

Assessing the Flowering and Fruiting Behaviour in Some Important Cultivars of Mango (*Mangifera indica* L.)

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Authors' contributions

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

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ABSTRACT

Flowering and fruiting behaviour studied in five important cultivars of mango viz. Langra, Bombai, Zardalu, Bangalora and Hemsagar. The bud break, the appearance of 50% flower in panicle and fruit set was noticed in different time among the cultivars. The flowering intensity (%), the percentage of hermaphrodite flower (%), inflorescence shape and colour, inflorescence length and breadth (cm) significantly differed among the cultivars. The fruiting behaviour like fruit set (%), fruit drop (%), number of fruits per tree and fruit weight (g) was also significantly varied among the cultivars. The earlier bud break, the appearance of 50% flower in panicle and fruit set was observed in cv. Bombai and late in cv. Hemsagar during both the years 2015 and 2016. The statistically pooled result of the year 2015 and 2016 recorded the maximum flowering intensity percentage (62.05%) and inflorescence length (27.72cm) was observed in cv. Bangalora, whereas a higher percentage of hermaphrodite flowers (16.55%) and inflorescence breadth (21.00cm) was in cv. Zardalu. In respect to maximum fruit set per cent (2.82%) was found in cv. Hemsagar, maximum fruit drop per cent (97.70%) in cv. Langra, a higher number of fruits per tree (348.25 fruits/tree) in cv. Bombai and maximum fruit weight (490.11g) in cv. Bangalore.

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Keywords: Mango; flowering; fruit set.

1. INTRODUCTION

Mango (*Mangifera indica* L.) is a very popular and choicest fruit crop widely cultivated in almost tropical and subtropical region of the world. It belongs to the family Anacardiaceae and originated in South-East Asia Tropical Regions [1]. Mango fruit crops have biennial bearing with the poor percentage of crossing resulting low fruiting [2] is a common problem for mango production and breeding. In view to overcoming the low fruit set problem in both the fields of production and breeding, more knowledge on floral biology and reproductive physiology of the mango is important.

The sex ratio of mango varies among different cultivars and also influenced by environmental conditions. Mango is highly cross-pollinated crop generally pollination takes place by insects [3]. In nature, more than 50% of the flowers do not receive any pollen and number of pollen grains per pollinated flower is also very low i.e. three per flower [4].

Generally in mango cultivation flowering comes in mid-season in Bihar agro-climatic condition with respect to South and North-Western India. The flowering period starts from February and extended up to March. The flowering period of mango is usually of the short duration of 2 to 3 weeks; low temperature may extend it, whereas higher temperature may shorten it. The mango tree does not produce flower simultaneously in all directions of canopy and at least two distinct flushes are noticed. The panicles located on the eastern and south-eastern aspects of the tree come first in flowering.

Therefore the keeping in the view of these problems on flowering and fruit set in mango, the present work of investigation was taken to assess the flowering and fruiting behaviour in some important cultivars of the region i.e. Langra, Bombay, Zardalu, Bangalora and Hemsagar.

2. MATERIALS AND METHODS

The present investigation was carried out in All India Co-ordinated Research Project on Fruits under Bihar Agricultural University, Sabour, Bhagalpur, Bihar on important mango cultivars of the respective region i.e. cv. Langra, Bombai, Zardalu, Bangalora and Hemsagar during two successive seasons (2015 and 2016). The

climate of Sabour is semi-arid, subtropical along with hot desiccating summer and cold frostless winter. The study design was laid out in a randomised block design (RBD) with four replications. Trees were 35 years old and maintained under uniform cultural practices during the course of the investigation. The experimental plot had well-drained sandy loam soil of good fertility with the levelled surface. Trees were spaced at 10x12 m, irrigated via modified basin system. The data on the following characters were recorded.

Time of flowering: The plants under observations were visited on daily basis to determine the appearance of first panicle from January to March. On each tree, a shoot was tagged and dates of all the appearing panicles were recorded. When the half of the total panicles bloomed was the assigned as the date of 50% flowering.

Total number of flowers per panicle: The ten fully opened panicles of all around the tree were randomly selected and covered with a paper bag and tagged. The bag was opened in the alternate day to record the dropped flowers in each panicle. This process was repeated till fruit setting. After fruit set the total number of flowers was counted from the bag and number of fruit set was also added and an average of ten panicles was taken for calculating a mean value for total numbers of flower per panicle.

Sex ratio: When the panicle fully bloomed was cut off from each experimental tree and 100 flowers were randomly taken on a paper. The number of hermaphrodite and staminate flowers were separated and counted which is the also percentage of hermaphrodite and staminate flowers.

Fruit set: The randomly tagged panicles were watched regularly to noticed the first fruit set and the number of fruit set per panicle was counted from March to April depending upon the flowering time of the cultivars. The fruit set percentage was calculated using the total number of flowers in the panicle.

Panicle size: 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 centimeter (cm).

Flowering intensity (%): 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:

$$\text{Flowering intensity (\%)} = \frac{\text{No. of flowering shoots}}{\text{Total numbers of shoot tagged}} \times 100$$

Fruit drop (%): It was determined as a number of fruit sets per panicle two weeks after petal fall for panicles on tagged shoots. The number of fruits per panicle retains or drop was counted at fortnightly intervals till maturity. The fruit retention or drop percentage was calculated using the total number of fruits in the panicle. It was determined at harvest as follows:

$$\text{Fruit drop (\%)} = \left[\frac{\text{No. of initial fruit set per panicle} - \text{No. of fruits retained at maturity}}{\text{Total no. of initial fruit set per panicle}} \right] \times 100$$

3. RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads:

(a) Time of first appearance of bud in panicle, time of 50% flower bloomed in panicle and time of first fruit set: The early appearance of bud in panicle was noticed in cv. Bombay in second week of January during 2015 and last week in 2016. This was followed by cv. Zardalu. The cultivars Langra, Bangalora and Hemsagar were showed flowering bud appearance in third week of January to first week of February. The differences in terms of panicle emergence might be due to the changes in the 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 [5]. Hence, this findings obtained during the present investigation are conformity with Anjum et al. [6]. The appearance of 50% flower bloomed in panicle was completed about 2 to 3 weeks of appearance of first panicle (Table 1). The changes in terms of time of appearance of 50% flower stage among parental mango cultivars might be attributed due to the genetic differences and interaction of genetic-environmental factors [7].

The appearance of first fruit set was observed in between 20th February to 13th March. The earliest fruit set was observed in Bombay (20th Feb. in 2015 and 2nd March in 2016) which was closely followed by Zardalu (24th February in 2015 and 10th March in 2016). Late fruit set was observed for Hemsagar (12th March in 2015 and 13th March in 2016). Fruit set in other varieties was observed between 22nd February to 10th March. This observation was closely related with the findings of Gangwar and Moti [8] who observed that the fruit setting extended over last three week of March.

(b) Flowering intensity (%), hermaphrodite flower (%), shape and colour of inflorescence, size of panicle (cm): The maximum flowering intensity percentage was found in the cultivar Hemsagar (42%) during the year 2015 and it is statistically at par with the cultivars Langra and Bangalora whereas cultivar Bangalora produced maximum flowering intensity (85.97%) during the year 2016 and pooled result i.e. 62.05 % also for both the year 2015 and 2016 . While minimum flowering intensity was found in Zardalu (43.06% pooled data of 2015 and 2016) (Table 2). Kumar et al. [9] and Azam et al. [5] also endorsed the variation in flowering intensity in mango varieties under tropical condition. The high intensity of flowering in some of the mango varieties might 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 [10]. The total number of panicle in a cultivar greatly depends on the genetic potential of the cultivar, its interaction with the environment and variation with place and season.

The percentage of hermaphrodite flowers among the cultivars also varied significantly and ranged from 11.48 to 17.52%. The significantly maximum number of hermaphrodite flowers percentage was observed in the cultivars Hemsagar (17.52%) during the year 2015 and it was found statistically at par with the cultivar Bangalora. Whereas the maximum hermaphrodite flowers percentage for the year 2016 was recorded in the cultivar Zardalu (16.49%). The pooled result of both year 2015 and 2016 the cultivar Zardalu showed a statistically higher number of hermaphrodite flower (16.55%) while minimum hermaphrodite flower percentage was found in Langra (12.29%). The environmental conditions play an important role to determine the sex ratio during the panicle development in mango [4]. The high temperature

during the panicle development is responsible for increasing the high percentage of hermaphrodite flowers [6]. The percentage of hermaphrodite flowers may be varied from 1 to 100% under different environmental conditions [11].

The inflorescence shape was noticed conical to cylindrical during the course of the investigation. The cultivar Langra, Bombai, Bangalora and Hemsagar produced conical shape of inflorescence whereas; it was seen cylindrical inflorescence shape in Zardalu. In respect to the colour of the inflorescence, it was found differences among the cultivars. The cultivars Langra show pinkish green, Bombai greenish pink, Zardalu light green, Bangalora light pink and Hemsagar greenish pink.

The size of the panicle was significantly varied among the cultivars; it was ranged in terms of length 22.25 cm to 28.25 cm and breadth 13.68cm to 21.50cm. Maximum panicle length was observed in Bangalora i.e. 27.19 cm and 28.25 cm during the year 2015 and 2016 respectively and pooled result of both the year was also maximum (27.72cm) in cultivar Bangalora while the minimum was found in Bombai (22.25 cm) Fig. 1. The panicle breadth was found maximum i.e. 21.50 cm 20.50 cm during the year 2015 and 2016 respectively and pooled result of both year (21.00cm) also in cultivar Zardalu Fig. 2. The variation in the

panicle length and breadth among the cultivars is mainly due to the fact that the genetic constitution of the cultivars and their interaction with the physico-chemical conditions and more specifically the physiological conditions of the shoot [7]. The variation among the mango genotypes is due to the genetic constitution of varieties and their interaction with environmental conditions [12]. This finding was also closely confirmed by Azam et al. [5].

(c) Fruit set (%), fruit drop (%), numbers of fruit per tree and fruit weight (g): The data regarding the initial fruit set percentage was presented in Table 3. The initial fruit set per panicle was varied from 0.81 to 3.82%. The maximum initial fruit set of fruits was recorded in Hemsagar (3.82 % and 1.83%) during the year 2015 and 2016 respectively and the pooled result (2.82%) of both the year. The lowest was found in cultivar Bombai for the year 2015 and 2016 i.e. 1.15% and 0.81% respectively while the pooled result for both the years also showed in the same cultivars (0.98%). The variation in fruit set could be due to genotypic differences. The ability of cultivars to bear fruit set also depends upon the availability of pollen, its viability, populations of pollinating insects and self and cross-compatibility of a cultivar and with other cultivars respectively [6]. The similar results were also closely supported by Scholefield and Oag [13].

Table 1. Time of flowering and fruit set in different mango cultivars of mango under Sabour Condition

Mango cultivar	Date of 1 st appearance of bud in panicle		Date of 50% flower bloomed in panicle		Date of 1 st fruit set	
	2015	2016	2015	2016	2015	2016
Langra	23.01.15	03.02.16	15.02.15	28.02.16	28.02.15	13.03.16
Bombai	12.01.15	25.01.16	07.02.15	18.02.16	20.02.15	02.03.16
Zardalu	18.01.15	28.01.16	11.02.15	27.02.16	24.02.15	10.03.16
Bangalora	28.01.15	02.02.16	20.02.15	28.02.16	05.03.15	13.03.16
Hemsagar	02.02.15	03.02.16	27.02.15	01.03.16	12.03.15	13.03.16

Table 2. Flowering intensity (%), hermaphrodite flower (%), inflorescence shape and colour of mango cultivars under Sabour condition

Mango cultivar	Flowering intensity (%)			Hermaphrodite flower (%)			Inflorescence shape	Colour of inflorescence
	2015	2016	Pooled	2015	2016	Pooled		
Langra	40.57	76.12	58.34	13.10	11.48	12.29	Conical	Pinkish green
Bombai	24.77	72.80	48.78	12.89	12.91	12.90	Conical	Greenish pink
Zardalu	25.71	60.42	43.06	16.61	16.49	16.55	Cylindrical	Light green
Bangalora	38.13	85.97	62.05	15.82	12.57	14.20	Conical	Light pink
Hemsagar	42.00	76.25	59.13	17.52	12.76	15.14	Conical	Greenish pink
SEm±	2.63	5.25	2.94	0.91	0.46	0.51	-	-
CD at 5%	8.11	16.20	8.47	2.80	1.43	1.47	-	-
CV	13.32	12.25	13.27	13.83	8.11	11.74	-	-

Table 3. Fruiting behaviour in different mango cultivars under Sabour Condition

Mango cultivar	Fruit set (%)			Fruit drop (%)			Number of fruit/tree			Fruit weight (g)		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
Langra	1.72	1.07	1.39	98.08	97.33	97.70	383.75	56.50	220.13	349.38	213.50	281.44
Bombai	1.15	0.81	0.98	91.32	92.57	91.94	643.75	52.75	348.25	304.23	195.25	249.74
Zardalu	1.77	1.49	1.63	94.72	95.22	94.97	495.00	17.75	256.38	212.98	179.50	196.24
Bangalora	2.17	1.31	1.74	90.75	90.85	90.80	27.50	372.75	200.13	510.48	469.75	490.11
Hemsagar	3.82	1.83	2.82	94.97	95.25	95.11	312.75	80.00	196.38	240.00	234.75	237.38
SEm±	0.18	0.16	0.12	2.39	1.91	1.53	39.62	11.61	20.64	9.14	4.67	5.13
CD at 5%	0.56	0.49	0.34	7.36	5.89	4.41	122.06	35.77	59.45	28.18	14.41	14.79
CV	19.73	28.60	23.14	4.40	3.51	3.98	18.42	17.34	20.70	4.89	3.13	4.32

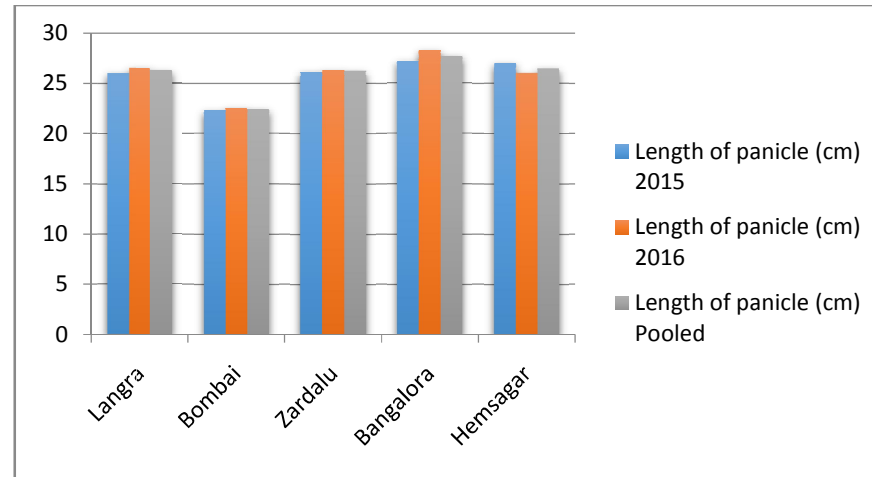


Fig. 1. Panicle length (cm) under Sabour condition
 CD (5%): Panicle length (cm): 2015(1.47):2016(2.60): Pooled (1.39)

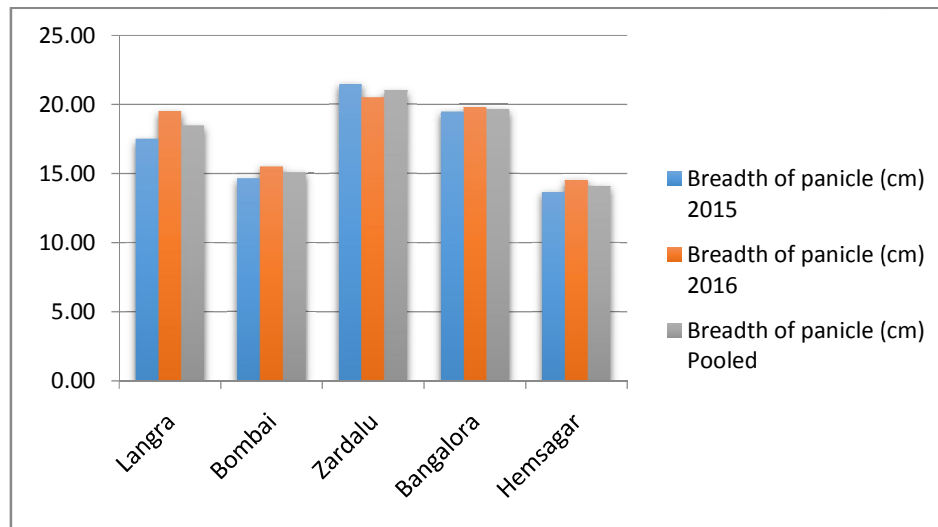


Fig. 2. Panicle breadth (cm) under Sabour condition
CD (5%): Panicle breadth (cm): 2015(0.91):2016(1.07): Pooled (0.65)

The maximum fruit drop per cent was found in cultivar Langra (98.08% and 97.33 %) during the year 2015 and 2016 (Table 3). The pooled result of both year 2015 and 2016 also showed maximum fruit drop per cent (97.70 %) in the cultivar Langra. The minimum fruit drop per cent was in cultivar Bangalora (90.80%). The variations in fruit drop percent were due to the fruiting behaviour attributes like genetic, taxonomic and ecological diversity of the species and the geographic and annual variations in the proportion of flowers and juvenile fruits that abscise, the factors limiting fruit set and the proximate causes of fruit drop [14]. The similar findings were reported by the various workers those are Shrivastava et al. [15], Jana and Sharangi [16] (1998), Muhammad et al. [17] and Kumar and Jaiswal [18].

The data presented in Table 3 indicates that the numbers of fruit per tree were varied from 17.75 to 643.75 fruits per tree. The number of fruits per tree was counted in cultivar Bombai (643.75 and 52.75) during the year 2015 and 2016 respectively. The pooled result of both year was also produced a maximum number of fruits per tree (348.25 fruits per tree) in cultivar Bombai. The pooled data of both year 2015 and 2016 showed the minimum fruits per tree (196.38 fruits per tree) in the cultivar Hemsagar. The variation in the number of fruits per tree is due to "off and on season" fruiting in last year and they reserve the carbohydrate synthesis that increases the higher yield. The similar findings were confirmed by the workers, Rajput and Panday [19], Ghosh

and Chattopadhyay [20], Shinde et al. [21], Kumar and Jaiswal [18], Anila and Radha [22] and Muhammad et al. [23].

The data regarding fruit weight are presented in Table 3. The fruit weight ranged from 179.50 to 510.48g. The cultivar Bangalora produced maximum fruit weight (510.48 and 469.75g) for the year 2015 and 2016. The pooled data of both year was also produced maximum fruit weight (490.11g) by the cultivar Bangalora which is statistically superior among all the cultivars followed by Langra (281.44g). The pooled data of both year 2015 and 2016 showed the weight of the minimum fruit (196.24g) in the cultivar Zardalu. The variation in fruit weight is due to attribute of a cultivar and species to multiply and enlarge the cells membrane of the fruit to accumulate more sugar and water for expanding the cells which is greatly influenced by the genetic makeup of particular cultivar. These results are in agreement with the findings of Uthaiyah et al. [24], Dalal et al. [25] and Dutta and Dhua [26].

4. CONCLUSION

On the basis of above-mentioned facts, it may be concluded that the flowering and fruiting of mango is an important physiological event which sets the beginning of fruit production. The understanding the information at the time floral bud differentiation, flowering and fruit set are crucial under a specific climatic condition for a variety. Hence, it is helpful to aware the mango

growers to schedule the manuring, irrigation and other cultural operations during the mango cultivation for achieving the higher yield with quality fruit production.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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