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Flowering attributes of parental mango genotypes

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ABSTRACT

Fifteen mango genotypes were characterized for their flowering behaviour under Delhi conditions during 2011-12. Dushehari, Langra and Primor de Amoreira showed very early panicle initiation, *i.e.*, before 10th February. However, Erwin and Husnara had very late panicle initiation, *i.e.*, after 3rd March. Totapari Red Small, Pusa Arunima and Janardan Pasand had flowering during 10-20th February. Whereas, Zill, Tommy Atkins, Sensation, Neelum, Mallika, Amrapali and Bhadauran initiated panicles during 21st February to 3rd March. The maximum duration of flowering was noticed in Primor de Amoreira (41.5 days). However, the minimum duration of flowering was noticed in Husnara (13.0 days) followed by Erwin (14.5 days). Flowering duration was more than 20 days but less than 30 days in Amrapali, Sensation, Bhadauran, Mallika, Totapari Red Small and Janardan Pasand. Total number of flowers ranged between 133.30 in Bhadauran to 506.10 in Tommy Atkins. In general, per cent hermaphrodite flowers was less in early emerged panicles compared to late emerged panicles in all mango genotypes. A scheme of hybridization was suggested on the basis of flowering duration employing these mango genotypes. The effective period of mango hybridization using diverse parental mango genotypes was found to be from 3rd week of February to mid March under Delhi conditions.

Key word: Fruit set, inflorescence, mango, panicle initiation, sex ratio.

INTRODUCTION

Mango (*Mangifera indica* L.) belonging to family Anacardiaceae is one of the commercially important fruit crop of tropical and sub-tropical worlds. The fruit occupies an important socio-economic position in India and south-east Asian countries where it is held in high esteem. India produces 18.67 million tonnes mango from 2.55 million hectare area with the productivity level as low as 7.3 tonnes per hectare (NHB, 9). Mango breeding work is in progress at several research stations. The common objectives for mango breeding are dwarf stature amenable for high density planting, tolerance to floral malformation and fruit quality suitable for export and processing industries. Different mango cultivars have been utilised as gene sources for imparting target traits in the progenies by different centres involved in mango improvement. The prerequisite for attempting hybridization using important parental mango genotypes is synchronisation in their flowering time. Mango blooming season in north India starts in February and lasts through March, whereas the regular harvesting season extends from 2nd fortnight of May to first fortnight of August. It has been experienced that flowering season and behaviour of some potential parental mango genotypes differ significantly. In mango hybridization programmes, the problem of asynchronized flowering among desired mango cultivars restricts their use as donor parent. The information pertaining to initiation of flowering, flowering duration, sex ratio, pollen viability etc. has significant implications on success of breeding efforts. Due to lack of information on flowering behaviour of parental genotypes, breeding efforts is under-performed and mango breeders normally face problem of non-availability of desired parental pollen source for attempting crosses. The present investigation aimed to have information about flowering behaviour of potential parental mango genotypes and to suggest effective period of hybridization using these parents.

MATERIALS AND METHODS

The present study was carried out on 15 important mango genotypes namely, Amrapali, Bhadauran, Dushehari, Erwin, Husnara, Janardan Pasand, Langra, Mallika, Neelum, Pusa Arunima, Primor de Amoreira, Sensation, Tommy Atkins, Totapuri Red Small and Zill available at the experimental orchard of the Division during 2011-12. The selection of mango genotypes was made on the basis of their importance in mango hybridization programmes. Trees of these mango genotypes are also healthy and in bearing (20-25 years) and free from diseases and pests. The plants of these mango genotypes were maintained under uniform cultural practices.

Time of panicle emergence on bearing shoots was rated using 1 to 5 scales as suggested by

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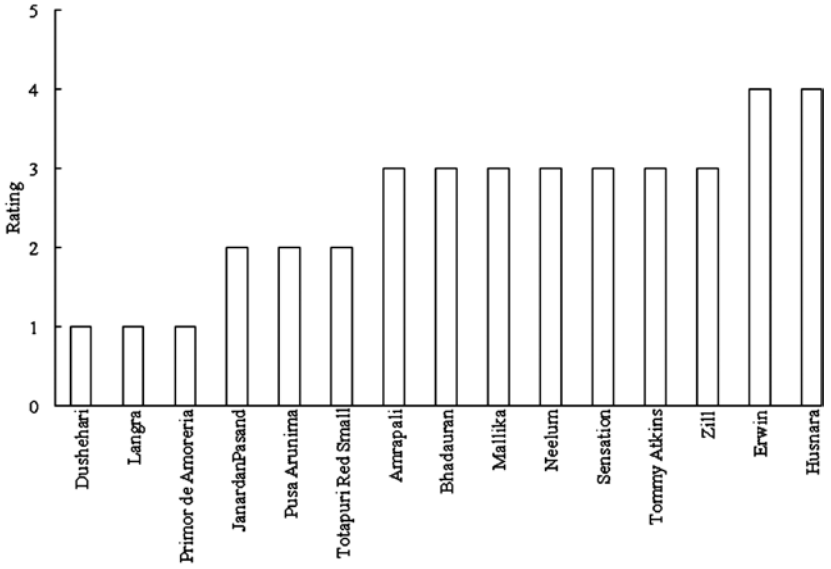
Rathore (11). Days to 50% bloom was calculated on the basis of number of days taken for emergence of 50 per cent panicles on individual tree. The inflorescence length was measured from the base to the tip of fully developed panicle with the help of a measuring scale. The panicle breadth was recorded in the middle portion of the fully developed inflorescence with the help of a measuring scale. The ratio of panicle length and breadth was calculated by dividing the panicle length with panicle breadth. For recording male and hermaphrodite flowers, 10 panicles were tagged on each tree in all four directions. Observation on male and hermaphrodite flowers were recorded at different intervals. Total numbers of flowers were counted on fully opened panicles. In order to avoid error, the counted flowers on panicles were removed and fresh open flowers were counted on daily basis. Sex ratio was calculated by dividing number of male flowers with number of hermaphrodite flowers. Pollens were collected between 8.00 and 10.00 hours in the morning for assessing pollen viability. Freshly and fully opened flowers with red or purple anthers were collected from selected pollen parents. For each replication, a minimum number of 50 flowers were placed in petridishes lined with moist paper. The flowers were then placed under sun to induce dehiscence and pollens were collected in small vials. Viability of fresh pollen was examined using *in vitro* germination (Stanley and Linskens, 16) and acetocarmine (Nassar *et al*., 8) tests.

The experiments were laid out in randomised block design (RBD). The data on different parameters were analysed by using analysis of variance (ANOVA) by using SAS statistical software version 9.2. In order to compare treatment means, critical differences were calculated.

RESULTS AND DISCUSSION

Out of 15 genotypes studied, Dushehari, Langra and Primor de Amoreira had very early flowering, *i.e.* before 10th February. However, Erwin and Husnara had very late panicle initiation, *i.e.*, after 3rd March. Other mango genotypes showed intermediate panicle initiation. Totapari Red Small, Pusa Arunima and Janardan Pasand had early flowering during 10-20th February. Whereas, Zill, Tommy Atkins, Sensation, Neelum, Mallika, Amrapali and Bhadauran initiated panicles emergence during 21st February to 3rd March (Fig. 1). The variation observed in terms of panicle initiation was might be due to the differences in genetic composition of parental mango genotypes. The seasonal cyclic change of growth, flower, fruit and their development differ between genotypes and location. Phenology pattern is strongly under environmental control in mango and 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. Flowering is commonly related with stoppage or dormancy of the terminal growth which is low temperature controlled in



Rating 1-5: 1 = very early (before 10th February), 2 - early (11th - 17th February), 3 = Mid 18th - 24th February), 4 = late (25th February to 3rd March) and 5 = very late (after 3rd March)

Fig. 1. Panicle initiation rating among mango genotypes.

subtropics (Chacko *et al.*, 1). In another study, Muhammad *et al.* (6) studied the panicle initiation time in three commercial mango genotypes, *i.e.* Anwar Rataul, Dushehari and Langra. They found that early panicle initiation was observed in Dasehari followed by Langra and Anwar Rataul.

Period required to attain the stage of 50 per cent bloom differed significantly among parental mango genotypes ($p \leq 0.05$, LSD = 2.19). The minimum days required to attain 50 per cent bloom was observed in Tommy Atkins (6.5 days). However, the maximum period required to attain 50 per cent bloom was noted in Pusa Arunima (21 days). It was interesting to note that only Pusa Arunima took more than 20 days to attain 50 per cent bloom stage. Whereas, two parental mango genotypes namely Bhadauran and Janardan Pasand took 16 days and Amrapali (9.0 days), Erwin (9.0 days), Husnara (8.0 days) and Sensation (8.5 days) took less than 10 days. Flowering duration ranged between 13 days (Husnara) to 41.5 days (Primor de Amoreira) and differed significantly ($p \leq 0.05$, LSD = 5.43) among parental mango genotypes. Out of 15 genotypes studied, the flowering duration was more than 20 days but less than 30 days in Amrapali, Sensation, Bhadauran, Mallika, Totapari Red Small and Janardan Pasand. The flowering duration of Pusa Arunima was 30.5 days. Whereas, the flowering duration of Zill, Neelum and Tommy Atkins ranged between 18 to 20 days (Table 1). The differences observed in terms of days required to attain 50% bloom stage among parental mango genotypes might be attributed to the genetic differences and interaction of genetic and environmental factors. Moreover, the maturity of shoot and temperature have more significant role in determining the rate of panicle initiation and flowering duration. Shu (14) observed that warm temperatures hastened growth rates of panicles and flowers, shortened flowering duration and life span of individual flowers, and decreased the number of hermaphrodite and male flowers. In contrast, cool temperatures retarded the growth of panicles and flowers, extended flowering duration and life span of flowers. Similar results were also obtained by Kumar and Jaiswal (5) and Pandey and Kumar (10).

It was interesting to note that regardless of mango cultivars different pollen viability tests showed differential results. Comparatively higher pollen viability was depicted by acetocarmine test; however, *in vitro* germination test depicted less fresh pollen viability. *In vitro* germination test of fresh pollen clearly indicated that pollen viability ranged between 38.89% in Zill to 67.75% in Husnara. In contrast, the maximum pollen viability as examined by acetocarmine test indicated maximum pollen viability in Dushehari (92.98%) and minimum pollen viability in Bhadauran (76.82%) (Table 1). The differences in pollen viability among mango genotypes may be attributed to several

Table 1. Flowering duration and fresh pollen viability among mango genotypes.

Genotype	Days to 50% bloom (days)	Flowering duration (days)	Pollen viability (%)	
			In vitro germination	Acetocarmine test
Amrapali	9.00 ± 0.20	22.5 ± 1.89	45.83 ± 1.32	89.18 ±0.99
Bhadauran	16.0 ± 0.60	24.0 ± 1.65	57.69 ± 0.68	76.82 ± 1.20
Dushehari	14.0 ± 1.21	33.5 ± 1.56	44.44 ± 1.53	92.98 ± 2.04
Erwin	9.0 ± 0.81	14.5 ± 1.04	43.75 ± 1.38	83.38 ± 2.15
Husnara	8.0 ± 0.67	13.0 ± 0.70	67.75 ± 1.20	87.10 ± 1.02
Janardan Pasand	16.0 ± 0.84	26.0 ± 1.83	44.00 ± 2.21	88.89 ± 1.32
Langra	13.0 ± 0.55	32.5 ± 0.88	42.86 ± 2.37	87.11 ± 1.32
Mallika	12.0 ± 0.71	20.5 ± 1.88	45.16 ± 1.36	82.67 ± 2.74
Neelum	13.5 ± 1.11	18.5 ± 0.68	62.50 ± 0.65	89.54 ± 1.13
Pusa Arunima	21.0 ± 0.44	32.5 ± 1.54	43.75 ± 1.20	85.87 ± 1.46
Primor de Amoreria	13.0 ± 0.82	41.5 ± 4.21	47.62 ± 2.07	83.90 ± 1.71
Sensation	8.5 ± 0.40	20.5 ± 0.48	46.67 ± 1.53	85.97 ± 2.44
Tommy Atkins	6.5 ± 0.46	18.0 ± 0.61	46.15 ± 1.51	86.40 ± 1.43
Totapuri Red Small	14.0 ± 0.33	27.0 ± 1.56	45.83 ± 0.54	81.19 ± 1.23
Zill	10.0 ± 1.01	19.0 ± 2.98	38.89 ± 1.04	86.01 ± 1.59
LSD ($P \leq 0.05$)	2.19	5.43	4.27	4.71

endogenous and exogenous factors, such as stage of flower development, prevailing temperature (Giordano *et al.,* 4) and luminosity.

The parental mango genotypes showed significant variation for total number of flowers, hermaphrodite flowers, male flowers and sex ratio ($p \leq 0.05$). Total number of flowers ranged between 133.30 in Bhadauran to 506.10 in Tommy Atkins followed by Dushehari (439.50). Other genotypes had intermediate number of flowers. Among 15 genotypes studied, Totapari Red Small, Sensation, Primor de Amoreira, Neelum, Mallika, Janardan Pasand, Erwin and Husnara had 300 to 400 flowers. However, in Langra (184.1), Zill (214.4) and Amrapali (261.2) had less than 300 flowers. Similarly, the number of hermaphrodite flowers showed statistically significant variation among parental mango genotypes ($p \leq 0.05$, LSD = 3.86). The maximum percentage of hermaphrodite flowers was in Bhadauran (77.82%), followed by Primor de Amoreira (63.91%) and Sensation (60.45%). However, the minimum percentage of hermaphrodite flowers was noted in Mallika (6.98%) followed by Husnara (13.89%). The data observed on per cent hermaphrodite flowers at a regular interval showed variation within the mango genotype at different point of time. 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 genotypes. In Dushehari, Langra and Primor de Amoreira, the percentage of hermaphrodite flowers in panicles emerged early in February was quite less than the later emerged flowers. The percentage of hermaphrodite flowers in panicles emerged in fortnight of February was only 19.30, 33.60 and 41.75% in Dushehari, Langra and Primor de Amoreira, respectively. However, the percentage of hermaphrodite increased upto 25.70, 73.51 and 63.91 in panicles flowered during 2nd week of March. Out of 15 genotypes studied, two mango genotypes namely Pusa Arunima and Totapari Red Small initiated panicles in the third week of February. In these two genotypes non-significant variation in terms of percentage of hermaphrodite flowers was observed among panicles initiated between 3rd week of February to 2nd week of March. The maximum percentage of male flowers was in Mallika (93.02%), followed by Janardan Pasand (86.13%), which was at par with Husnara (86.11%). However, the minimum of male flowers was noted in Bhadauran (22.18%) followed by Langra (26.49%).

The sex ratio, in terms of number of male flowers per hermaphrodite flower significantly varied among parental mango genotypes ($p \leq 0.05$, LSD = 0.66). The sex ratio ranged between 0.29 in Bhadauran to 13.33 in Mallika. This indicates that in Bhadauran every hermaphrodite flower has 0.29 male flowers, however in Mallika for every hermaphrodite flower there was 13.33 male flowers. Out of 15 mango genotypes studied, seven genotypes namely Bhadauran, Erwin, Langra, Pusa Arunima, Primor de Amoreira, Sensation and Totapari Red Small had less than 1.0 per cent sex ratio, which indicates that proportion of hermaphrodite flowers was more than the male flowers. In remaining eight mango genotypes, the sex ratio was more than one, indicating presence of more than one male flower per hermaphrodite flower. The data observed on sex ratio at a regular interval showed variation in sex ratio within the mango cultivar. The sex ratio is a variable component within panicles, trees and among genotypes. This ratio varies with genotypes (Davenport and Nunez-Elisea, 3). The variability in the perfect and staminate flower ratio may be governed by physiological and environmental conditions. The lesser number of hermaphrodite flowers in early emerged flowers may be attributed to the fact that cool weather conditions. Mukherjee (7) also reported that the panicles emerging during the middle and end of flowering season produce two and seven times more perfect flowers than the early emerging panicles.

There was significant difference among the studied genotypes in terms of panicle length, diameter and ratio of panicle length and diameter ($p \leq 0.05$). Panicle length ranged between 14.50 cm in Neelum to 31.50 cm in Sensation. The maximum length of panicle was recorded in Sensation (31.50 cm) which had non-significant differences with Primor de Amoreira (29.13 cm) and Amrapali (29.05 cm). However, the minimum panicle length was recorded in Neelum (14.50 cm) which did not differ significantly with Langra (16.13 cm). Out of 15 mango genotypes observed, 10 had panicle length more than 20 cm. Whereas, in rest of the genotypes panicle length ranged between 14.5 to 19.13 cm. Similarly, panicle diameter and ratio of panicle length and diameter also showed statistically significant variation among parental mango genotypes (Table 2). The variation in size and shape of panicles in mango genotypes might be due to genetic composition of mango genotypes and more specifically the physiological condition of the shoot on which panicle is raised. In the same line of work, Chandra *et al*. (2) reported that the length and breadth of the panicle and number of flowering laterals per square metre had distinct variation in eight mango genotypes and hybrids under agro-climatic condition of Orissa. Similarly, Sarkar *et al.* (12) found that cv. Amrapali produced the highest panicle length and breadth among the ten mango

Table 2. Flowering attributes of mango genotypes.

Genotype	Panicle length (cm)	Panicle diameter (cm)	Ratio of panicle length and diameter	Hermaphrodite flower (%)	Male flower (%)	Total flowers	Sex ratio (Hermaphrodite : Male)
Amrapali	29.05 ± 1.11	22.10 ± 1.53	1.31 ± 0.5	34.00 ± 2.47	66.00 ± 2.48	261.20 ± 3.98	1.95 ± 0.21
Bhadauran	17.38 ± 1.03	9.75 ± 0.43	1.78 ± 0.79	77.82 ± 2.03	22.18 ± 2.04	133.30 ± 1.06	0.29 ± 0.03
Dushehari	17.88 ± 0.49	11.13 ± 0.47	1.61 ± 0.05	25.70 ± 1.02	74.03 ± 1.02	439.50 ± 5.78	2.89 ± 0.15
Erwin	20.75 ± 0.87	8.25 ± 0.55	2.52 ± 0.23	57.78 ± 2.89	42.22 ± 2.89	302.50 ± 2.54	0.74 ± 0.09
Husnara	19.13 ± 1.22	9.82 ± 0.37	1.95 ± 0.07	13.89 ± 1.26	86.11 ± 1.26	346.10 ± 1.70	6.19 ± 0.56
Janardan Pasand	26.75 ± 0.50	16.00 ± 0.38	1.67 ± 0.02	13.87 ± 0.41	86.13 ± 0.41	357.20 ± 2.87	6.20 ± 0.20
Langra	16.13 ± 0.31	11.13 ± 0.72	1.45 ± 0.11	73.51 ± 3.12	26.49 ± 3.13	184.10 ± 1.72	0.37 ± 0.06
Mallika	26.63 ± 0.69	19.13 ± 01.07	1.39 ± 0.10	6.98 ± 0.30	93.02 ± 0.30	337.60 ± 3.76	13.33 ± 0.61
Neelum	14.50 ± 0.69	9.88 ± 0.32	1.47 ± 0.08	38.23 ± 2.08	61.77 ± .08	334.30 ± 4.72	1.62 ± 0.13
Pusa Arunima	21.38 ± 0.53	9.50 ± 0.55	2.25 ± 0.14	58.01 ± 2.28	41.99 ± 2.29	281.20 ± 1.25	0.72 ± 0.07
Primor de Amoreria	29.13 ± 1.29	16.38 ± 0.60	1.81 ± 0.22	63.91 ± 1.18	36.09 ± 1.18	372.50 ± 3.43	0.56 ± 0.03
Sensation	31.50 ± 1.20	13.75 ± 0.58	2.29 ± 0.16	60.45 ± 0.72	39.55 ± 0.72	370.10 ± 4.68	0.65 ± 0.02
Tommy Atkins	28.40 ± 1.51	21.00 ± 0.46	1.35 ± 0.08	31.33 ± 1.41	68.67 ± 0.95	506.10 ± 2.46	2.20 ± 0.14
Totapuri Red Small	21.88 ± 1.69	14.25 ± 0.60	1.54 ± 0.13	55.82 ± 1.68	44.18 ± 1.62	371.20 ± 1.24	0.79 ± 0.06
Zill	22.11 ± 0.51	11.75 ± 0.66	1.84 ± 0.15	27.12 ± 1.71	72.88 ± 1.71	214.40 ± 1.42	2.69 ± 0.22
LCD ($P \leq 0.05$)	2.94	2.20	0.37	3.86	3.83	8.78	0.66

hybrids evaluated for floral character. Singh (15) evaluated twenty-one mango varieties and reported the maximum panicle length (22.5 cm) in Amrapali followed by Rataul and Khatma Belkhar.

Based on the results, it can be concluded that flowering behaviour of parental mango genotypes differ significantly and the effective period for mango hybridization using diverse parental mango genotypes under Delhi conditions is from 3rd week of February to mid March.

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