adapted to the tropical parts of country. It is a hardy tree that can be cultivated in saline soils too. Sapota is cultivated mainly in the southern states of India, with maximum area under it in Karnataka. Apart from its use as fresh fruit, various processed products like pulp powder, fig, juice, flakes, etc., are becoming popular. Therefore demand for the fruits has increased in recent years. Two main types of sapota are found, based on fruit shape, viz., 'round' and 'oval'. But, like in the other tree crops, due to occurrence of heterozygosity, there are several intermediates types. Studies on fruit variability was reported by Dinesh and Reddy (2000) Avaiyo and Singh (1991) Ponnuswamy and Irulappan (1987 and 1989). Saraswathy *et al* (2010) observed that number of fruits per tree and canopy-spread had positive correlation with fruit-yield per tree. Quality traits like total sugars and ascorbic acid content had negative correlation with fruit-yield. In the present study, an effort has been made to categorize the available variability into groups based on fruit characters, analyze the variability and study correlations among various fruit characteristics, which would be useful in further breeding programmes.

### MATERIAL AND METHODS

Germplasm collected from various sources in Karnataka, Andhra Pradesh, Tamil Nadu and Gujarat was maintained in a field gene bank, with four trees per accession, at Indian Institute of Horticultural Research, Bangalore. Twenty accessions were selected for the study, which included an important commercial cultivar, Cricket Ball. Five mature fruits from each accession were selected after pooling the fruits from all four trees and observations were recorded in five replications, i.e., fruits were harvested five times as and when fruits matured. Observations were recorded on 25 fruits per accession on morphological characters like fresh-fruit weight, fruit length, fruit breadth (at the broadest region), ripe-fruit weight, pulp weight (after scraping the pulp from peel), peel weight, number of seeds per fruit, TSS (°Brix), seed length and seed breadth. Some morphological parameters like leaf length and leaf breadth were also included in Cluster Analysis, as, variations in leaf-size were observed. For this purpose, five fully-mature leaves from each accession were selected. The means of all 12 characters were subjected to Squared Euclidian Cluster Analysis and a dendrogram was derived using Ward's method (1963). Variability studies were made using fruit characteristics in 17 accessions of sapota. Observations on fresh-fruit weight, fruit length, fruit breadth, ripe-fruit

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weight, pulp weight, peel weight, number of seeds per fruit and TSS (°Brix) were recorded and subjected to analysis of variation (ANOVA). Phenotypic correlation was calculated.

## RESULTS AND DISCUSSION

### Fruit variability

Studies on fruit parameters involving 17 accessions showed that fresh-fruit weight at harvest ranged from 54.48g to 143.95g, with maximum in the variety CO-1 and minimum in ‘Jhumakiya’. Maximum fruit length of 7.23cm was observed in ‘CO-1’, and minimum (4.46cm) in ‘Jhumakiya’. Fruit girth was maximum in var. Bombay with 5.65cm, and minimum (4.33cm) was recorded in the variety Pilipatti. At ripening, 25% reduction in fruit weight was observed in all the accessions studied. Peel weight varied between 13.25g and 35.00g in ‘Jhumakiya’ and ‘Hybrid’, respectively. Maximum number of seeds was found in the variety Guruvayya with an average of six seeds per fruit and, the minimum of one seed per fruit was observed in var. Gavaraiah, followed by ‘CO-1’. TSS (°Brix) was maximum in Pilipatti (20.39) and minimum in Guruvayya (15.02). Coefficient of variation was maximum in peel weight (28.38%), followed by number of seeds (24.72%) and the minimum (7.23%) was observed for fruit girth, followed by 9.54% in fruit length (Table 1). Analysis of variance showed high variability for fruit characteristics among all the varieties. All the characters except fruit length and TSS exhibited variability within a variety (Table 2).

**Table 1. Fruit parameters in 17 sapota varieties**

Variety	Fruit weight (g)	Fruit length (cm)	Fruit girth (cm)	Ripe fruit weight (g)	Pulp weight (g)	Peel weight (g)	No. of seeds	TSS (°Brix)
1. Cricket ball	112.70	5.16	5.13	103.67	69.99	31.20	3.35	18.75
2. Calcutta round	98.30	5.03	5.39	87.90	49.83	27.58	3.49	18.74
3. Pilipatti	64.46	5.33	4.33	58.69	37.58	17.14	2.80	20.39
4. Gavaraiah	134.62	6.60	5.62	119.34	89.21	30.78	1.52	17.99
5. Mohangooti	81.74	6.06	4.59	75.76	57.63	17.86	3.10	19.56
6. Krishna Rao	125.93	6.37	5.49	100.31	70.67	33.45	5.38	18.20
7. Jumakiya	54.48	4.46	4.38	49.42	30.70	13.25	3.66	16.49
8. Kirti barti	91.95	5.68	5.02	82.29	57.00	22.09	2.12	17.45
9. Hybrid	139.30	7.19	5.49	125.80	86.50	35.00	2.16	17.12
10. Bombay	108.99	5.17	5.65	97.56	67.97	28.18	4.19	17.69
11. Seedless	90.02	5.71	4.95	82.98	58.70	22.36	2.24	18.15
12. Dwarapudi	62.50	5.19	4.57	57.24	40.68	14.04	3.20	17.97
13. Vavilavalasa	94.82	4.94	5.47	82.72	60.33	23.15	3.35	18.31
14. CO1	143.95	7.23	5.59	131.77	92.71	41.01	1.78	16.77
15. CO2	93.76	5.19	5.57	82.49	55.42	22.33	3.70	19.01
16. Unknown	89.24	5.58	5.00	83.07	59.09	21.42	2.08	17.57
17. Guruvayya	113.05	6.04	5.39	101.69	70.36	28.89	6.23	15.02
Range	54.48 to 143.95	4.46 to 7.23	4.33 to 5.65	49.42 to 131.77	30.70 to 92.71	13.25 to 35.00	1.52 to 6.23	15.02 to 20.39
CV (%)	13.85	9.54	7.23	15.83	18.89	28.38	24.72	8.85

### Phenotypic correlation

Correlation studies among the eight fruit parameters under study revealed significant positive relationship for all parameters except number of seeds/fruit and TSS, where it was found to be negative. Correlation indicated that ripe-fruit weight, fruit length, fruit breadth, pulp weight, and peel weight contributed to fresh-fruit weight. TSS showed negative correlation with all the parameters, indicating that increase in fruit weight affected quality of the fruit through TSS, as reported by Saraswathy *et al* (2010). Number of seeds per fruit did not show significant correlation with any character, but had significant negative correlation with fruit length. This shows that seed number can influence fruit shape (Table 3).

### Cluster analysis

Cluster analysis clearly indicated affinity and relationship between different sapota accessions (Fig. 1). There were two main clusters, further divided into two sub-clusters i.e., a total of four sub-clusters). The first sub-cluster comprised seven varieties. The second sub-cluster included six accessions. The third sub-cluster had two accessions which were distinct. The fourth sub-cluster was composed of five accessions. All accessions within each cluster showed a close relationship. The first cluster (including sub-clusters 1 and 2) had 13 accessions comprising of small, oval fruit types. The first sub-cluster included the accessions Calcutta Round, CO-2, Vavilavalasa, Kirtibarti, Mohangooti,

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**Table 2. Analysis of variance (ANOVA) of fruit characteristics**

	df	Fruit weight	Fruit length	Fruit girth	Ripe weight	Pulp weight	Peel weight	No. of seeds	TSS
Replication	4	38.22**	0.59(NS)*	5.31**	26.43**	9.47**	22.57**	3.17**	0.92(NS)*
Treatments	16	18.22**	10.45**	7.75**	13.54**	10.96**	5.71**	12.44**	3.55**

\*NS= Non-significant

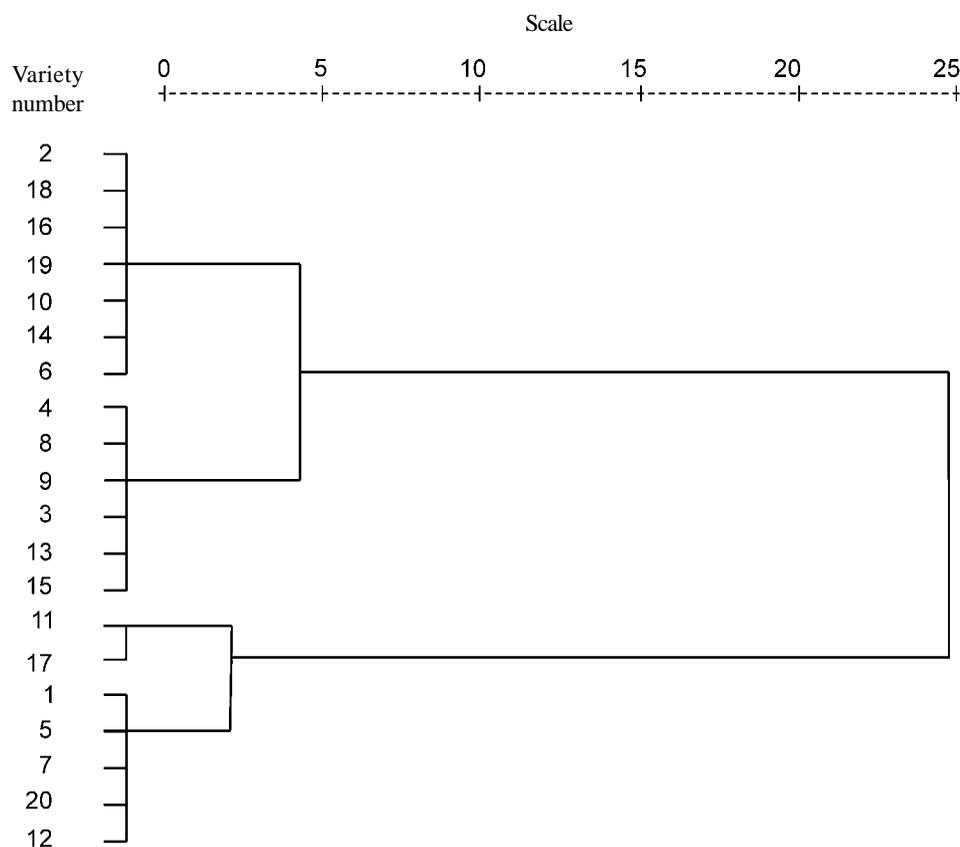
\*\* Significant at 1% level

**Table 3. Phenotypic correlation among various fruit parameters of sapota**

	1	2	3	4	5	6	7	8
1. Fruit weight	—	0.657**	0.753**	0.988**	0.899**	0.846**	0.026	- 0.191
2. Fruit length		—	0.503**	0.635**	0.737**	0.385**	<b>-0.248*</b>	- 0.039
3. Fruit girth			—	0.726**	0.741**	0.492**	0.117	- 0.114
4. Ripe fruit weight				—	0.901**	0.850**	0.023	<b>- 0.220*</b>
5. Pulp weight					—	0.611**	- 0.130	- 0.135
6. Peel weight						—	0.094	- 0.196
7. No. of seeds							—	- 0.263
8. TSS								—

\* Significant at 5% level

\*\* Significant at 1% level



1-Cricket Ball, 2-Calcutta Round, 3- Pilipatti, 4- Gutti, 5- Gavaraiah, 6- Mohangooti, 7- Krishna Rao, 8- Oval, 9-Jhumakiya, 10- Kirtibarti, 11- Hybrid, 12- Bombay, 13- Pakala oval, 14- Seedless, 15-Dwarapudi, 16-Vavilavalasa, 17- CO 1, 18-CO 2, 19-Unknown, 20-Guruvayya

**Fig 1. Dendrogram derived using Ward's method for twenty varieties of sapota**

Seedless, and an unknown collection from Gujarat. The second sub-cluster included varieties like Gutti, Oval, Jhumakiya, Pilipatti, Pakala oval, and Dwarapudi. Despite having round fruit-shape, the accessions Calcutta Round, CO-2 and Vavilavalasa were also grouped here in the first sub-cluster. Affinity of the varieties may be due to heterozygosity and seedling selection. The second group encompassing sub-clusters 3 and 4 had seven accessions, consisting mainly of large-fruit types. 'Hybrid' and 'CO-1', grouped in the third sub-cluster, were morphologically identical and were closely placed. Hence, the unknown hybrid collection and CO-1 seem to be identical. The fourth sub-cluster had five accessions, namely, Guruvayya, Krishna Rao, Cricket Ball, Bombay and Gavaraiah. The accessions Guruvayya, Krishna Rao and Gavaraiah showed morphological similarities too. But, inclusion of 'Cricket Ball' and 'Bombay' in this group is not justified should fruit shape be considered as a factor in clustering, as these bear round-shaped fruits. These observations reveal that affinities and grouping of varieties depend chiefly on fruit size.

The study thus shows a high variability for fruit parameters like fresh-fruit weight, fruit length, fruit girth, fruit weight at ripening, pulp weight, peel weight, number of seeds and TSS, among different cultivars. Correlation studies showed relation among various fruit characteristics. Though fruit weight was directly related to all the fruit parameters studied, it affected TSS negatively. This indicated that excessive increase in fruit weight reduced quality of the fruit and, hence, selection should be preferably made for optimum fruit weight. Cluster analysis also

revealed affinity among different cultivars. Selection of distantly placed cultivars in breeding programs bought to result in better progeny for further evaluation.

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