Current Journal of Applied Science and Technology

31(4): 1-6, 2018; Article no.CJAST.45986
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

Studies on Floral Biology and Leaf Characteristics of Mango Hybrids and Their Parents

Abha Sinha[1], Hidayatullah Mir[1*], Ruby Rani[1] and Bishun Deo Prasad[1]

[1]Department of Horticulture (Fruit and Fruit Technology), Bihar Agricultural University, Sabour, Bhagalpur, (Bihar)-813210, India.

Authors' contributions

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

Article Information

DOI: 10.9734/CJAST/2018/45986

Original Research Article

Received 08 November 2018
Accepted 30 November 2018
Published 08 December 2018

ABSTRACT

Flowering plays a very crucial role in the production and productivity of mango cultivars. An experiment was conducted to investigate phenological behaviour of mango hybrids and their parents developed at BAU, Sabour. Results showed the earliest bud break in cultivar Sunderprasad on 24th January however, the late bud break was observed in Fazli on 14th February. The cultivar Fazli took maximum time (124.67 days) while Sunderprasad recorded minimum time (92.67 days) from full bloom to maturity. Cultivar Langra showed the higher percentage (74.18) of hermaphrodite flower while a lower percentage (37.60) was observed in Jawahar. The hybrids like Hybrid-60-1, Hybrid 140 and Hybrid 60 were recorded to have more than 50 percent hermaphrodite flowers. Mainly two types of inflorescence shapes were observed viz., conical and pyramidal except for Bombai where the shape of inflorescence was observed to be broadly pyramidal. The maximum leaf length was recorded in Fazli (29.04 cm) and maximum leaf width (9.38 cm), leaf area (132.69) was observed in Alfazli while the minimum leaf length (16.84 cm), width (4.06 cm) was found in cv. Gulabkhas. Mahmood Bahar, Prabha Shankar, Jawahar and Alphonso had oblong-lanceolate leaf shape while others were observed to have the lanceolate shape of leaf. At several occasions due to lack of information on flowering behaviour of parental cultivar, breeding efforts are under-performed. The information pertaining to time of bud break, initiation of flowering, flowering duration, hermaphrodite flower percentage *etc*. has significant implications on the success of breeding efforts.

Keywords: Floral biology; mango hybrids; germplasm.

**Corresponding author: E-mail: hidayatmay14@yahoo.co.in;*
Note: Special issue with selected papers presented in National Conference on Biotechnological Initiatives for Crop Improvement (BICI 2018), December 08-09, 2018, Organized by Bihar Agricultural University, Sabour, Bhagalpur - 813210 (Bihar), India. Conference organizing committee and Guest Editorial Board completed peer-review of this manuscript.

1. INTRODUCTION

Mango *(Mangifera indica* L.) is one of the most popular fruit of the tropical and sub-tropical region of the world belonging to the family Anacardiaceae which covers 73 genera and concerning 830 species and it originated from northern foothills of Indo-Burma region [1]. Mango (*Mangiferaindica*L.) is popularised as one of the best fruit among all the indigenous fruits due to its delicious taste, outstanding flavour, attractive fragrance,aroma with high nutritive values [2]. Mango has enormous diversity due to open pollination, allopolyploid, outbreeding and phenotypic variations occur from diverse agro climatic situation of different regions [3]. Due to its extensive range of diversity and adaptability, mango is widely distributed in India with around 1500 varieties but only few (25-30) distinct varieties are cultivated commercially as per suitability of their particular location. India is the largest mango producer in the world and the major mango producing states are Uttar Pradesh, Bihar, Orissa, Gujarat, West Bengal, Maharashtra, Andhra Pradesh and Karnataka.

Most of the reproductive phases of mango varieties occur during October-December under tropical as well as subtropical conditions. Phenological Studies of different mango genotypes are essential to determine their performance. Generally, the numbers of flower in one panicle vary from 1000-6000 in mango varieties. The flushing pattern, time of flower bud differentiation, number of flower in one panicle and sex ratio of mango genotypes are greatly influenced by their genetic constitution, age of the tree and terminal resting shoots along with environmental conditions which experienced by the tree [4]. Flowering is a very complex physiological phenomenon which influences the production and productivity of various mango varieties [5]. The process associated with mango flowering involves shoot initiation followed by floral differentiation, and panicle emergence [6]. Different mango cultivars across the world possess several hindrance namely lower number of perfect flowers, low fruit set, low yield, and inadequate fruit quality which prevents the exploitation of full potential of this crop. The preference of appropriate cultivar is a prime need for booming cultivation because the same cultivar behaves differently in different locations and/or climate. In Bihar, the peak flowering period of mango is 2-3 weeks in the month of February and March. Present investigation pertaining to floral biology of mango hybrids and their parents has importance in commercial fruit production in Bihar. Bihar Agricultural College, Sabour is a pioneer in mango breeding in India and is proud to have first mango hybrids Mahmud Bahar and Prabha Shankar developed in 1951. After that intensive research programme is being undertaken for improvement in mango and many hybrids have been developed. The limited literatures on the phenological studies of these hybrids encouraged us to examine the floral biology and leaf characteristics. This study may also be useful to trace and exploit the genetic diversity in mango and ultimately preserve the vital germplasm of mango.

2. MATERIALS AND METHODS

The present experiment was conducted at Horticulture garden, Bihar Agricultural University, Sabour, Bhagalpur during the year 2017-18. The experimental orchard situated 87 º 2'72'' east and latitude 25º15´40'' north and at an altitude of 45.72 meters above the mean sea level in the hearts of the Indo-Gangetic plains of north India, south of river Ganga. The experimental plot has well drained sandy loam soil of good fertility with the levelled surface. The climate of Sabour is semi-arid, subtropical with hot desiccating summer and cold frostless winter. The experiment was carried out in a randomized block design with 3 replications of 17 mango genotypes. The genotypes studied were Mahmood Bahar, Prabhashanker, Alfazli, Sabari, Jawahar, Sunder Langra, Hybrid 140, Hybrid 60, Hybrid 60-1, Bombai, Kalapadi, Alphonso, Fazli, Gulabkhas, Langra, Sunderprasad, Amrapalli. The mango tree canopy for each individual selected tree was marked and tagged the panicle of each tree on four sides i.e., north, south, east and west using the paper tag. The critical dates from bud initiation to fruit maturity in mango cultivars were recorded on the tagged shoots by visiting the experimental orchard every day during the time of different stages. Care was taken to ensure that the residual parts of the labelled panicles were not physically damage. Hermaphrodite flowers were counted on selected panicles and average number was expressed as number of hermaphrodite flower per panicle. Percentage Hermaphrodite flower was calculated with the help of the following equation:

$$\text{Percentage of hermaphrodite flowers} = \frac{\text{Number of hermaphrodite flowers}}{\text{Total no. of flowers}} \text{x} 100$$

The inflorescence shape, inflorescence type, leaf length, leaf width and leaf shape was recorded as per IBPGR descriptor of mangoes whereas leaf area was measured by using portable leaf area meter. The foliage density was recorded during the month of December.

3. RESULTS AND DISCUSSION

Floral biology and characterization of germplasm of any fruit crop provides a rapid, reliable and efficient tool for exploring the existing genetic variability in crop improvement programmes. Results of our study ascertained that the mango hybrids and their parents varied for different parametres of flowering. February month was observed to be the most crucial period for bud break and panicle initiation in the majority of the mango genotypes. Out of seveenteen mango genotypes Sunderprasad had very early bud break on 24th January followed by Bombai and Gulabkhas on 25th January and 27th January. However, Alfazli, Kalapadi, Mahmood Bahar, Prabha Shankar, Amrapali and Fazli had very late bud break extending upto 14th Feb. The seasonal cyclic variation of bud break is dependent on environmental factors and might be due to the differences in the genetic composition of parental mango genotypes. Phenology pattern is strongly under environmental control in mango. The vegetative cycle ceases with the advent of winter and maturation of the leaves takes place along with the dormancy of the apical and axillary buds. The plant remains visually dormant for about 3 months during winter. Flowering is commonly related with cease in or dormancy of the terminal growth which is controlled by low temperature in subtropics [7]. Time of appearance of 50% flower varied from 10 Feb in Sunderprasad to 25th Feb in Mahmood Bahar, PrabhaShankar and Fazli. Kalapadi, Alfazli, Jawahar, Amrapali and Langra took more time for the appearance of 50% flower. The differences observed in terms of time of appearance of 50% flower stage among mango hybrids and their parents might be attributed to the genetic differences and interaction of genetic-environmental factors [8].

Table 1. Flowering parameters of different mango cultivars

S. no	Treatments	Time of bud break	Time of appearance of 50% flowering	Period from bud break to full bloom	Period of full bloom to maturity	Hermaphrodite flower (%)
1	Mahmood Bahar	09-Feb	25-Feb	36.33	121.00	54.27 (47.43)
2	Prabha Shankar	10-Feb	25-Feb	35.67	120.00	47.33 (43.45)
3	Alfazli	08-Feb	24-Feb	37.67	117.00	43.43 (41.21)
4	Sabri	01-Feb	18-Feb	34.00	108.00	38.50 (38.34)
5	Jawahar	05-Feb	23-Feb	35.00	109.67	37.60 (37.80)
6	Sunderlangra	04-Feb	21-Feb	33.33	108.00	44.83 (42.02)
7	Hybrid 140	03-Feb	20-Feb	33.00	109.67	56.27 (48.58)
8	Hybrid 60	05-Feb	19-Feb	32.00	102.33	54.03 (47.30)
9	Hybrid 60-1	04-Feb	21-Feb	31.00	103.00	59.53 (50.48)
10	Bombai	25-Jan	12-Feb	28.33	96.00	40.30 (39.39)
11	Kalapadi	08-Feb	24-Feb	38.67	118.00	43.83 (41.44)
12	Alphonso	01-Feb	15-Feb	32.00	114.33	47.37 (43.47)
13	Fazli	14-Feb	25-Feb	39.67	124.67	44.77 (41.98)
14	Gulabkhas	27-Jan	13-Feb	27.67	98.00	55.43 (48.10)
15	Langra	01-Feb	22-Feb	28.67	100.00	74.18 (59.44)
16	Sunderprasad	24-Jan	10-Feb	26.33	92.67	55.03 (47.87)
17	Amrapalli	12-Feb	24- Feb	37.67	118.00	56.03 (48.45)
CV		-	-	2.52	0.81	1.71
C.D. at 5%		-	-	1.40	1.49	1.29

Table 2. Phenological characteristics of different mango cultivars

S. no	Treatments	Foliage density	Inflorescence shape	Inflorescence Type
1	Mahmood Bahar	Dense	Conical	Pentamerous
2	Prabha Shankar	Dense	Conical	Pentamerous
3	Alfazli	Dense	Pyramidal	Pentamerous
4	Sabri	Dense	Conical	Tetra & Pentamerous
5	Jawahar	Intermediate	Conical	Tetra, Penta&Hexamerous
6	Sunderlangra	Dense	Pyramidal	Pentamerous
7	Hybrid 140	Sparse	Conical	Pentamerous
8	Hybrid 60	Sparse	Conical	Pentamerous
9	Hybrid 60-1	Sparse	Conical	Pentamerous
10	Bombai	Sparse	Broadly Pyramidal	Pentamerous
11	Kalapadi	Intermediate	Pyramidal	Pentamerous
12	Alphonso	Dense	Conical	Tetra & Pentamerous
13	Fazli	Intermediate	Pyramidal	Tetra & Pentamerous
14	Gulabkhas	Dense	Conical	Tetra, Penta&Hexamerous
15	Langra	Intermediate	Conical	Pentamerous
16	Sunderprasad	Dense	Broadly Pyramidal	Pentamerous
17	Amrapalli	Dense	Pyramidal	Pentamerous

Table 3. Leaf characteristics of different mango cultivars

S. no	Treatments	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Leaf shape
1	Mahmood Bahar	18.37	5.04	50.42	Oblong- lanceolate
2	Prabha Shankar	20.37	4.92	61.04	Oblong- lanceolate
3	Alfazli	29.00	9.38	132.69	Lanceolate
4	Sabri	20.77	5.69	64.20	Lanceolate
5	Jawahar	19.63	4.70	61.13	Oblong- lanceolate
6	Sunderlangra	24.37	6.63	73.57	Lanceolate
7	Hybrid 140	22.67	5.33	67.17	Lanceolate
8	Hybrid 60	20.99	6.48	66.05	Lanceolate
9	Hybrid 60-1	24.93	6.49	69.80	Lanceolate
10	Bombai	21.21	6.12	66.93	Lanceolate
11	Kalapadi	22.35	4.37	65.28	Lanceolate
12	Alphonso	18.93	4.50	52.90	Oblong- lanceolate
13	Fazli	29.04	8.58	125.57	Lanceolate
14	Gulabkhas	16.84	4.06	53.57	Lanceolate
15	Langra	23.35	5.54	57.43	Lanceolate
16	Sunderprasad	18.51	5.15	57.47	Lanceolate
17	Amrapalli	21.38	5.14	66.47	Lanceolate
CV		2.13	4.56	6.73	-
C.D. at 5%		0.78	0.44	7.88	-

Period from bud break to full bloom in different mango genotypes were significantly varied from 26.33 to 39.67 days. Fazli took maximum time (39.67 days) from bud break to full bloom followed by Kalapadi, Amrapalli and Alfazli while Sunderprasad took minimum time (26.33 days) followed by Gulabkhas. Singh et al. [9] studied the flowering and fruiting behaviour of eleven mango cultivars (Langra, Bombay, Mithua, Gulabkhas, Zardalu, Dashehari, Sipia, Fazli, Ketaki, Prabha Shankar and Mahmood Bahar) at Ranchi, Jharkhand and observed early flowering in Gulabkhas and 100% flowering occurred by 4th February. However, the minimum period for 100% flower opening was recorded in Fazli (16 days). Period from full bloom to maturity in mango cultivars were found significant variation. The cultivar Fazli took maximum time (124.67 days) which was statistically at par with Mahmood Bahar and Prabhashanker while Sunderprasad took only (92.67 days) from full bloom to maturity followed

by Bombai and Gulabkhas. Kishore et al. [10] observed Arka Neelachal Kesari had the shortest maturity period followed by Himsagar and Prabhashankar. On the other hand Totapari took more than 140 days. Thus, it is evident that early variety had short maturity period.

Mango is a terminal bearer and is polygamous in nature bearing both perfect and staminate flower. Both types of flowers are born on same inflorescence i.e. andromonocious [11]. The intensities of the male and perfect flower vary with the varieties, position of panicle and climatic conditions. The number of hermaphrodite flowers showed statistically significant variation among Hybrids and its parental mango cultivars. Langra showed the maximum percentage of hermaphrodite flowers (74.18%) while minimum hermaphrodite flower percentage was found in Jawahar (37.60%) followed by Sabri (38.50%). The Hybrid-60-1, Hybrid 140 and Hybrid 60 were recorded to have more than 50% hermaphrodite flowers viz., 59.53, 56.27, 54.03% respectively. These results were in agreement with Azam et al. [12] who also observed maximum percentage of hermaphrodite flower (73.86%) in cultivar Langra and minimum hermaphrodite flower percentage in Swarnarekha. Singh et al. [9] reported minimum male flower in Langra and maximum male flowers in Fazli. The variability in the perfect and staminate flower ratio may be governed by physiological and environmental conditions [12]. Flower sex ratio is a genetic character but influenced by environmental factors especially temperature. Low temperature (10°C–15°C) during flowering resulted in predominantly staminate flowers, while high temperatures favoured the production of hermaphrodite flowers [13]. However, the stage of low-temperature exposure determines the proportion of hermaphrodite flowers. Foliage density of different mango genotypes were categorized into dense, intermediate and sparse foliage type based on the density. The hybrids like Hybrid-60-1, Hybrid 140 and Hybrid 60 were recorded to have sparse foliage while MahmoodBahar, Prabha Shankar and Alfazli have dense foliage. Majumder et al. [14] studied on physio-morphology, floral and fruit characteristics of 60 genotypes of mango and reported that foliage density was medium in Amrapalli, Dashehari and Pant sinduri while sparse type density was found in Gaurjit and Mallika and dense foliage was recorded in rest of the cultivars. They also reported wide variation in the colour of the foliage and concluded Amrapalli, Dashehari, Gulabkhas, Mallika and Pant Sinduri have green foliage, while all other genotypes produced dark green foliage. In our study Inflorescence shapes were observed of mainly two types viz., conical and pyramidal, except for Bombai where the shape of inflorescence was observed to be broadly pyramidal. The hybrids like Hybrid-60-1, Hybrid 140 and Hybrid 60, Mahmood Bahar and Prabhashankar were recorded to have conical shape inflorescence while Kalapadi, Fazli, Sunderlangra and Alfazli were recorded to have pyramidal shape inflorescence. In term of Inflorescence type, most of the genotypes and almost all of the hybrids were recorded to have pentamerous inflorescence. Both tetra and pentamerous inflorescence was found in Sabri, Alphonso and Fazli while tetra, penta and hexamerous inflorescence were observed in Gulabkhas and Jawahar.

Mango hybrids and their parents also varied in the leaf characteristics. Longest leaves were observed in the cv. Fazli (29.04 cm) closely followed by Alfazli (29.00 cm) while the smallest leaves were recorded in the Gulabkhas (16.84 cm). Maximum leaf width was recorded for Alfazli (9.38 cm) followed by Fazli (8.58 cm) while least was recorded in Gulabkhas (4.06 cm). Rymbai et al. [15] showed considerable variations in leaf morphological characters among the eight mango cultivars and found that maximum leaf length and leaf ratio was observed in Alphonso and minimum in Langra and Fazli. They also found that maximum and minimum leaf width was observed in Totapuri and Dashehari respectively but maximum leaf area was recorded in Alphonso while minimum in Borsha. The maximum leaf area was observed in Alfazli (132.69) followed by Fazli (125.57) while the minimum was recorded in Mahmoodbahar (50.42) followed by Alphonso (52.90) and Gulabkhas (53.57). Variation in leaf characters particularly leaf area is probably due to genetic divergence of mango cultivars and environmental effect (Shrivastav et al., 1987; Reddy et al., 2000; [15]). Leaf shape of mango genotypes were categorized into two groups, one having lanceolate leaves and other with oblong lanceolate leaves. Mahmood Bahar, Prabhashankar, Jawahar and Alphonso had oblong-lanceolate leaf shape while others were observed to have lanceolate shape of leaf. Joshi et al. (2013) also reported that the leaf shape was found elliptic lanceolate in Amrapali and Mallika, ovate lanceolate in Chausa and Pant Sinduri, while rest of the cultivars had oval lanceolate shape.

4. CONCLUSION

Mango breeders normally face problem of non-availability of parental pollen for fertilization of the receptive target female cultivars due to asynchronised flowering. At several occasions due to lack of information on flowering behaviour of parental cultivar, breeding efforts are under-performed. The information pertaining to time of bud break, initiation of flowering, flowering duration, hermaphrodite flower percentage *etc*. has significant implications on success of breeding efforts. Based on the results, it may be concluded that flowering behaviour of mango genotypes differ significantly. Cultivar Langra and Hybrid60-1 performs best with higher percentage of hermaphrodite flower. So it could be used as one of the parent in mango breeding programmes for enhancing yield and quality.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Yamanaka N, Hasran M, XU DH, Tsunematsu H, Idris S, Ban T. Genetic relationship and diversity of four Mangifera species revealed through AFLP analysis. Genet. Res. Crop Evol. 2006;53:949-954.
2. Sogi DS, Siddiq M, Roidoung S, Dolan KD. Total Phenolics, Carotenoids, Ascorbic Acid, and Antioxidant Properties of Fresh-cut Mango (Mangifera indica *L., cv*). Tommy Atkin as Affected by Infrared Heat Treatment. J. Food. Sci. 2012;77(11): C1197-C1202.
3. Ravishankar KV, Lalitha A, Dinesh MR, Anand L. Assesment of genetic relatedness among mango cultivars of India using RAPD markers. Journal of Horticultural Science Biotechnology. 2000; 15(2):198-201.
4. Davenport TL. Reproductive physiology of mango. Brazilian Journal of Plant Physiology. 2007;19(4):363-376.
5. Davenport TL. Management of flowering in three tropical and subtropical fruit tree species. Hort. Science. 2003;38:1331-1335.
6. Murti GSR, Upreti KK. Endogenous hormones and phenols in rootstock seedlings of mango cultivars and their relationship with seedling vigour. Europe. J. Hort. Sci. 2003;68(1): 2-7.
7. Chacko EK, Randhawa GS. Towards an understanding of the factors affecting flowering in mango. Andhra Agric. J. 1971; 18:226-36.
8. Singh A, Srivastav M, Singh AK, Dubey AK, Lal SK. Flowering attributes of parental mango genotypes. Indian Journal of horticulture. 2014;71(4):458-463.
9. Singh RK, Singh SK, Ojha RK, Singh C. Flowering and fruiting behavior of different mango cultivars under Jharkhand condition. Environment and Ecology. 2009;27:2013-2015.
10. Kishore K, Singh HS, Kurian RM, Srinivas P, Samant D. Performance of certain mango varieties and hybrids in east coast of India. Indian Journal of Plant Genetic Resources. 2015;28(3):296-302.
11. Mukherjee SK, Litz RE. The mango: Botany production and uses. 2nd Edition. CAB international, Wallingford, UK; 2009.
12. Azam K, Mir H, Kumar R, Ahmad F. Study on flowering behaviour of elite mango cultivars in subtropical conditions of Bihar. International Journal of Chemical Studies. 2018;6(2):2913-2917.
13. Shi-Jin O, Zhu JH, Hong-Xiang P, Tai-Ming H, Q.-G. He, X- Xu H, Ning H. Relationship between humidity, temperature and hermaphrodite flower ratio of Kate mango Chin. J. Ecol. Agric. 2007;5:21-25.
14. Majumder DAN, Hassan L, Kabir MA. Genetic Diversity of Mango (*Mangifera indica* L., Anacardiaceae) Detected by RAPD Markers. IJAEB. 2011;4(1):45-51.
15. Rymbai H, Laxman RH, Dinesh MR, Johnsunoj VS, Ravishankar KV, Jha AK. Diversity in leaf morphology andphysiological characteristics among mango (*Mangifera indica*) cultivarspopular in different agro-climatic regions of India. Sci. Hort. 2014;176:189–193.