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Genetic variability in some Indian mango cultivars and hybrids

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ABSTRACT

Mango is a perennial and highly heterozygous plant. Therefore, it takes a long time to breed a variety in this crop. Information on genetic variability among cultivars and hybrids helps plan meaningful crop improvement programmes. Due to the high heterozygosity, complexity of its flowers and poor fruit-set, the progeny population that can be raised from a cross is very meagre. Hence, there is a need to choose parents that have good fruit-set and show genetic divergence. It would also be interesting to establish if the hybrids generated are truly open-pollinated progenies, or arise from controlled crossing. Basic information thus obtained would help chalk out a potentially successful breeding programme. A study in this direction was carried out by using morphological characters of twelve hybrids and their respective parents. Cluster analysis indicated a relationship between the parents and hybrids. Two major clusters were observed from the clustering pattern. In the first cluster, varieties Dashehari, Banganapalli, Manjeera, Sindhu, Janardhan Pasand, Ratna, Rumani, Amrapali, Neelgoa and Alphonso grouped together. The second cluster consisted of vars. Arka Aruna, Neelum, Arka Puneet, Neeleshan, Mulgoa, Mallika, Arka Anmol and Arka Neelkiran. The hybrid, Sindhu was observed to be genetically closer to Ratna than to Alphonso. The sub-clustering pattern also showed a close relationship between parents and their hybrids. The hybrid, Arka Anmol, was found to distantly placed from the centre (8.54), as also the hybrid, Arka Neelkiran (7.05). 'Sindhu' was also found to be closer to the centre (1.55).

Key words: Breeding, characterization, cluster analysis, heterozygosity, genetic variability

INTRODUCTION

Mango *(Mangifera indica* L.) is grown widely throughout the tropics and sub-tropics of India. It has continued to play a major role in fruit production and export. Most of the commercial varieties grown in India suffer from one or the other shortcoming, be it susceptibility to pests and diseases, or lack of attractive skin colour. Over the past four decades, various workers have bred several hybrids using commercial varieties as parents (Iyer, 1991). Some of these have performed well in specific areas. Diversity in mango has also been studied by attempting to correlate geographic diversity with genetic diversity. Karibasappa *et al* (1999) reported that canonical analysis and cluster analysis using sixty-nine genotypes of mango resulted in eleven clusters. They concluded that geographic diversity was not necessarily related to genetic diversity.

One of the drawbacks in mango breeding has been lack of information on inheritance of characters. Deriving information on inheritance is also rendered difficult due to the high heterozygosity and highly cross-pollinated nature of the crop, besides a difficulty in crossing. However, it is extremely useful to generate information on genetic distance between varieties so that, based on the lineage, as regards their parentage. A programme in this direction was carried out at Indian Institute of Horticultural Research, Bengaluru, by studying morphological characters of the hybrids and their parents.

MATERIAL AND METHODS

The material consisted of twelve hybrids, viz., Arka Anmol, Arka Puneet, Arka Neelkiran, Arka Aruna, Amrapali, Mallika, Ratna, Sindhu, Neeluddin, Neelgoa, Neeleshan, Manjeera; and seven parents, viz., Alphonso, Rumani, Mulgoa, Neelum, Dashehari, Banganapalli and Janardhan Pasand. These were evaluated for fruit, stone, inflorescence, leaf and petiole characteristics, viz., fruit length, fruit breadth, fruit thickness, fruit weight, TSS, acidity, pulp content, stone length, stone weight, fiber length, inflorescence length, leaf length, leaf width and petiole length (Table 1). Observation

Table 1. Fruit, floral and foliage characteristics of mango varieties / hybrids under study

Sl. No.	Variety / Hybrid	Fruit length (cm)	Fruit breadth (cm)	Fruit thickness (cm)	Fruit weight (g)	TSS (ºBrix)	Titrable acidity (%)	Pulp (%)	Stone length (cm)	Stone weight (g)	Fiber length (mm)	Inflore-scence length	Leaf length (cm)	Leaf width (cm)	Petiole length (cm)
1	Arka Anmol	11.03	7.75	7.10	350.00	18.60	0.32	78.28	9.40	34.17	15.0	25.3	16.86	3.9	3.7
2	Arka Aruna	13.80	10.93	9.60	765.67	21.00	0.19	83.06	8.77	35.00	10.0	22.7	14.06	3.1	3.6
3	Arka Neelkiran	9.73	8.15	7.60	338.75	18.30	0.19	75.05	7.17	34.17	9.0	19.2	17.00	3.3	5.5
4	Arka Puneet	9.70	8.00	7,10	283.70	21.10	0.32	72.12	8.17	44.23	9.0	11.0	16.22	3.7	5.0
5	Amrapali	10.00	6.10	6.00	186.00	23.20	0.38	72.10	9.03	31.87	17.0	24.5	15.26	3.2	2.1
6	Mallika	13.60	8.00	6.60	347.00	27.00	0.18	65.80	9.37	29.43	12.0	28.0	14.22	3.6	2.0
7	Manjeera	7.70	7.60	7.50	272.30	18.20	0.57	74.61	5.83	32.97	4.0	16.0	16.34	3.1	1.7
8	Neeleshan	12.90	9.30	7.13	394.00	18.50	0.51	59.32	10.63	34.53	8.0	21.5	13.50	3.4	1.3
9	Neelgoa	7.70	8.00	8.20	328.00	17.20	0.19	75.61	7.80	27.50	5.0	48.0	16.86	3.7	1.8
10	Neeluddin	7.70	6.40	7.00	188.00	22.50	0.96	68.78	6.10	24.00	8.0	30.5	19.16	4.2	2.6
11	Ratna	10.50	8.00	6.90	283.70	20.00	0.38	70.90	7.17	30.50	11.0	26.3	18.70	4.3	3.3
12	Sindhu	9.40	6.20	6.20	167.00	27.40	0.51	84.92	7.73	7.29	20.0	42.0	24.20	5.4	6.6
13	Banganapalli	10.80	8.90	7.70	440.00	18.50	0.12	61.70	7.80	33.93	6.0	25.2	12.16	2.8	1.2
14	Dashehari	10.50	6.40	5.60	170.50	19.00	0.11	62.30	7.63	24.70	5.0	28.3	14.30	3.3	1.6
15	Janardhan Pasand	8.90	6.60	6.60	256.20	14.60	0.44	67.50	7.15	26.00	8.0	30.8	15.10	3.9	1.9
16	Neelum	7.70	6.00	6.70	256.00	20.00	0.40	57.00	6.13	21.87	13.0	26.5	14.30	3.2	1.4
17	Rumani	6.90	8.00	8.60	200.00	19.20	0.25	75.40	5.00	20.80	14.0	20.3	14.66	2.8	1.4
18	Alphonso	8.80	7.40	7.30	246.20	19.00	0.32	66.90	6.03	22.43	7.0	29.0	17.18	3.8	3.0
19	Mulgoa	9.50	8.60	8.30	362.50	20.80	0.27	64.40	8.30	50.17	13.0	18.7	13.80	2.6	1.7

on fruit parameters were recorded on ripe fruits. Observations on foliage were made with the fourth mature leaf. Observations were recorded over a period of three years. The mean of all the fourteen characteristics was subjected to Squared Euclidean Cluster Analysis, and a dendrogram was drawn using Ward's method (1963). SAS V 9.3 (SAS, 2011) package available at IIHR, Bengaluru, was used for cluster analysis.

This method joins up clusters to maximize likelihood at each level of the hierarchy. Distance between two clusters was the ANOVA sum of squares between the two clusters, added up over all the variables. At each generation, the within-cluster sum of squares was minimized over all partitions obtainable, by merging two clusters from the previous generation.

RESULTS AND DISCUSSION

Cluster analysis indicated relationship between the varieties (parents) and hybrids (Fig. 1). Two major clusters were observed in the clustering pattern. In the first cluster, varieties Dashehari, Banganapalli, Manjeera, Sindhu, Janardhan Pasand, Arka Neelkiran, Ratna, Rumani, Amrapali, Neelgoa and Alphonso grouped together, based on the morphological characters evaluated. In the second cluster, vars. Arka Aruna, Neeleshan, Neelum, Arka Puneet, Mulgoa, Mallika, Arka Anmol figured. It can be seen that the hybrid Sindhu and both its parents, Alphonso and Ratna, grouped under the same cluster. However, 'Sindhu' was closer to Ratna (3.73) than to Alphonso (7.10). In the case of Manjeera, one of its parents, Rumani, grouped with it, the genetic distance being 5.30. In the case of vars. Arka Neelkiran and Amrapali, one each of their parents (Alphonso and Dashehari, respectively) observed to figure in the same cluster. The hybrid, Arka Neelkiran, was closer to Neelum (5.72). This shows that the hybrids placed closer to their

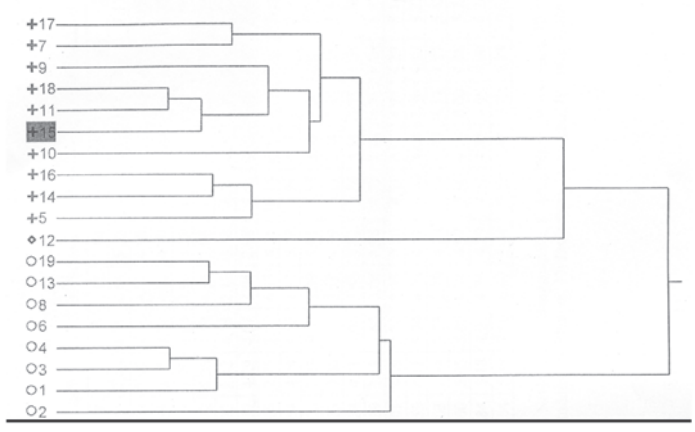

Fig. 1. Hierarchical Clustering by Fast Ward method

parents. In the second cluster, it can be seen that among the varieties, Amrapali (a hybrid itself) was close to both Dashehari and Neelum (5.1 and 4.1, respectively). Hybrids derived from 'Neelum' were found to be closer to 'Neelum' (Table 2 and 3). This shows that hybrids and parents, although generated from different locations, are related. The sub-clustering pattern also showed a close relation between parents and their hybrids, viz., grouping together of the hybrids, Alphonso and Ratna. 'Neelum', as one of the parents, is seen as the dominating parent. Hybrid 'Arka Anmol' was observed to be placed distantly from the centre, while the variety Sindhu was observed to be the closest. Hybrid 'Arka Aruna', which resembles its female parent Banganapalli morphologically, was closer to the latter (4.56). Ravishankar *et al* (2000) studied genetic diversity in eighteen commercial varieties of mango grown in India, using RAPD analysis. They observed two major groups: one group consisted Northern, Eastern and Western varieties; another of Southern cultivars. Their study also indicated that variety Kesar from Western region of India associated with Neelum and Rumani. In our study too, variety Ratna, which is from the Western region of India, grouped with Rumani, a South Indian commercial variety. The same result is seen in the case of Dashehari, which grouped with Banganapalli, along with Janardhan Pasand. However, in a heterozygous crop like mango, pedigree of the varieties is not clear, which is quite understandable. The present study indicates that the hybrids were closely related, even if one of the parents was common; the other parent could be from altogether a different region. The variety Arka Aruna, although a hybrid from the parentage Banganapalli x Alphonso, seemed to be genetically divergent from other varieties. The present study, thus, shows that morphological characterization can be used for working out distance between varieties and for validating parentage of the hybrids.

Table 2. Clustering history

Variety	Number of clusters	Distance	Leader	Joiner
Sindhu	18	1.550062867	18	11
Dashehari	17	1.579511642	4	3
Rumani	16	2.004343454	18	15
Neeluddin	15	2.113115127	19	13
Amrapali	14	2.165261418	16	14
Neelum	13	2.220924837	4	1
Alphonso	12	2.427018483	17	7
Janardhan Pasand	11	2.697839538	19	8
Ratna	10	2.712693496	16	5
Manjeera	9	2.944699556	9·	18
Arka Puneet	8	3.502879488	19	6
Banganapalli	7	3.514379316	9	10
Neeleshan	6	3.670255392	17	9
Neelgoa	5	4.222008230	17	16
Mulgoa	4	4.497405724	19	4
Mallika	3	4.641642925	19	2
Arka Neelkiran	2	7.054252685	17	12
Arka Anmol	1	8.542871487	17	19

Table 3. Cluster distance between mango varieties

V/H	17	7	9	10	16	18	15	12	19	4	3	5	11	14	13	1	8	6	2
17	0.00	3.43	4.78	5.53	4.21	3.51	4.39	8.67	4.85	5.33	4.46	4.94	4.55	5.10	4.88	5.26	6.53	6.82	7.17
7	3.43	0.00	4.68	4.09	4.18	3.01	3.37	8.83	4.56	4.09	3.92	4.76	3.70	4.50	4.58	4.79	5.42	5.91	7.09
9	4.78	4.68	0.00	5.52	5.30	3.38	3.62	8.00	5.64	5.83	4.75	5.51	4.07	4.70	4.73	4.66	5.92	5.78	6.78
10	5.53	4.09	5.52	0.00	4.45	3.73	4.16	6.45	6.75	5.67	5.79	4.96	3.90	5.59	6.92	5.58	6.61	6.59	8.98
16	4.21	4.18	5.30	4.45	0.00	3.15	3.05	8.24	5.29	5.42	5.26	3.59	4.16	3.06	4.83	5.29	5.66	5.86	8.65
18	3.51	3.01	3.38	3.73	3.15	0.00	2.29	7.10	5.06	4.22	3.42	4.18	2.19	3.18	4.32	4.06	5.28	5.05	7.11
15	4.39	3.37	3.62	4.16	3.05	2.29	0.00	7.95	5.29	4.79	4.29	4.07	3.04	2.98	4.46	4.03	4.88	5.65	7.69
12	8.67	8.83	8.00	6.45	8.24	7.10	7.95	0.00	10.02	8.06	7.75	7.12	6.33	8.55	10.18	6.90	9.80	8.67	10.42
19	4.85	4.56	5.64	6.75	5.29	5.06	5.29	10.02	0.00	3.64	4.04	4.65	4.83	5.38	2.99	4.21	3.92	5.21	5.50
4	5.33	4.09	5.83	5.67	5.42	4.22	4.79	8.06	3.64	0.00	2.23	4.28	3.39	5.01	4.55	3.03	4.60	4.84	6.04
3	4.46	3.92	4.75	5.79	5.26	3.42	4.29	7.75	4.04	2.23	0.00	4.71	3.18	4.79	4.11	2.84	5.05	5.18	5.39
5	4.94	4.76	5.51	4.96	3.59	4.18	4.07	7.12	4.65	4.28	4.71	0.00	3.63	3.72	5.24	3.53	5.05	4.95	7.66
11	4.55	3.70	4.07	3.90	4.16	2.19	3.04	6.33	4.83	3.39	3.18	3.63	0.00	3.95	4.73	2.79	4.71	4.76	6.47
14	5.10	4.50	4.70	5.59	3.06	3.18	2.98	8.55	5.38	5.01	4.79	3.72	3.95	0.00	4.11	4.83	4.97	4.29	8.14
13	4.88	4.58	4.73	6.92	4.83	4.32	4.46	10.18	2.99	4.55	4.11	5.24	4.73	4.11	0.00	4.54	3.30	4.12	5.21
1	5.26	4.79	4.66	5.58	5.29	4.06	4.03	6.90	4.21	3.03	2.84	3.53	2.79	4.83	4.54	0.00	4.14	4.87	5.42
8	6.53	5.42	5.92	6.61	5.66	5.28	4.88	9.80	3.92	4.60	5.05	5.05	4.71	4.97	3.30	4.14	0.00	4.0.8	5.72
6	6.82	5.91	5.78	6.59	5.86	5.05	5.65	8.67	5.21	4.84	5.18	4.95	4.76	4.29	4.12	4.87	4.08	0.00	6.24
2	7.17	7.09	6.78	8.98	8.65	7.11	7.69	10.42	5.50	6.04	5.39	7.66	6.47	8.14	5.21	5.42	5.72	6.24	0.00

1. Arka Anrnol, 2. Arka Neelkiran, 3. Mallika, 4. Mulgoa, 5. Neelgoa, 6. Neeleshan, 7. Banganapalli, 8. Arka Puneet, 9. Manjeera, 10. Ratna, l1. Janardhan Pasand, 12. Alphonso, 13. Neelum, 14. Amrapali, 15. Neeluddin, 16. Rumani, 17. Dashehari, 18. Sindhu, 19. Arka Aruna; V/H – Variety / Hybrid

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