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Phenological characterization of different mango genotype under Sabour condition

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Abstract
The present investigation was carried out during 2019-20 in the Department of Horticulture (Fruit & Fruit Technology), Bihar Agricultural College, Sabour, Bhagalpur, Bihar. Twenty mango genotypes were taken for the experiment with the objective to study the phenological behaviour and incidence of malformation. Wide variability was recorded for different phenological traits. Earliest bud break and panicle emergence was recorded in the cultivar Zardalu (25th January and 1st February, respectively). Maximum flowering intensity with highest number of flowers panicle^{-1} as well as maximum hermaphrodite flower was recorded in the cultivar Langra (77.87%, 943.00 and 69.44%, respectively). However, no malformation recorded in the cultivar Langra, Zardalu, Alphonso and Bombay. Hence, it could be concluded that the cultivar Langra, Bombay and Zardalu can be used in breeding programme for developing new hybrids having precocity in flowering with increased flowering intensity, maximum number of hermaphrodite flowers and resistance to mango malformation.

Keywords: flowering intensity, hermaphrodite flower, mango, malformation, phenological traits

Introduction
Mango (*Mangifera indica* L.) belongs to the family, Anacardiaceae is the most important fruits of the tropical and subtropical part of the world. It has the chromosome number 2n = 4x = 40. The Indo-Burma region is the main centre of origin of mango. Mukherjee (1951) [12] reported that the existence of the wild form of *Mangifera indica*, its associated species which supports its Indian origin and the cultivated nature, is apparently due to allopolyploidy, likely amphidiploidy. Mango is a nutritionally complete fruit and the nutrient benefits of mango varies from varieties and the period of growth. It is an excellent source of vitamin A (4800 IU 100 g^{-1}). It also contain 8.8 per cent fat, 0.01 per cent starch and several other nutrients. Mango is India's award-winning summer popular fruit with over 1,000 recognised varieties eaten as fresh. Besides, it also has good demand in the processing industries for the preparation of various processed products including squash, nectar, jam, leather, pickles and amchoor, etc.
Mango is evergreen trees of semi vigorous to vigorous growth and can grow to a height of 25 metres in optimal conditions. India is the world's largest mango producer contributing for around 50 percent of overall global production. It is the national fruit of India commonly cultivated for its unique features such as high nutritious values with pleasant taste. It is a well adopted crop under the climate condition of Bihar. In Bihar, the annual production of mango is 14.81 lakh tons from an area coverage of 1.52 lakh hectare with the productivity of 8 t/ha (Anonymous, 2018) [3].
Due to the wide range of diversity in the cultivated mango varieties throughout the countries, the morpho-phenological attributes of different mango cultivars are also varied significantly among the cultivars (Joshi *et al.*, 2014). Under tropical and sub-tropical climate, the flower bud differentiation takes place on the 6-8 months old shoots during the month of October-November. Phenological activity, thus, plays an integral role in the flower initiation in mango. Phenology is the advancement of any plants demonstrating the recognisable stages of growth. It depends on the environmental factors and the adaptation capacity of the plants to a particular environment. Under subtropical environments, vegetative growth flushes develop at mild temperatures of about 25 ºC or higher (Nunez-Eliséa *et al.*, 1996) [13] while flower induction process initiated at 5–15 ºC. The amount of flushes emerging depends on the cultivar, the size of the tree and the growth environment (Davenport, 2000) [8].
Mango plant does not develop flowers uniformly in both directions of the tree canopy and at least two different flushes are observed.

The panicles on the eastern and south-eastern sides of the tree begin to bloom. The number of flowers in a single panicle ranges between 1000-6000, depending on the variety and the maturity of the shoots. Floral initiation in mango is the transient engagement of buds to invoke a specific direction of development (*i.e.* vegetative shoots, generative shoots or mixed shoots) when growth is stimulated (Davenport, 2009) [9]. Tightly correlated with the initiation of a shoot, induction happens on the basis of circumstances at the moment of initiation (Davenport, 2000) [8].

Although the crop shows several infections by diseases such as powdery mildew, anthracnose, black spot, gummosis etc., but mango malformation is one of the most harmful problem responsible for significant deterioration of yield of the crop. Hence, it is very important to study the diversity of the existing mango cultivars for morpho-phenological traits as well as the resistance of the cultivars against mango malformation. Keeping these views in mind, the present research work was formulated to characterize the morpho-phenological attributes and malformation intensity in different mango genotype under Sabour condition.

Materials and Methods

An investigation was carried out in the Department of Horticulture (Fruit & Fruit Technology), Bihar Agricultural University, Sabour, Bhagalpur, Bihar during 2019-20. Bihar Agricultural College, Sabour, situated between 25º15'40" North latitude and 87º2'72" East longitude and at an elevation of 45.72 m above mean sea level in the focal point of giant alluvial Gangetic fields of North India, South of River Ganga. Mostly silty loam soil was found in this region which has highest water holding capacity. The climate of Sabour is subtropical with distinct summer months, cold and dry winter with a typical yearly precipitation of around 1150 mm especially between middle of June to middle of October. The experiment was conducted on mango plants growing in the Horticulture Garden and orchard of AICRP (Fruits) of Bihar Agricultural University, Sabour, Bhagalpur.

Materials

Twenty mango cultivars of nearly similar age namely Alphonso, Amrapali, Bombay, Dashehari, Kent, Kurukkan, Langra, Lilli, Mulgoa, Mylepelian, Nisar Pasand, Prabha Shankar, Pusa Shreshtha, Pusa Surya, Sindhu, Sonpari, Suvarna, Swarnarekha, Tommy Atkins and Zardalu were chosen for the experiment.

Observations recorded

The 1st bud break (appearance) was recorded among the 25 tagged shoots by observing the plants regularly during the period of bud break. Branches arising from the core trunk were tagged and used to count the total number of panicles per branch. The panicle length was recorded with the help of measuring scale from the panicle base to the panicle apex. An average of 10 panicle length was taken for calculating average length of the panicle. Panicle breadth was recorded by measuring at the point where it is maximum with the help of measuring scale. Days to 50% flowering from panicle emergence was measured by observing the tagged panicle every day after panicle emergence and the number of days was determined from the day of panicle initiation to the days when 50% flowers bloomed on the panicle. Flowering duration was calculated by counting the number of days taken by the plant from the anthesis of 1st flower to last one. Total number of flowers per panicle was recorded by counting all the flower of a single panicle for ten panicles per plant and average flowers per panicle was calculated thereafter. To obtained the flowering intensity, counting of total the number of shoots bearing flowering panicles per square meter canopy in all the directions to each plant was done and the equation was used for calculating flowering intensity-

$$\text{Flowering intensity} = \frac{\text{No. of flowering shoots}}{\text{Total no. of shoots}} \times 100$$

Thereafter, total number of hermaphrodite flowers per panicles was counted and the per cent of hermaphrodite flower was calculated with the help of following formula-

$$\text{Hermaphrodite flower (\%)} = \frac{\text{No. of hermaphrodite flower}}{\text{Total number of flowers}} \times 100$$

Percentage of malformed panicles was calculated by counting the total numbers of healthy and malformed panicles on the twenty-five tagged shoots of individual tree. Per cent of malformation was calculated thereafter using following formula-

$$\text{Malformation percent} = \frac{\text{No. of malformed panicle per plant}}{\text{Total number of Panicle per plant}} \times 100$$

Statistical analysis

The observations were subjected to statistical analysis by using randomized block design (RBD) with three replications. Mean difference were tested by 'F' test at five per cent level of significance (LOS). Critical difference (CD) at 5 per cent level of significance was used for comparison among treatments. Data were analyzed using statistical analysis software (OPSTAT, HAU, Hissar).

Results and Discussions

The experimental results revealed that the time of 1st bud break of different mango cultivars ranged between 25th January to 11th February (Table 1). Earliest bud break was recorded in the cultivars Zardalu and Bombay (25th January) followed by Nisar Pasand (27th January), Mulgoa (28th January), Alphonso and Mylepelian (29th January), Kurakkan and Swarnarekha (31st January). However, the late bud break was recorded in the cultivar Suvarna (11th February) followed by Pusa Shreshtha and Amrapali (10th February). Azam *et al.* (2018) [2] also reported earliest bud break in Bambay and Zardalu cultivar of mango. Numbers of panicles per branch of different mango cultivars as present in the table 1 indicates a significant variation among the cultivars with the range between 662.66 to 57.33 panicles per branch. The results clearly indicated that the number of panicles per branch was highest in the cultivar Langra (662.66) followed by the cultivar Mulgoa (476.66), Alphonso (471.66), Pusa Shreshtha (457.33) and Dashehari (442.66) whereas the least number of panicles per branch was observed in the cultivar Lilli (57.33) with at par value in the cultivars Tommy Atkins (64.00). This variation might be due to the genetical differences among the cultivars its collaboration with the atmosphere (Chandra *et al.*, 2001) [6]. The results confirm the earlier findings of Sudah *et al.*, (2012) [15].

On the other hand, the panicle length of different mango cultivars under this investigation was also differed significantly among the cultivars (Table 1). Maximum panicle length was estimated in the cultivar Lilli (35.23 cm) which was statistically at par with the cultivar Pusa Shreshtha, Langra, Bombay, Kent, Alphonso and Swarnarekha (34.20, 33.83, 33.26, 32.7, 32.56 and 31.45 cm, respectively). However, the minimum length of panicles was measured in the cultivar Mylepelian (16.66 cm) with at par value in Kurukkan (19.16 cm). Uthaiah *et al*. (1988) [17] reported that length of panicle range between 12.40 cm to 38.60 cm in 29 mango genotypes growing under costal Karnataka condition. Maximum breadth of panicle was observed in the cultivar Swarnarekha (20.66 cm) followed by the cultivar Kurukkan, Dashehari, Langra, Prabha Shankar and Pusa Shreshtha (16.76, 16.75,15.46, 15.16 and 15 cm, respectively). However, the minimum panicle breadth was recorded in the cultivar Mylepelian (10.06 cm) with at par value in the cultivars Pusa Surya, Mulgoa, Tommy Atkins, Sonpari and Amrapali (10.23, 10.53, 11.1, 11.16 and 11.24 cm, respectively). Flowering is generally associated with end of dormancy of the terminal growth (Chacko *et al*. 1971) which generally ends with the raise of temperature in subtropical conditions. The age of the last flush has positive correlation with flowering in mango (Ramirez and Davenport, 2010) [14]. The days to 50% flowering from panicle initiation varied significantly among different mango cultivars and ranged between 14.3 to 27.3 days (Table 2). 50% flowering was observed earliest in the cultivar Prabha Shankar and Dashehari (14.30 days) with at par value in the cultivars Kurukkan and Swarnarekha (16.33 days). The cultivar Tommy Atkins took maximum days after panicle initiation to complete its 50% flowering (27.30 days). Gangwar and Moti (1974) [10] also reported significant variation for the flowering time of 12 mango genotypes. A significant difference has been observed for flowering duration in different mango cultivars under the present investigation (Table 2). Cultivars Mulgoa was estimated to have longest flowering duration (31.66 days) which was statistically at par with the cultivar Dashehari (30.33 days). However, minimum flowering duration was estimated in the cultivar Amrapali (17.33 days) followed by the cultivars Kent (21.33 days), Sindhu and Lilli (22.33 days), Zardalu (23.33 days).

A perusal of information presented in the table 2 demonstrates that the flowering intensity of the twenty mango cultivars differed significantly from each other. Percent of flowering intensity was estimated in the cultivar Langra (77.87%) which was statistically at par with the cultivar Swarnarekha (76.75%) and Bombay (75.49%). However, lowest flowering intensity was observed in the cultivar Pusa Surya (26.04%) followed by the cultivar Sindhu (32.40%), Tommy Atkins (34.77%) and Kent (37.44%). Davenport, (2003) [7] reported high intensity of flowering in some cultivars of mango might be due to the synchronization in the shoot maturity for flowering in the tropics and it is primarily controlled by the age of the opening shoots along with a high level of florigen promoter.

The maximum number of flowers on a single panicle was estimated in the cultivar Langra (943.00) followed by the cultivars Zardalu, Dashehari, Bombay and Pusa Shreshtha present in the table 3 (9.54%, 16.11%, 20.78% and 31.49% lower than the Langra, respectively). However, lowest number of flowers per panicle was reported in Mylepelian (218.00) followed by the cultivars Kurukkan (16.06% higher than the Mylepelian). Anjum *et al*. (1999) [1] reported that the total number of flowers/panicles ranged between 664- 1675. Likewise, Thimmappaiah and Suman (1987) [16] studied 13 mango genotypes and observed that the flowers/panicles ranged between 302 - 994.

The percent of hermaphrodite flowers also differed significantly among different mango cultivars (Table 3). The maximum percent of hermaphrodite flowers was observed in the cultivar Langra (69.44%) followed by the cultivars Suvarna (58.18%), Kent (57.27%), Sonpari (54.46%) and Pusa Shreshtha (52.27%). However, the minimum hermaphrodite flower was recorded in the cultivar Mylepelian (18.80%) followed by Swarnarekha (26.30%), Dashehari (27.46%), Sindhu (28.21%). Vijayalakshmi and Srinivasan, (2002) [18] reported that development of perfect flowers required more reserves from the tree than staminate flowers.

The data on the incidence of mango malformation presented in the table 3. The highest percent of malformation was observed in the cultivar Mylepelian (32.34%) which was followed by the cultivars Kurukkan (24.32%), Tommy Atkins (22.64%), Amrapali (17.24%) and Pusa Surya (12.90%) whereas, no malformation was observed in the cultivars Zardalu, Langra, Bombay and Alphonso. Chakrabarti *et al*. (1990) [5] reported that maximum concentration of mangiferin in diseased tissues may decrease the level of *Fusarium* sp. infection inside the diseased tissue.

Table 1: Phenological behavior of different cultivars of mango

Cultivars	Time of 1st bud break	Number of panicles per branch	Length of panicles at anthesis (cm)	Breadth of panicle (cm)
Alphonso	29th January	471.66	32.56	13.30
Amrapali	10th February	108.66	27.33	11.24
Bombay	25th January	433.00	33.26	13.75
Dashehari	03rd February	442.66	28.27	16.75
Kent	09th February	91.33	32.70	12.33
Kurukkan	31st January	75.65	19.16	16.76
Langra	05th February	662.66	33.83	15.46
Lilli	07th February	57.33	35.23	13.33
Mulgoa	28th January	476.66	31.03	10.53
Mylepelian	29th January	98.59	16.66	10.06
Nisar Pasand	27th January	395.00	26.16	13.33
Prabha Shankar	08th February	134.00	25.16	15.16
Pusa Shreshtha	10th February	457.33	34.20	15.00
Pusa Surya	08th February	85.33	26.13	10.23
Sindhu	02nd February	108.66	29.23	12.29
Sonpari	06th February	205.81	26.33	11.16

Suvarna	11th February	313.33	30.16	12.16
Swarnarekha	31st January	134.66	31.45	20.66
Tommy Atkins	02nd February	64.00	23.00	11.10
Zardalu	25th January	367.33	24.03	13.46
CD (P ≤ 0.05)	-	11.65	3.94	1.62
SE(m)	-	4.05	1.37	0.56
CV (%)	-	2.71	8.39	7.25

Table 2: Flowering behavior of different mango cultivars

Cultivars	Days to 50% flowering from panicle emergence (Days)	Flowering Duration (Days)	Flowering intensity (%)
Alphonso	19.30	28.66	73.70
Amrapali	19.67	17.33	67.26
Bombay	17.30	27.33	75.49
Dashehari	14.30	30.33	68.08
Kent	25.30	21.33	37.44
Kurukkan	16.30	24.33	52.73
Langra	23.67	24.66	77.87
Lilli	25.30	22.33	41.38
Mulgoa	21.67	31.66	63.41
Mylepelian	19.67	23.66	56.14
Nisar Pasand	17.33	27.66	71.28
Prabha Shankar	14.30	26.66	45.46
Pusa Shreshtha	45.46	23.66	59.65
Pusa Surya	18.30	28.66	26.04
Sindhu	23.67	22.33	32.40
Sonpari	20.30	24.33	53.47
Suvarna	22.67	26.33	49.50
Swarnarekha	16.33	28.33	28.33
Tommy Atkins	27.30	25.33	34.77
Zardalu	24.33	23.33	73.55
CD (P≤0.05)	2.51	2.76	4.05
SE(m)	0.87	0.96	1.41
CV (%)	7.38	6.56	4.29

Table 3: Flowering behavior and incidence of malformation in different mango cultivars

Cultivars	Total number of flowers per panicle	Hermaphrodite flowers (%)	Malformed panicles (%)
Alphonso	540.00	46.80	0.00
Amrapali	406.00	38.03	17.24
Bombay	747.00	37.60	0.00
Dashehari	791.00	27.46	5.30
Kent	425.00	57.27	8.20
Kurukkan	253.00	39.16	24.32
Langra	943.00	69.44	0.00
Lilli	510.00	43.38	2.40
Mulgoa	577.00	33.47	6.60
Mylepelian	218.00	18.80	32.34
Nisar Pasand	398.00	34.75	5.80
Prabha Shankar	454.00	48.25	2.10
Pusa Shreshtha	646.00	52.27	8.50
Pusa Surya	311.00	43.26	12.90
Sindhu	298.00	28.21	4.80
Sonpari	366.00	54.46	4.37
Suvarna	489.00	58.18	7.53
Swarnarekha	297.00	26.30	2.80
Tommy Atkins	343.00	38.07	22.64
Zardalu	853.00	38.26	0.00
CD (P≤0.05)	12.47	3.75	1.76
SE(m)	4.34	0.99	0.62
CV (%)	1.52	3.91	12.62

Conclusion

Based on finding it could be concluded that the morpho-phenological behaviour of different cultivar are differ significantly. Highest percent of flowering intensity, maximum number of flowers per panicle and highest percent of hermaphrodite flower was recorded in Langra. Zardalu, Alphonso and Bombay have lowest malformation percent. So, these varieties should be used for the breeding programme for improving yield with minimum susceptibility of mango malformation.

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References

1. Anjum MA, Chattha GA, Sultan M, Abbas S. Studies on flowering behavior, fruit setting and extent of floral malformation in different cultivars of mango (*Mangifera indica* L.). Int. J. Agric Biol 1999;1(3):88-90.
2. Azam K, Mir H, Kumar R, Ahmad F. Study on flowering behaviour of elite mango cultivars in subtropical conditions of Bihar, Int. J Chem. Stud. 2018;6(2):2913-2917.
3. Anonymous. Horticultural statistics at a glance. Horticulture Statistics Division, Department of Agriculture, Cooperation and Farmers' Welfare, Ministry of Agriculture and Farmers' Welfare, Government of India. India Offset Press, New Delhi 2018.
4. Chacko EK, Randhawa GS. Towards an understanding of the factors affecting flowering in mango. Andhra Agril. J 1971;18:226-236.
5. Chakrabarti DK, Singh A, Singh K. Physiological and biochemical changes induced by accumulated mangiferin in Mangifera indica. J. Hortic. Sci 1990;65(6):731-737.
6. Chandra A, Roy DP, Lenka PC. Studies on floral character of mango cultivar and hybrids under agroclimatic conditions of Orissa. Orissa J. Hortic. 2001;29(1):29-33.
7. Davenport TL. Management of flowering in three tropical and subtropical fruit tree species. Hort Science, 2003;38:1331-1335.
8. Davenport TL. Processes influencing floral initiation and bloom: The role of phytohormones in a conceptual flowering model. Hort. Technol. 2000;10:733-739.
9. Davenport TL. Reproductive physiology. *In*: Litz, R.E. (Ed.), The Mango: Botany Production and Uses, 2nd edition, CAB International, Wallingford, UK, 2009, 97-169.
10. Gangwar BM, Moti A. Study on flowering, fruiting behaviour, maturity, yield and quality of some late mango varieties, Prog. Hortic 1974;5(4):61-68.
11. Joshi R, Kundu M, Singh CP. Morphological Characters: Efficient Tool for Identification on Different Mango Cultivars. Environ. Ecol 2013;31(1A):385-388.
12. Mukherjee SK. Origin of mango. Indian J. Genet. Plant Breed 1951;11:49-56.
13. Nuñez-Elisea R, Davenport TL, Caldeira ML. Control of bud morphogenesis in mango (*Mangifera indica* L.) by girdling, defoliation and temperature modification. J Hortic Sci 1996;71:25-40.
14. Ramirez F, Daveport TL. Mango (*Mangifera indica* L.) flowering physiology, Scientia Hortic 2010;6:65-72.
15. Sudha R, Balamohan TN, Soorianathasundaram K. Effect of foliar spray of nitrogenous chemicals on flowering, fruit set and yield in mango (*Mangifera indica* L.) cv. Alphonso. J. Hortic. Sci 2012;7(2):190-193.
16. Thimmappaiah CL, Suman D. Sex in relation to fruit set and fruit yield in mango. Punjab Hortic. J 1987;27:8-11.
17. Uthaiah BC, Indiresh KM, Hussain ISA, Rao KB, Hanummaiah H. Flower and sex variation in mango varieties under coastal Karnataka. Prog. Hortic 1988;20:120-123.
18. Vijayalakshmi D, Srinivasan PS. Impact of chemicals and growth regulators on induction of flowering in "off" year mango cv. Alphonso. Orissa J. Hortic 2002;30(2):32-34.