



Qualitative and quantitative characterization of off-season mango cultivars in some districts of West Bengal

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ABSTRACT

The research work was carried out during 2015-2017 with the objective to characterize 'off season' mango cultivars of West Bengal based on 26 morphological characters which will help in tree improvement programme. Characterization of cultivars depending on morphological traits is the quickest and easily adoptable method for identification of cultivars at the field level which is necessary for tree improvement programme. Floral biology and leaf characteristics of different off-season mango cultivars are the key stone for determining the performance and yield of a particular variety. In case of mango hermaphrodite flower directly increase fruit set percentage. Leaf fragrance of mango is found to be directly correlated with fruit flavor. Flowering is the most important physiological phenomenon that influences the production and productivity of a mango cultivar. In West Bengal, the peak flowering period for off season mango is 2-3 weeks that resides in the month of April to June. Based on the present studies, it is concluded that Devdas is exhibiting highest flower duration (30 days) among all the other cultivars and Chine has the highest hermaphrodite flower (56.87%) followed by Sada Vastara (51.83%). The leaves of Dutta Dofala has highly strong fragrant followed by Kalo Vastara which has strong fragrance. Depending on the similarity matrix table based on 26 morphological characters, Chine Dofala is showing a significant 36% dissimilarity with Dutta Dofala. So, Chine Dofala and Dutta Dofala can be used as parents in mango hybridization programme to have a variety with greater yield along with fruit aroma.

Keywords: Floral biology, hermaphrodite flower and leaf fragrance

Mangifera indica L., the most important member of the dicotyledonous belonging to the family Anacardiaceae. The genus *Mangifera* consists of 41 species (Mukherjee, 1949). Owing to easy availability of this fruit for a longer period, excellent flavor, delicious taste with uniform blend of sweet and sour, and great nutritive value, it has attained a mass appeal and is called the 'King of Fruits'. In West Bengal, mango is cultivated in an area of 103250 ha with a total production of 918350 MT and a productivity of 8.89MT ha⁻¹ (Horticultural Statistics at a Glance, 2018). The important mango growing districts in West Bengal are Malda, Murshidabad, Nadia and North 24-Parganas. Besides, it is also grown in the district of Hooghly, Burdwan, Jalpaiguri, Coochbehar. The important commercial mango varieties of West Bengal are Himsagar, Langra, Fazli, Gopalbhog, Lakhambhog, Ranipasand, Amrapali etc.

Alternate bearing or biennial bearing is one of the major problems in mango. Each mango tree in commercial bearing does not bear equal crop year after year, which makes mango cultivation less remunerative to the growers and fruit traders. Besides, mango is a seasonal fruit, so it is not available throughout the year. The "Off season mango cultivar" may be a fruitful approach to solve the aforesaid problems. There are so

many off-season mango cultivars cultivated throughout West Bengal especially in Hooghly, Nadia and North 24 Parganas. The important cultivars are Dutta Dofala, Chine Dofala, Shadad Vastara, Kalo Vastar, Shurer Dofala, Tora, Debdas, Swarnamoi Dofala, Lagno etc.

Mango is generally heterozygous in nature and has a large diversity that has resulted from seed propagation. This in turn has resulted in ambiguity in nomenclatures, the same variety is known by different names in different regions and different group of people. Diversity studies would help to choose parents, so that heterosis can be exploited for various traits. Phenological Studies of different 'off-season' mango cultivars are the key stone for determining the performance and yield of a particular variety. The flushing pattern, regularity of flower, time of flower bud differentiation, flower density, type of flowers are directly influenced by their genetic constitution, age of the tree and environmental conditions (Davenport, 2007). Flowering is the most important physiological phenomenon that influences the production and productivity of a mango cultivar. In West Bengal, the peak flowering period for offseason mango is 2-3 weeks in the month of April to June. Present investigation pertaining to floral biology and leaf characteristics of offseason mango cultivars has importance in commercial exploitation throughout West

Bengal. But nomenclature ambiguity is one of the major hindrances. Very few studies on diversity have been made and choice of ideal parents has remained a problem (Dinesh, 2003). The limited available literatures on the phenological studies of these cultivars encouraged us to examine the floral biology and leaf characteristics. There are so many 'offseason' cultivars throughout West Bengal and if this diversity is adequately assessed and utilized, it can be a boon for mango improvement.

MATERIALS AND METHODS

The experimental area was comprised of the districts of Hooghly, Nadia and 24 Parganas (North) in 2015-2017. There are 16 off season cultivars of mango found in different area of Hooghly Nadia and North 24 Pgs for observation. The age of the trees was on an average 13-15 years. Like- Baromashi Hooghly, Lagno, Baromashi NB1, Devdas, Baromashi Nadia 1, Dutta Dofala, Baromashi Nadia 2, Swarnamoi Dofala, Baromashi NB 2, Tora Dofala, Bhadramalli, Lalfuli, Shurer Dofala, Kalo Vastara, Chine Dofala, Shada Vastara. All the morphological characters of different cultivars were recorded by visual observation and were categorized as mentioned in the descriptor for mango (IPGRI, 2006). In this particular study a total no of 26 morphological characters of tree, leaves, flowers and inflorescences were selected from the Descriptor. The mango tree canopy for each individual selected tree was marked and ten no of panicle of each tree on four sides i.e., north, south, east and west were tagged using the paper tag (IPGRI, 2006).

Dendrogram and correlation matrix was done by using Jaccard's similarity coefficient. Selected 26 Characters were either in binary or in categorical form. Characters which reveal only two alternative form were directly considered to binary form (0,1) depending on its presence or absence in a particular genotype. Characters of categorical fashion were considered to binary mode by taking each category as a trait and thereby the presence of a character was considered as 1 and absence as 0 in particular a genotype. The 26 characters which were considered are presented in table 1 to 5. Data were analyzed and similarity matrix was constructed from binary data with Jaccard's coefficient (Jaccard, 1908) and dendrogram were generated by Unweighted Pair-Group Method of Arithmetic mean (UPGMA) algorithm, using SHAN sub-programme of NTSYS-pc version 2.11 software (Rohlf, 2000)

RESULTS AND DISCUSSION

From the observations made it was found that the mango genotypes expressed morphological variations from genotype to genotype. These available

morphological variations have the ability to distinguish the mango genotypes each other.

Only 6 cultivars were grown up from seedling and the rest 10 were grafted and 9 cultivars were erect type and the rest 7 showed spreading type tree habit. The Crown shape of most mango cultivars were found oblong where as Shada Vastara, Lalfuli, Kalo Vastara, Surer Dofola are broadly pyramidal and Baromasi Hooghly, Baromasi NB 2, Bhadramalli, Chine are semicircular. The tree height was divided into 4 major groups and it was measured in m. a) short (≤ 2), b) medium (2-3.0), c) tall (3.0-4.0), d) very tall (>4.0). Most of the cultivars were tall to very tall in height where as Baromashi Hooghly and Baromashi Nadia 1 were recorded as medium in height. Most of the trees were grafted plants except Baromashi Mon, Baromashi NB 1, Baromashi Nadia1, Baromashi Nadia2, Baromashi NB 2, Bhadramalli which were seedling originated (Table 1).

Various forms of mango tree canopies have been reported based on different genotypes, propagation method, density of plantation, and prevailing agro-climatic conditions. Trees of mango cv. 'Latra' exhibits creeper-growth habit due to their spreading growth pattern. The largest mango tree in the world has been reported in India with a spreading crown growth of 36.6 \times 45.7 m (Singh, 1968; Dhillon *et al.*, 2004; Majumder *et al.*, 2011). Height of mango trees may range from 10 to 30 m with broad, round, symmetrical or even erect canopy. This Variation may be due to genotype or environmental factor. Comparative slender crown shapes have also been found in mango (Mukherjee and Litz, 2009; Ahmed, 2004). Seedling trees are more tolerant to drought, disease-pest and other environmental stress. Whereas grafted trees can reduce the long juvenile phase which is very economical for mango cultivation. Crown shape and tree habit are greatly involved in regulating the microclimate. Actually, better air and light penetration inside the canopy and light intensity will result greater yield and higher quality of mango.

Only two cultivars (Kalo Vastara and Shada Vastara) showed dense foliage density, another two cultivars (Baromashi NB2 and Chine Dofala showed sparse foliage density, rest of the cultivars were having intermediate foliage density (Table 2).

The variation in foliage density of mango varieties might be due to variation in genetic constitution among different cultivars which confirm the earlier finding of Dhillon *et al.* (2004). This variation among different genotypes might be due to the variation in genetic constitution and interaction of various genotypes with agro-climatic conditions. Similar results has been reported by (Barua *et al.*, 2013; Majumder *et al.*, 2011; Mitra *et al.*, 2013) in mango varieties.

Table 1: Qualitative tree characters of different off season mango cultivars

Cultivars	Type of tree	Tree height	Crown shape	Tree habit
Baromashi Hooghly	Seedling	Medium	Semi circular	Spreading
Baromashi NB 1	Seedling	Very tall	Oblong	Erect
Baromashi Nadia 1	Seedling	Medium	Oblong	Erect
Baromashi Nadia 2	Seedling	Very tall	Oblong	Erect
Baromashi NB 2	Seedling	Very tall	Semi circular	Spreading
Bhadramalli	Seedling	Very tall	Semi circular	Spreading
Shurer Dofala	Grafted	Very tall	Broadly pyramidal	Spreading
Chine Dofala	Grafted	Tall	Semi circular	Spreading
Lagno	Grafted	Tall	Oblong	Spreading
Devdas	Grafted	Tall	Oblong	Erect
Dutta Dofala	Grafted	Tall	Oblong	Erect
Swarnamoi Dofala	Grafted	Tall	Oblong	Erect
Tora Dofala	Grafted	Tall	Oblong	Erect
Lalfuli	Grafted	Tall	Broadly pyramidal	Erect
KaloVastara	Grafted	Tall	Broadly pyramidal	Erect
ShadaVastara	Grafted	Tall	Broadly pyramidal	Spreding

Table 2: Qualitative leaf characters of different off season mango cultivars

Cultivars	Foliage density	Leaf blade shape	Leaf attitude	Leaf apex shape	Leaf base shape
Baromashi Hooghly	Intermediate	Oblanceolate	Horizontal	Acuminate	Acute
Baromashi NB 1	Intermediate	Elliptical	Semi Erect	Acuminate	Acute
Baromashi Nadia 1	Intermediate	Elliptical	Semi Erect	Acute	Acute
Baromashi Nadia2	Intermediate	Elliptical	Semi Erect	Acute	Acute
Baromashi NB 2	Sparse	Oblong	Horizontal	Acute	Obtuse
Bhadramalli	Intermediate	Oblong	Semi Erect	Acute	Obtuse
ShurerDofala	Intermediate	Oblong	Horizontal	Acuminate	Acute
Chine Dofala	Sparse	Elliptical	Semi Erect	Obtuse	Acute
Lagno	Intermediate	Elliptical	Semi Erect	Acuminate	Obtuse
Devdas	Intermediate	Elliptical	Semi Erect	Acute	Acute
Dutta Dofala	Intermediate	Oblong	Horizontal	Acuminate	Obtuse
Swarnamoi Dofala	Intermediate	Oblong	Semi Erect	Acute	Acute
Tora Dofala	Intermediate	Oblong	Semi Drooping	Acute	Acute
Lalfuli	Intermediate	Oblong	Horizontal	Obtuse	Acute
KaloVastara	Dense	Oblong	Semi Erect	Acute	Acute
ShadaVastara	Dense	Elliptical	Horizontal	Acute	Acute

There were mainly two types of leaf shape *i.e.* oblong shape in cultivars Baromasi NB2, Bhadramalli, Surer Dofola, Dutta Dofola, Swarnamoi Dofala, Lalfuli, Tora Dofola, Kalo Vastara and elliptical shape in cultivars like Baromasi NB1, Baromasi Nadia1, Baromasi Nadia2, Chine Dofola, Lagno, Debdas, Shada Vastara. In the cultivar Baromashi Hooghly the leaf shape was oblanceolate. Most of the cultivars had acute leaf tip. Acuminate leaf tip was found in Baromasi NB1, Baromashi Hooghly, Lagno, Surer Dofola, and Dutta Dofola. In few cultivars obtuse leaf tip was also found like Chine Dofola and Lalfuli. In case of leaf base most of the cultivars had acute leaf base. Obtuse type of leaf

base was also found in few cultivars like Baromasi NB2, Bhadramalli, Dutta Dofola and Lagno. Out of sixteen cultivars most were having Semi-Erect leaf attitude, 6 cultivars (Baromashi Hooghly, Baromashi NB2, Surer Dofola, Dutta Dofola, Lalfuli, Shada Vastara) were having horizontal leaf attitude and only Tora Dofola showed Semi-drooping leaf attitude (Table 2). In Baromashi Hooghly, Surer Dofola, Dutta Dofola, Tora and Lalfuli had wavy leaf margin. The remaining all cultivars had leaves with entire leaf margin (Table 3).

Similar results for characterization and identification of mango cultivars by leaf shape have been reported by

Table 3: Qualitative leaf characters of different off season mango cultivars

Cultivars	Young leaf colour	Mature leaf colour	Leaf margin	Leaf fragrance	Leaf blade length (cm)	Leaf blade width (cm)
Baromashi Hooghly	Light Green	Dark Green	Wavy	Absent	13.90	5.46
Baromashi NB 1	Reddish Brown	Green	Entire	Strong	16.50	4.56
Baromashi Nadia1	Light Green	Dark Green	Entire	Mild	16.93	4.96
Baromashi Nadia2	Light Green	Dark Green	Entire	Absent	15.00	3.53
Baromashi NB 2	Light Green	Green	Entire	Strong	14.26	5.43
Bhadramalli	Light Brick Red	Dark Green	Entire	Absent	13.33	4.26
ShurerDofala	Reddish Brown	Green	Wavy	Strong	17.13	5.47
Chine Dofala	Light Brick Red	Dark Green	Entire	Absent	15.00	4.50
Lagno	Light Green	Green	Entire	Absent	15.10	5.33
Devdas	Light Green	Green	Entire	Mild	22.23	4.30
Dutta Dofala	Light Brick Red	Pale Green	Wavy	Highly strong	18.03	5.26
SwarnamoiDofala	Light Brick Red	Green	Entire	Strong	17.46	3.36
Tora Dofala	Reddish Brown	Dark Green	Wavy	Mild	16.30	4.10
Lalfuli	Reddish Brown	Green	Wavy	Absent	20.16	5.16
KaloVastara	Light Brick Red	Green	Entire	Strong	16.36	3.13
SadaVastara	Light Brick Red	Green	Entire	Strong	16.06	3.63

Table 4: Qualitative inflorescence characters of different off-season mango cultivars

Cultivars	Inflorescence colour	Inflorescence position	Inflorescence axis growth habit	Inflorescence shape	Leafy bracts
Baromashi Hooghly	Light Green	Terminal	Semi Erect	Broadly Pyramidal	Absent
Baromashi NB 1	Light Green	Terminal	Drooping	Broadly Pyramidal	Present
Baromashi Nadia1	Light Green	Terminal	Semi Erect	Broadly Pyramidal	Absent
Baromashi Nadia2	Pinkish	Terminal	Semi Erect	Conical	Absent
Baromashi NB 2	Green With Red Patches	Both Terminal and Auxillary	Horizontal	Broadly Pyramidal	Absent
Bhadramalli	Yellowish Green	Terminal	Semi Erect	Pyramidal	Present
ShurerDofala	Light Green	Terminal	Horizontal	Pyramidal	Present
Chine Dofala	Light Green	Terminal	Semi Erect	Conical	Present
Lagno	Light Green	Terminal	Semi Erect	Conical	Absent
Devdas	Yellowish Green	Terminal	Semi Erect	Conical	Absent
Dutta Dofala	Yellow	Both Terminal and Auxillary	Drooping	Conical	Absent
SwarnamoiDofala	Yellowish Green	Terminal	Semi Erect	Pyramidal	Absent
Tora Dofala	Light Green	Terminal	Horizontal	Pyramidal	Absent
Lalfuli	Yellowish Green	Both Terminal and Auxillary	Semi Erect	Pyramidal	Absent
Kalo Vastara	Light Green	Terminal	Horizontal	Conical	Present
Shada Vastara	Yellowish Green	Terminal	Semi Erect	Conical	Absent

numerous scientists (Khan, 1960; Rhodes *et al.*, 1970; Mussane, 2010; Rajwana *et al.*, 2011; and Joshi *et al.*, 2013).

Wide variation in colour of young leaf (light green, reddish brown, light brick red) was observed in different 'off-season' mango cultivars. In case of mature leaves most of the leaves were found green to dark green in colour but Dutta Dofala had pale green mature leaves

(Table 3). In a research by Fivaz (2008) and Christopher *et al.* (2017) young leaves of different varieties usually show characteristic colours. These colours may vary from copper-red to purplish in nature.

Mature stage and may produce mild, strong or no fragrance. Leaves of Dutta Dofala have highly strong fragrant, Tora Dofala, Kalo Vastara, Sada Vastara, Surer Dofala, Baromashi NB2, Baromashi NB1 and

Table 5: Qualitative flower characters of different off season mango cultivars

Cultivars	Regularity of flower	Duration of flowering	Start of flowering	Nature of disk	Hermaphrodite flowers or inflorescence (%)	Type of flower
Baromashi Hooghly	Regular	25.00	1st week of June	Swollen, Broader Then Ovary	29.45	Pentamerous
Baromashi NB 1	Regular	21.00	1st week of May	Swollen, Broader Then Ovary	35.42	Pentamerous
Baromashi Nadia1	Regular	22.00	3rd week of May	Swollen, Broader Then Ovary	33.12	Pentamerous
Baromashi Nadia2	Regular	25.00	2nd week of May	Swollen, Broader Then Ovary	42.06	Pentamerous
Baromashi NB 2	Regular	17.00	2nd week of May	Swollen, Broader Then Ovary	18.91	Pentamerous
Bhadramalli	Regular	18.00	2nd week of May	Swollen, Broader Then Ovary	39.34	Pentamerous
Shurer Dofala	Regular	20.00	2nd week of May	Swollen, Broader Then Ovary	19.21	Pentamerous
Chine Dofala	Regular	21.00	2nd week of May	Swollen, Broader Then Ovary	56.87	Pentamerous
Lagno	Irregular	28.00	last week of April	Swollen, Broader Then Ovary	28.52	Pentamerous
Devdas	Regular	30.00	2nd week of May	Swollen, Broader Then Ovary	40.96	Pentamerous
Dutta Dofala	Regular	23.00	2nd week of May	Swollen, Broader Then Ovary	25.67	Pentamerous
Swarnamoi Dofala	Regular	15.00	1st week of May	Swollen, Broader Then Ovary	23.17	Pentamerous
Tora Dofala	Regular	24.00	2nd week of May	Swollen, Broader Then Ovary	43.23	Pentamerous
Lalfuli	Irregular	14.00	Last week of April	Swollen, Broader Then Ovary	29.54	Pentamerous
KaloVastara	Regular	22.00	2nd week of May	Swollen, Broader Then Ovary	26.42	Pentamerous
ShadaVastara	Regular	28.00	2nd week of May	Swollen, Broader Then Ovary	51.83	Pentamerous

Swarnamoi Dofala shows strong leaves fragrance. Cultivar like Tora, Devdas and Baromashi Nadia1 were having mild leaf fragrant. Rest of the cultivars has no leaf fragrant (Table 3). Some correlations worked out in mango have shown leaf flavour to be directly correlated with fruit flavour (Majumder *et al.*, 1972; Whiley *et al.*, 1993).

The leaf length varied from 13.33 cm (Bhadramalli) to 22.23 cm (Kalo Vastara) and the leaf width ranged between 3.13 cm (Swarnamoi Dofala) and 5.47 cm (Chine Dofala). Leaf size was maximum in Shurer Dofala being, 20.16 × 5.16 cm (Table 3). Characterization and identification of mango cultivars by leaf length, width and shape have been reported by numerous scientists (Khan, 1960; Rhodes *et al.*, 1970; Mussane, 2010; Rajwana *et al.*, 2011). Usually length of leaf varies based on genotypes. Variations in the length of leaves may also

be due to cultural practices, climatic conditions, genetic variations and growth stages. Simple, alternate and oblanceolate with 16–40 cm length, 5–15 cm width, orange–pink dark lustrous red to green leaves have also been reported in mango (Singh, 1960; Litz, 2003).

The inflorescence colours in most of the cultivars were either yellow to yellowish green or light green. However, Baromashi Nadia 2 exhibited pinkish and Baromasi NB2 showed green with red patches inflorescence (Table 4). Similar findings have been reported by Hossain and Talukdar (1974).

Inflorescence appeared terminally as well as axillary in 3 cultivars namely Baromashi NB 2, Dutta Dofala and Lalfuli whereas it was only terminal in rest 13 cultivars (Table 4). This is also in agreement with the findings of Iqbal *et al.* (1995) and Mazumder *et al.* (2011). The different shapes of inflorescence were found

Table 6: Correlation matrix depicting relationship among 16 cultivars based on 26 morphological characters by using Jaccard's similarity coefficient

Cultivars	Baromashi Hooghly	Baromashi NBI	Baromashi Nadial	Baromashi Nadial2	Baromashi NB2	Baromashi NB2	Bhadra-malli	Shurer Dofala	Chine Dofala	Lagno Dofala	Devdas	Dutta Dofala	Swarnamoi Dofala	Tora Dofala	Lalfuli	Kalo Vastara	Shada Vastara
Baromashi Hooghly	1																
Baromashi NBI	0.74	1															
Baromashi Nadial	0.84	0.84	1														
Baromashi Nadial2	0.74	0.79	0.89	1													
Baromashi NB2	0.71	0.66	0.68	0.68	1												
Bhadramalli	0.74	0.74	0.76	0.76	0.74	1											
Shurer Dofala	0.74	0.76	0.63	0.63	0.71	0.71	1										
Chine Dofala	0.72	0.72	0.73	0.73	0.65	0.76	0.72	1									
Lagno	0.76	0.79	0.82	0.79	0.68	0.74	0.71	0.80	1								
Devdas	0.69	0.77	0.84	0.89	0.65	0.71	0.67	0.76	0.88	1							
Dutta Dofala	0.68	0.68	0.66	0.66	0.66	0.66	0.68	0.64	0.76	0.72	1						
Swarnamoi Dofala	0.66	0.74	0.79	0.79	0.68	0.79	0.74	0.76	0.79	0.89	0.74	1					
Tora Dofala	0.68	0.74	0.79	0.79	0.66	0.71	0.76	0.71	0.74	0.81	0.71	0.84	1				
Lalfuli	0.71	0.66	0.68	0.66	0.63	0.68	0.76	0.65	0.68	0.73	0.82	0.79	0.76	1			
Kalo Vastara	0.66	0.71	0.71	0.68	0.61	0.71	0.76	0.76	0.71	0.73	0.76	0.76	0.76	0.76	1		
Shada Vastara	0.72	0.65	0.73	0.73	0.65	0.73	0.69	0.78	0.79	0.81	0.75	0.79	0.71	0.80	0.83	1	

in the studied mango cultivars. Majority of cultivars produced either conical or broadly pyramidal shaped inflorescence. However, few cultivars like Shurer Dofala, Bhadramalli, Tora, Swarnamoi Dofala produced pyramidal shaped inflorescence (Table 4). This type of difference was also noted by Singh (1968).

Presence of leafy bract in inflorescence is an important character which was found in 5 cultivars namely Kalo Vastara, Chine, Baromashi NB1, Surer Dofala and Bhadramalli among 16 cultivars (Table 5). All the cultivars produced pentamerous flower and the flowers showed swollen, lobed disc which was broader than the ovary. Flowering of all the mango cultivars commenced between last week of April and second week of May with a variation of 7 to 15 days. Few cultivars such as Lagno, Devdas, Lalfuli, Tora Dofala and Dutta Dofala were irregular in bearing. Other cultivars were regular in bearing with profuse flowering. In most of the case the flowering intensity were medium. Only 3 cultivars namely Baromashi Nadia 2, Devdas, Tora Dofala were recorded as dense flowering intensity and in case of Baromashi NB 2, Shurer Dofala, Chine Dofala and Swarnamoi Dofala the flower intensity were sparse (Table 5).

Flowering regularity, time and intensity are critical factors directly associated with the economic status of the mango growers. Flowering is usually related with prevailing native environmental conditions, heredity, nutrition status and hormonal aspects as every mango genotype has specific flowering time (Kulkarni, 2004). In nature bearing both perfect and staminate flowers are present and the born on same inflorescence i.e. andromonocious (Mukherjee and Litz, 2009). The intensities of the male and perfect flower vary with the varieties, position of panicle and climatic conditions. Chine Dofala showed the maximum percentage of hermaphrodite flowers (56.87%) followed by ShadaVastara (51.83%) while minimum hermaphrodite flower percentage was found in Baromashi NB 2 (18.91%) followed by Shurer Dofala (19.21%). Baromasi Nadia2, Devdas and Tora Dofala were recorded to have more than 40% hermaphrodite flowers viz., 42.06, 40.96, 43.23%, respectively.

These results were in similar with Azam *et al.*, 2018 who observed maximum percentage of hermaphrodite flower (73.86%) in cultivar Langra and minimum hermaphrodite flower percentage in Swarnarekha. Singh *et al.* reported minimum male flower in Langra and maximum male flowers in Fazli. The variation of the perfect and staminate flower ratio may be governed by both physiological and environmental conditions (Azam *et al.*, 2018). Though sex ratio of flower is a genetic character but also influenced by environmental factors

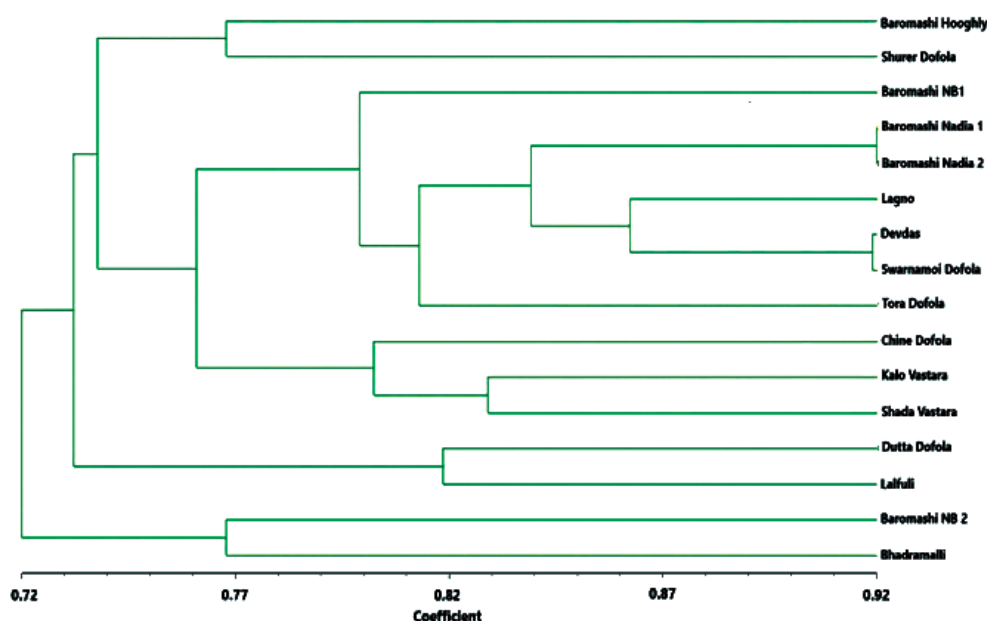


Fig. 1: Dendrogram depicting relationship among 16 cultivars based on 26 morphological characters by using Jaccard's similarity coefficient

especially temperature. Low temperature (10°C–15°C) during flowering resulted in predominantly staminate flowers, while higher temperatures favoured the production of hermaphrodite flowers (Shi-Jin *et al.*, 2007).

Based on dendrogram (Fig.1), it was found that the cultivar Chine Dofala (having highest hermaphrodite flower) is closely related to the cultivars like Tora Dofala, Kalo Vastara, Devdas and Swarnamoi Dofala. But it is quite distantly related to the cultivars like Baromashi NB2, Lalfuli and Dutta Dofala. This Dutta dofala (having highly strong fragrant leaves) may be used as a good combiner with Chine Dofala for breeding purpose with an aim of having genotype of high hermaphrodite as well as high aroma.

Depending upon the similarity matrix (Table 6) based on 26 morphological characters, Chine Dofala (having highest hermaphrodite flower) is more than 75% similar with Lagno, Devdas, Swarnomoi Dofala, Tora Dofala, Kalo Vastara and Sada Vastara. Height dissimilarity was found with Dutta Dofala (36%) (which has highly strong fragrant leaves) followed by Lalfuli(35%). So, Chine Dofala and Dutta Dofala can be used as parents in mango hybridization programme to have a variety with greater yield along with fruit aroma.

Characterization of cultivars through morphological traits is the simplest, quickest and easily adoptable method for identification of cultivars at the field level which is mandatory for tree improvement programmes. In present study, major focus was given to characterize

'off season' mango cultivars of West Bengal based on some important characters of plant, leaf and inflorescence. In Mango breeding programme the most serious problem is non-availability of parental pollen to fertilize the receptive target female cultivars due to asynchronised flowering behavior and alternate bearing or biennial bearing is also a major problem in mango. The information pertaining to time of bud break, initiation of flowering, flowering duration, hermaphrodite flower percentage etc. has significant importance on success of breeding programme. Based on the results, it may be concluded that cultivar Chine and Sada Vastar performs best with higher percentage of hermaphrodite flower. So, evaluation and conservation of this species need special attention as it may be used as one of the parents in mango breeding programmes for enhancing yield, quality and commercial exploitation of these cultivars.

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