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# Study on flowering behaviour of elite mango cultivars in subtropical conditions of Bihar

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**Abstract**
Flowering is a decisive factor in the productivity of mango. Twenty mango cultivars were studied for the flowering behaviour at Bihar agricultural university, sabour. The perusal of data recorded showed the earliest bud break in cultivar Bombay Green on 19th January followed by Bombai and Zardalu on 26th January. However, SB Chausa, Fazli and Neelum recorded a very late bud break. Maximum numbers of panicles were found in the cultivar Langra (2275) while the minimum number of panicle was found in Neelum (587). Maximum panicle length was observed in SB Chausa (34.5 cm) while minimum was found in Bombay green (17.25 cm) followed by Neelum (20.75 cm). There were differences between cultivars for the date of first flower opening and in the time and duration of peak flowering. There is, therefore, a possibility of carrying out selection for earliness as well as duration of flowering. In terms of the flower types, staminate flowers were first to appear in all the cultivars followed by hermaphrodite one. The cultivar Langra showed maximum percentage of hermaphrodite flower (73.86%) while minimum hermaphrodite flower percentage was found in Swarnarekha.

**Keywords:** Mango, floral biology, inflorescence

## Introduction

Mango (*Mangifera indica* L.), one of the oldest and the most popular fruits of tropics and subtropics belongs to the family Anacardiaceae which comprises of 73 genera and about 830 species and has its origin in the northern foothills of India-Myanmar region (Yamanaka *et al.*, 2006) [24]. Among the fruits, mango is one of the best tropical fruit in the world market due to its excellent flavour, attractive fragrance, beautiful colour, delicious taste and health giving properties. It is undoubtedly the most important fruit crop of India. Its popularity and importance can easily be realised by the fact that it is often referred as 'king of the fruits 'in the tropical world (Singh, 1996) [20, 21]. Mango has been reported to have extensive diversity due to allopolyploid, out breeding and phenotypic differences arising from varied agro climatic conditions in different mango growing regions (Ravishankar *et al.*, 2000) [12]. Owing to its wide range of diversity and adaptability, mango is found to grow in different tropical and subtropical parts of India. India produces nearly 56.6% of the total mango production of the world. The major states in mango production are Uttar Pradesh, Andhra Pradesh, Maharashtra, Bihar, Orissa, Karnataka, west Bengal and Gujarat.

Flowering behaviour, sex expression, yield and physico-chemical attributes of mango varieties are important determinants of assessing their performance. Flowering is a decisive factor in the productivity of mango and is more or less a varietal character mainly influenced by weather conditions. It has been observed that the flowering pattern of mango cultivars expresses differentially under tropical and subtropical conditions (Davenport, 2003) [4]. The process associated with mango flowering involves shoot initiation followed by floral differentiation, and panicle emergence (Murti and Upreti, 2000) [9]. All these developmental events occur in most of the mango cultivars during October-December under tropical as well as subtropical conditions. The induction of floral bud formation is correlated with the prevailing environmental conditions as well as age of terminal resting shoots (Davenport, 2007) [5].

Evaluation of mango varieties for a given set of ecology is one of the pre-requisites for successful mango cultivation (Singh and Singh 1996) [20, 21]. Mango flowering is greatly influenced by the weather conditions and varietal genotypes and is most important traits as it directly affects the yield.

The flowering period of mango is of short duration lasting for 2 to 3 weeks. Mango is andromonoecious and the plant bears both staminate and perfect flowers on same panicle. The distribution pattern, intensity of both types of flowers varies with cultivar, bloom time and environmental factors (Singh, 1960) [22]. In Bihar, the flowering period starts from February and extend up to March. A study pertaining to flowering behaviour of commercial cultivars of mango has significant implications on the mango production scenario in Bihar. The limited reports on the floral biology of popular cultivars of mango in our region prompted us to analyse the behaviour of this critical biological event among twenty popular mango cultivars of Bihar.

## Materials and Methods

The present study was undertaken to evaluate the popular mango cultivars of Bihar for flowering traits at Bihar Agricultural University, Sabour, Bhagalpur, Bihar. The university is situated between 25º15'40" North longitude and 45.72 meters above mean sea level. The climate of Sabour is semi-arid, subtropical with hot desiccating summer and cold frostless winter. The experiment was conducted during the flowering season of mango beginning from January 2016 at AICRP (Fruits) garden at sabour, Bhagalpur on twenty cultivars of mango. The experiment was laid out in randomised block design (RBD) with four replications. The observations were made on a daily basis to determine the time of emergence of panicles from January to March. Panicle length was measured using a measuring scale from shoot apex to panicle apex. An average of ten panicles was taken for calculating mean value for panicle length. Panicle breadth at its maximum point was recorded with the help of measuring scale, expressed in centimetres (cm). Reproductive shoots (panicle bearing) per square meter canopy were counted in all directions in the replicates and the flowering intensity was worked out with the following formula:

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

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 following equation:

$$\text{Percent Hermaphrodite flowers} = \frac{\text{No. of hermaphrodite flowers X 100}}{\text{Total no. of flowers}}$$

The total number of flowers per panicle was counted in non-sacrificing method by taking ten fully opened panicles (one on each experimental tree) and average was calculated. Total number of panicles was counted by counting the panicles in one fourth part of the tree and multiplying it by four for the whole tree.

## Results and Discussions

Observations tabulated in Table 1 ascertained that the mango genotypes varied for the time of bud break. January and February months were observed to be the most crucial period for bud break and panicle initiation and February and March for 50% flowering in majority of the mango varieties. There was variation in mango varieties for panicle initiation and peak flowering during the study period. Out of twenty mango cultivars Bombai green had very early bud break on 19th January followed by Bombai and Zardalu on 26th January. However, SB Chausa, Fazli and Neelum recorded very late bud break. Mankurad, Beneshan, Alphonso, Dashehari and Krishnabhog had bud break on 29th January. While Langra, Mulgoa, Fernandin, Mallika and Bangalora showed bud break during 1st February to 4th February. The variations observed in terms of panicle emergence may be due to the differences in genetic makeup of the parental mango genotypes. Flowering in mango is commonly related with dormancy of the terminal growth which is controlled by low temperature in subtropics (Chacko *et al.*, 1971) [1]. The seasonal cyclic change of growth, flower, fruit and their development differ between cultivars and location. The variation observed in terms of panicle initiation might be due to the differences in 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. Also reported variation in panicle initiation mango varieties and grouped Swarnarekha, Vanraj, Langra, Kesar and Fernandin as early, while Neelum, Fazli, Bangalora and Mulgoa as late cultivars. Time of appearance of 50% flower varied from 2nd February in Bombay green to 27th February in Himsagar. Langra, Neelum, Himsagar, Bangalora showed the appearance of 50% flower from 21st February to 27th February. The differences observed in terms of time of appearance of 50% flower stage among parental mango cultivars might be attributed to the genetic differences and interaction of genetic- environmental factors (Singh *et al.* 2014).

**Table 1:** Flowering behaviour of twenty mango cultivars

| S. No | Cultivars | Time of Bud break | Time of appearance of 50% flower | Period from bud break-Full bloom (Days) | Period from full bloom-maturity (Days) | Flowering duration (Days) | Number of Panicle/tree |
|---|---|---|---|---|---|---|---|
| 1. | Langra | 2 Feb | 22 Feb | 33.00 | 109.25 | 30.75 | 2275.00 |
| 2. | Zardalu | 26 Jan | 20 Feb | 37.00 | 98.75 | 23.25 | 1763.75 |
| 3. | Mankurad | 29 Jan | 21 Feb | 36.00 | 129.25 | 29.75 | 757.00 |
| 4. | Mulgoa | 4 Feb | 13 Feb | 33.50 | 125.00 | 31.50 | 1275.00 |
| 5. | Fernandin | 2 Feb | 14 Feb | 30.50 | 118.75 | 28.50 | 877.50 |
| 6. | Swarnarekha | 31 Jan | 15 Feb | 34.25 | 121.25 | 29.00 | 1380.00 |
| 7. | Baneshan | 29 Jan | 15 Feb | 38.00 | 135.75 | 33.50 | 2262.50 |
| 8. | Alphanso | 29 Jan | 12 Feb | 31.00 | 115.25 | 25.50 | 1247.50 |
| 9. | Dashehari | 29 Jan | 17Feb | 36.00 | 106.50 | 32.50 | 1405.50 |
| 10. | Bombai | 26 Jan | 16Feb | 38.50 | 103.00 | 29.25 | 1437.50 |
| 11. | Bombai green | 19 Jan | 2 Feb | 25.75 | 114.00 | 25.25 | 1827.50 |
| 12. | Fazli | 7 Feb | 15 Feb | 37.00 | 148.25 | 31.25 | 897.00 |
| 13. | SB Chausa | 11 Feb | 19 Feb | 38.50 | 145.50 | 28.25 | 1155.00 |
| 14. | Neelum | 13 Feb | 22 Feb | 37.00 | 141.50 | 18.25 | 587.50 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 15. | Kesar | 30 Jan | 15 Feb | 34.00 | 118.25 | 32.00 | 1287.50 |
| 16. | Vanraj | 30 Jan | 18 Feb | 40.50 | 129.00 | 23.75 | 1344.75 |
| 17. | Krishnabhog | 29 Jan | 18 Feb | 44.50 | 133.50 | 23.00 | 1992.50 |
| 18. | Hemsagar | 3 Feb | 27 Feb | 34.25 | 93.75 | 13.50 | 1350.00 |
| 19. | Mallika | 4 Feb | 17 Feb | 37.75 | 117.25 | 20.75 | 1910.00 |
| 20. | Bangalora | 3 Feb | 21 Feb | 28.25 | 141.25 | 25.50 | 1300.00 |
| C.D. (at 5%) | | - | - | 2.044 | 6.747 | 2.278 | 237.62 |
| c.v. | | - | - | 4.082 | 3.887 | 5.997 | 11.815 |

Flowering duration among the mango cultivars differed and it ranged between 13.5 to 33.5 days. The maximum duration of flowering was noticed in Beneshan (33.5 days) which was at par with Mulgoa, Dashehari, Fazli and Kesar. Minimum flowering duration was observed in Himsagar (13.5). Out of 20 cultivars studied, the flowering duration was more than 20 days in all the cultivars but less than 30 days in Bangalora, Mallika, Krishnabhog, Bombai green, Bombai, Alphonso, Swarnarekha, Fernandin, Mankurad and zardalu whereas, the flowering duration of Langra, Mulgoa, Dashehari, Fazli, and Kesar, ranged between 30-33 days. Schnell and Knight (1998) [14] studied three variables (days to bloom, days in bloom and days in bloom and fruit) for six years in eight mango cultivars to characterize the phenology of flowering and observed significant differences in flowering responses among cultivars. They concluded that the repeatability of each of the flower phenology character was high indicating that much of these variations was heritable and useful for further breeding. Similarly, Pandey and Kumar (2006) [11] studied flowering behaviour of 10 mango hybrids and found that the maximum duration of panicle emergence was in Langra (55.11 days), IIHR-51(45.39 days), Amrapali (44.86 days) and IIHR-10 (44.41 days). The duration of the flowering season ranged from 34.00 days in Langra to 12.00 days in Prabhashankar. Observations pertaining to panicle size in the present study revealed that there is significant variation observed in length of panicle among the 20 mango cultivars. Maximum panicle length was observed in SB Chausa (34.5 cm) while minimum was found in Bombay green (17.25 cm) followed by Neelum (20.75 cm). Singh *et al.* (2015) [15] also recorded panicle length in Bombay green (17.56 cm) under Tarai conditions of Uttarakhand. The variation in the panicle length among cultivars is due to the genetic constitution of the cultivars and their interaction with the environmental conditions and more specifically the physiological conditions of shoot (Singh *et al.* 2014) [6]. Singh *et al.* 2015 [15] also reported that the variation among the mango genotypes is due to genetic constitution of varieties and their interaction with environmental conditions.

Significant variations were found for Period from bud break-full bloom. Krishnabhog took maximum time (44.5 days) from bud break to full bloom while cultivar Bombay Green took minimum time (26 days) for bud break to full bloom. Yadav *et al.* (2010) [23] studied ten mango cultivars and found that for their flowering and fruiting behaviour and found that time of full bloom ranged from 1st to 3rd week of March. Blooming was earliest in Dashehari, Chausa and Langra whereas late blooming noted in Luckhnow Safeda.

There was significant variation in the cultivars with respect to period taking for full bloom to maturity. Cultivar Fazli took maximum time (148 days) from full bloom to maturity which was statistically at par with SB Chausa, Neelum and Bangalora while the cultivar Himsagar took only 94 days from full bloom to maturity. Kishore *et al.* (2015) [6] 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.

Data pertaining to flowering intensity is given in Table 2. Data reveals that maximum flowering intensity is found in the cultivar Langra (78%) while minimum flowering intensity was found in vanraj (45%). Kumar *et al.* (2014) [7] also reported variation in flowering intensity in mango varieties under tropical condition. The high intensity of flowering in some of the mango varieties may be due to the synchronisation in the shoot maturity as flowering in the tropics is primarily regulated by the age of the initiating shoots as well as high level of florigenic promoter (Davenport, 2003) [4]. Maximum number of panicle was found in the cultivar Langra (2275) which was statistically at par with Beneshan while the minimum number of panicle was found in Neelum (587). Chandra *et al.* (2001) [2] reported the total number of panicles ranged from 1236 in Kesar to the maximum in Mallika (10, 377). The total number of panicle in a cultivar greatly depends on the genetic potential of the cultivar, its interaction with the environment and varies with place and season.

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 (Mukherjee and Litz, 2009) [8]. The intensities of the male and perfect flower varies with the varieties, position of panicle and climatic conditions. The number of hermaphrodite flowers showed statistically significant variation among parental mango cultivars. There was significant variation in the percentage of hermaphrodite flowers. Langra showed maximum percentage of hermaphrodite flower (73.86%) while minimum hermaphrodite flower percentage was found in Swarnarekha (15.79%). Total number of flowers ranged between 247.5 in Swarnarekha to 942 in Langra. In general, it was observed that per cent hermaphrodite flowers were less in early emerged panicles compared to late emerged panicles in all the parental mango cultivars. The variability in the perfect and staminate flower ratio may be governed by physiological and environmental conditions. Most studies indicated that although the total number of flower is substantially less in the distal half of the panicles, there is greater proportion of perfect flowers in this region (Davenport and Nunez-Elisea, 1997) [3]. The lesser number of hermaphrodite flowers in early emerged flowers may be attributed to the fact that cool weather during inflorescence contributes to the fewer perfect flowers (Naik and Rao, 1943, Singh *et al.*, 1966) [20, 21]. Present results are in strong conformity with the findings of Singh *et al.* (1966) [20, 21]. who reported that the panicles emerging during the middle and end of flowering season produce two and seven times more perfect flowers, respectively, than the early breaking panicles.

**Table 2:** Flowering behaviour of twenty mango cultivars

| S. No | Cultivars | Length of panicle (cm) | Breadth of panicle (cm) | Flowering intensity (%) | Number of flowers/panicle | Hermaphrodite Flowers (%) |
|---|---|---|---|---|---|---|
| 1. | Langra | 25.87 | 15.75 | 77.92 (61.96) | 942.25 | 73.86 (59.23) |
| 2. | Zardalu | 24.75 | 13.5 | 73.25 (58.85) | 282.25 | 39.10 (38.69) |
| 3. | Mankurad | 23.00 | 11 | 56.24 (48.57) | 312.5 | 41.37 (40.01) |
| 4. | Mulgoa | 28.26 | 14 | 63.25 (52.67) | 337.5 | 34.00 (35.65) |
| 5. | Fernandin | 20.50 | 9.87 | 49.14 (44.48) | 637.5 | 52.13 (45.610) |
| 6. | Swarnarekha | 31.50 | 22 | 75.02 (60.01) | 247.5 | 15.79 (23.39) |
| 7. | Baneshan | 25.25 | 17.75 | 64.75 (53.56) | 479.5 | 45.54 (42.42) |
| 8. | Alphonso | 27.50 | 12 | 74.14 (59.43) | 452.0 | 47.16 (43.35) |
| 9. | Dashehari | 26.75 | 16.75 | 68.22 (55.68) | 607.5 | 24.55 (29.68) |
| 10. | Bombai | 29.00 | 11.62 | 75.62 (60.42) | 327.5 | 38.87 (38.55) |
| 11. | Bombay Green | 17.25 | 10.25 | 69.49 (56.46) | 347.0 | 38.58 (38.38) |
| 12. | Fazli | 24.62 | 14.25 | 59.375 (50.39) | 497.5 | 41.74 (40.22) |
| 13. | SB Chausa | 34.50 | 18 | 54.8 (47.738) | 397.5 | 36.74 (37.29) |
| 14. | Neelum | 20.75 | 10.25 | 68.5 (55.86) | 262.5 | 36.88 (37.37) |
| 15. | Kesar | 22.75 | 10.12 | 58.465 (49.86) | 510.0 | 29.975 (33.181) |
| 16. | Vanraj | 24.37 | 12.37 | 45.4 (42.34) | 317.50 | 51.72 (45.96) |
| 17. | Krishnabhog | 22.50 | 17 | 56.325 (48.62) | 747.5 | 27.00 (31.19) |
| 18. | Hemsagar | 27.25 | 13 | 46.15 (42.77) | 277.0 | 40.77 (39.57) |
| 19. | Mallika | 26.25 | 10.5 | 58.08 (49.63) | 379.25 | 17.37 (24.48) |
| 20. | Bangalora | 29.00 | 14 | 66.02 (54.33) | 704.75 | 29.52 (32.78) |
| C.D. (at 5%) | | 5.32 | 4.95 | 2.44 | 6.74 | 6.60 |
| CV | | 14.65 | 25.49 | 3.26 | 3.88 | 12.28 |

**Fig 1:** pictures showing different stages of mango inflorescence

**Fig 2:** Pictures showing different stages of inflorescence of different mango cultivars

## Conclusion

Based on the results, it may be concluded that flowering behaviour of mango cultivars differ significantly. Cultivar Langra performs best with higher percentage of hermaphrodite flower and flowering intensity. So it could be used as one of the parent in mango breeding programmes for enhancing yield. This study may also be useful for expanding the harvesting period and fulfilling other breeding objectives.

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