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Floral and flushing pattern of *baramasi*, regular and biennial bearing cultivars of mango in Eastern India

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ABSTRACT

Flowering in mango is a very complex phenomenon. The potentiality to form flower buds depends on the florious condition of the tree that depends up on many factors like genotype, climatic factors, physiological behaviour, agro-techniques, pests and disease management *etc*. The present study was carried out on flowering and flushing behaviour of *Baramasi*, regular and biennial bearing cultivars of mango at Bihar (Eastern Indian) condition. Results indicated that *Baramasi* had more than four times panicle and flush emergence in a year. Time of panicle emergence was the earliest in cv. Alphonso among all the cultivars. The maximum number of panicles per branch was recorded in Langra (725.21) during its 'on' year. However, it was the minimum in cv. *Baramasi*. The maximum number of flowers per panicle was recorded in cv. Langra (1215 and 1132) during both the years of study. The longest panicle was measured in cv. Alphonso (31.72-33.99 cm) while, the shortest panicle was observed in cv. *Baramasi* (21.30-29.02 cm). Cultivar Alphonso took more time (35.6 and 33.2 days) for bud break to full bloom whereas; Amrapali (23.80 and 22.14 days) took fewer periods during both the years. The shortest duration of flowering was also noticed (17 days) in cv. Amrapali. Cultivar Langra had the maximum number of hermaphrodite flowers (65.0 and 66.2) as well as flowering intensity (4448 and 4143 flowers/ft^2) however, it was the minimum in cv. *Baramasi* (23.8 and 24.4%and 2006.4 and 3235.6 flowers/ft^2) during both the consecutive years. Higher incidence of malformation was found in cv. Amrapali but at the same conditions cv. Langra did not show any incidence of malformation. Variation in floral and flushing behaviour among the cultivars might be due to variation in climatic conditions and individual genetic characteristics.

Keywords: *Mangifera indica*, flowering, flush, malformation.

INTRODUCTION

Mango (*Mangifera indica* L.) is one of the choicest fruit crops of tropical and subtropical regions of the world, belonging to the family Anacardiaceae. It is often termed as 'King of fruits' due to its popularity and importance in the tropical world. India is the largest producer of mango in the world, contributing about 40.48% of the total world mango production (Anonymous, 2). In India, mango has been under cultivation since past 4000 years and more than 1200 varieties were reported to exist in the country. The cultivated mango varieties in India exhibit an unusual diversity of fruit form, flavour, taste as well as flowering behavior (regular, irregular and *Baramasi*/off season bearing). Flowering is the first step of sexual reproduction and the change from vegetative to reproductive stage is one of the most dramatic and important events in the ontogeny of plant. Successive events like anthesis, fruit set, fruit development, maturation and ripening is completed after flowering. Continuous growth habit is not observed in mango and some other tropical fruit trees (Nakasone *et al.*, 8). Growth occurs as intermittent, ephemeral flushes of shoots from apical or lateral buds. Apical buds of the mango spend most of the time in rest in their life cycle. Depending on the cultivar and climatic conditions, vegetative shoot development from initiation of growth to full elongation requires about 3–6 weeks. Generally, a mango shoot completes four to five flushing cycles every year (Davenport and Nunez-Elisea, 6) whereas, flowering appears on a few shoots during the next year. From the perspectives of the industry, flowering and fruiting in mango are the most important and critical events that determines when and how much fruit yield could be produced during a season. Despite many research on mango flowering and growth have been carried out during previous years, the vegetative and reproductive growth pattern of mango is highly dependent on variety and growth conditions of a particular growing region (Davenport and Nunez-Elisea, 6). Thus, there is a need to understand the growth and flowering

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pattern of mango under different agro-climatic conditions of India. In India, three types of mango varieties have been reported *i.e*., regular, irregular and *Baramasi*/off season bearing. There is no any report on the flowering and flushing pattern of *Baramasi* cultivar (produces multiple flowering and fruiting in a year) in comparison with regular and irregular cultivars of mango. So, the present study was carried out to understand the nature of flowering and flushing pattern of *Baramasi* in comparison to regular and irregular bearing cultivars of mango in the subsequent growing season under subtropical climate of Bihar (India).

MATERIALS AND METHODS

The study was carried out on four mango cultivars namely cv. Amrapali (regular bearer), cvs. Langra and Alphonso (irregular bearer) and cv. *Baramasi* (multiple times flowering in a year). The experiment was conducted in the orchard of Horticultural Garden of Department of Horticulture (Fruit and Fruit Technology), Bihar Agricultural University, Sabour, Bhagalpur, Bihar (India). It is situated at a longitude of 87º2'72" E, latitude of 25º15'40" N and 46 meters above mean sea level in the heart of the vast Indo-Gangetic plain of North India. The climate of this place is tropical to subtropical, slightly semi-arid in nature and is characterized by very dry summer, moderate rainfall and very cold winter. December and January are usually the coldest months when mean temperature generally falls to about 8.5ºC while, May and June are the hottest months, having the maximum average temperature of 39.8ºC. The normal rainfall is about 1200 mm, mostly precipitates during middle of June to middle of October.

The date of appearance of first panicle was recorded on the 100 tagged shoots by visiting the experimental orchard every day during the time of panicle emergence. Fifty per cent flowering from panicle emergence was recorded by visiting the experimental orchard every day after panicle emergence and the number of days was counted from the date of panicle emergence to the day when 50 per cent flowers appeared on a panicle were opened. Branches arising from the main trunk were tagged and used to count the total number of panicles per branch. Number of panicles producing shoots was also counted to calculate the total number of panicles per branch. The length of panicle was measured with the help of measuring tape from the shoot apex to panicle apex. Average of ten values was taken for computing the mean panicle length. Data on period of bud break to full bloom was recorded by counting the days taken from emergence of first panicle to the termination of panicle emergence in individual trees. Period of full bloom to maturity was recorded by counting the days taken from full bloom to the maturation of fruits in individual trees. The total number of flowers in a panicle was counted from ten panicles and average value was taken. To observe the percentage of malformed panicles, total numbers of healthy and malformed panicles were counted on individual trees and results were expressed as percentage. Duration of flowering was recorded by counting the days taken from anthesis to date of fruit set in individual trees. Flowering intensity was observed by the counting the total number of flowers per square foot area of tree. Flowering intensity was calculated from total number of panicles per square foot area and total number of flowers in a panicle. Date of emergence of new flushes was noted on 100 tagged shoots to know the flushing pattern of individual cultivar.

The experiment was laid out on Randomized Block Design (RBD) with twenty treatments and five replications. The experimental data were subjected to statistical analysis in order to find out which of the treatments showed significant variation in different parameters/attributes studied under investigation. The technique of analysis of variance (ANOVA) for randomized block design was adopted as suggested by Panse and Sukhatme (9).

RESULTS AND DISCUSSION

In this study, interesting results were observed in cv. *Baramasi* which exerted panicles several times in a year. In this cultivar, panicle initiation was taken place from February to September months in both the experimental years (Table 1). First panicle was emerged on 15th February followed by 30th March, 10th May, 6th July and the last panicle was emerged on 5th September during first year of the

Table 1. Time of panicle emergence in *Baramasi*, regular and biennial bearing mango cultivars.

Cultivars	2013 (1st year)					2014 (2nd year)				
Baramasi	15-Feb	30-Mar	10-May	6-Jul	5-Sep	20-Feb	1-Apr	13-May	5-Jul	7-Sep
Amrapali	18-Feb	-	-	-	-	26-Feb	-	-	-	-
Langra	13-Feb	-	-	-	-	17-Feb	-	-	-	-
Alphonso	30-Jan	-	-	-	-	2-Feb	-	-	-	-

experiment and similar trend was noticed during next year. Irregular bearing cultivar Alphonso showed early emergence of panicles (30th January and 2nd February) followed by Langra (13th February and 17th February), as compared to regular bearing cv. Amrapali (18th February and 26th February) during 1st and 2nd experimental years, respectively. Chandra *et al.* (4) also reported early flowering in cv. Alphonso and Langra under Sabour condition. Singh and Maurya (12) emphasized the influence of a place with respect to environmental factors for emergence of panicles. Damodaran *et al*. (5) reported differential flowering of mango (May-June, August-September and November-December) in many parts of the Andaman Islands.

The minimum time taken for 50% flowering was recorded in cv. Alphonso *i.e*., 17.2 days and 17.8 days during 2013 and 2014, respectively followed by Amrapali (19.8 days and 19.6 days). Whereas, cultivar Langra showed maximum duration for 50% flowering of about 23.40 days during both the years of experiment (Table 2). But during first year of experiment, cultivar *Baramasi* took 23.60 days for 50% flowering while only 20.60 days was taken during second year of experiment. Likewise, Anjum *et al.* (1) observed that 50% flowering completed in mango after 2-3 weeks of first panicle appearance. The differences in time of flowering between the years were possibly due to variation in weather conditions.

The number of panicles per branch varied significantly among the cultivars. It was noted highest in cultivar Langra (725.21) during the 'on' year (2013) followed by cultivar Alphonso (462.2) during its 'on' year in 2014 (Table 2). However the lowest number of panicles per branch was recorded in cv. *Baramasi* (18.91 and 45.88) followed by cv. Amrapali (117.50 and 58.56) during 2013 and 2014, respectively. Kumar and Jaiswal (7) found maximum blooming period of 42.17 days in cv. Bangalora, while it was minimum in cv. Langra (26.27 days).

In the present study, number of flowers per panicle also differed significantly among the cultivars (Table 2). The maximum number of flowers per panicle was recorded in cultivar Langra (1215 and 1132) which was statistically at par with cultivar *Baramasi* (1091.2 and 1120.2) in both the years. Whereas, the minimum number of flowers per panicle was noted in cultivar Amrapali (799.2 and 918.4) followed by Alphonso (963.8 and 1004.8), during 2013 and 2014, respectively. The results obtained in present study coincide with the findings of Anjum *et al*. (1) where they reported that the total number of flowers/panicle ranged from 664-1675. The number of inflorescence per meter square had the favourable environmental factors which resulted in higher reserves *i.e*. carbon-nitrogen ratio (Vijayalakshmi and Srinivasan, 16).

The maximum panicle length was measured in biennial bearing cultivar Alphonso (33.99 cm) which was at par with cultivar Langra followed by *Baramasi* and regular bearer Amrapali during both the years. The minimum panicle length was noted in cv. *Baramasi* during 2014 (Table 2). Uthaiah *et al.* (15) studied 29 varieties of mango under coastal Karnataka condition and observed that the length of panicle ranged from 12.4 cm to 38.60 cm with a mean value of 22.3 cm. Sudha *et al.* (14) found maximum panicle length (31.4cm) in Alphonso.

The period of bud break to full bloom also varied significantly among the cultivars. The maximum period of bud break to full bloom was recorded in cv. Alphonso (35.6 and 33.2 days), which was at par with cv. Langra (32.6 and 31.24 days) followed by cv. *Baramasi* (25.5 and 24.174 days) whereas, the minimum period of bud break to full bloom was recorded in cv. Amrapali (23.80 and 22.14 days) during 2013 and 2014 (Table 3). Minimum period of full bloom to maturity was observed in cultivar *Baramasi i.e.* 84.55 days and 87.60 days in the years 2013 and 2014, respectively followed by cv. Langra (98.00 days and 98.80 days) whereas, the

Table 2. Time of 50% flowering, number of panicles/branch, number of flowers/panicle and length of panicles at anthesis in *Baramasi*, regular and biennial bearing mango cultivars.

Cultivars	50% flowering from panicle emergence (Days)		No. of panicles/branch		No. of flowers/panicle		Length of panicles at anthesis (cm)	
	2013	2014	2013	2014	2013	2014	2013	2014
Baramasi	23.60	20.60	18.91	45.88	1091.20	1120.20	29.02	21.30
Amrapali	19.80	19.60	117.50	58.56	799.20	918.40	27.99	26.29
Langra	23.40	23.40	725.21	331.68	1132.00	1215.00	31.30	30.29
Alphonso	17.20	17.80	247.00	462.20	963.80	1004.80	31.72	33.99
CD (P=0.05)	1.16	1.50	25.63	21.88	83.87	76.80	1.89	1.399

Table 3. Period of bud break to full bloom, period of full bloom to maturity, flowering duration and flowering intensity of *Baramasi*, regular and biennial bearing mango cultivars.

Cultivars	Period of bud break to full bloom (days)		Period of full bloom to maturity (days)		Flowering duration (days)		Flowering intensity (No. of flowers/ft^2)	
	2013	2014	2013	2014	2013	2014	2013	2014
Baramasi	25.50	24.17	84.55	87.60	18.10	18.40	2006.40	3235.60
Amrapali	23.80	22.14	108.10	109.10	17.60	17.10	4196.00	3926.60
Langra	32.60	31.24	98.00	98.80	24.20	23.40	4448.00	4143.00
Alphonso	35.60	33.32	104.40	100.70	29.50	29.30	2891.40	3621.20
CD 0.05	0.96	0.67	3.32	3.57	0.87	0.60	306.87	283.64

maximum period of full bloom to maturity was noted in cultivar Amrapali (108.10 days and 109.10 days) followed by Alphonso (104.40 days and 100.70 days) during both the years of study (Table 3). However, not more differences were observed between two consecutive years of study. Among the cultivars, the minimum duration of flowering was observed in cv. Amrapali which was statistically at par with cv. *Baramasi*. However, it was recorded maximum in cv. Alphonso during both the experimental years. The duration of flowering in cv. *Baramasi* was 18.10 and 18.40 days, in cv. Amrapali 17.60 and 17.10, and in cv. Langra24.20 and 23.40 days, respectively in both the years of study. The maximum flowering intensity was noticed in cv. Langra (4448 flowers/ft^2 and 4143 flowers/ft^2 for 2013 and 2014, respectively) which was statistically at par with cv. Amrapali however it was noted minimum in cv. *Baramasi* (2006.4 and 3235.6 flowers/ft^2) followed by cv. Alphonso (2891.4 and 3621.2 flowers/ft^2) during both the consecutive years. Cultivars differed significantly in percentage of hermaphrodite flowers (Table 4). The maximum percentage was observed in cv. Langra (65.0 and 66.2%) followed by cv. Amrapali (39.6 and 38.4%) and cv. Alphonso (30.0 and 32.4%). While, cultivar *Baramasi* had the minimum percentage of hermaphrodite flowers (23.8 and 24.4%) during the experimental years. Data on Table 4 clearly indicated that cultivars differed significantly with respect to malformation percentage. The maximum percentage of malformed panicles was found in cv. Amrapali (7.60% during 2013 and 6.08% during 2014). However, it was recorded minimum in cv. *Baramasi* (1.33 and 1.49%) followed by cv. Alphonso (1.94 and 1.94%) in both the experimental years. Besides these, cultivar Langra at the same conditions did not show any incidence of malformation.

Table 4. Hermaphrodite flowers and malformed panicles in *Baramasi*, regular and biennial bearing mango cultivars.

Cultivars	Hermaphrodite flowers (%)		Malformed panicles (%)	
	2013	2014	2013	2014
Baramasi	23.80	24.40	1.33	1.49
Amrapali	39.60	38.40	7.56	6.08
Langra	65.00	66.20	0.0	0.0
Alphonso	30.00	32.40	1.94	1.94
CD(P=0.05)	2.78	2.06	0.17	0.18

It is reported increased nitrogen level in leaves increased the production of hermaphrodite flowers (Rajput and Tiwari, 10). Thus, high leaf nitrogen level in the month of February (flowering stage) might have exhibited increased percentage of hermaphrodite flowers. The development of hermaphrodite flowers needed more reserves from the tree than male flowers (Vijayalakshmi and Srinivasan, 16). Sex expression in mango was influenced by temperature. Higher temperature seems conducive for production of more number of perfect flowers. The significant differences in sex ratio noticed among the cultivars studied might be due to their genetic makeup, time of flowering, response to prevailing environmental conditions and the level of endogenous growth hormones. Among different climatic triggers, temperature is a key factor for floral induction in mango (Shu and Sheen, 11), which influenced the sex ratio and malformation incidence invariably (Singh *et al*, 13). Lower temperature usually favours the development of malformed panicles. In addition, it also favours the development of male flowers in higher proportion, which increases the sex ratio (Singh *et al,* 13). They also reported that panicles, which developed during December and January, when environmental temperature is comparatively low, usually have higher proportion of male flowers and they tend to be malformed than those that appeared late in the season.

Time of emergence of new flushes also differed among all the cultivars (Table 5). Cultivar *Baramasi*

Table 5. Flushing pattern of *Baramasi*, regular and biennial bearing mango cultivars.

	Date of emergence of new flushes							
Cultivars	2013							
Baramasi	17-Feb	10-Mar	12-Apr	19-May	7-June	12-July	8-Aug	13-Sep
Amrapali	20-Feb	8-Mar	2-Apr	19-May	22-June	-	-	-
Langra	-	9-Mar	7-Apr	3-May	6-June	11-July	7-Aug	-
Alphonso	15-Feb	20-Mar	19-Apr	20-May	-	7-July	-	-
	2014							
Baramasi	15-Feb	12-Mar	13-Apr	18-May	10-June	11-July	7-Aug	13-Sep
Amrapali	22-Feb	10-Mar	3-Apr	17-May	20-June	-	-	-
Langra	-	9-Mar	9-Apr	6-May	5-June	10-July	9-Aug	-
Alphonso	17-Feb	21-Mar	19-Apr	22-May	-	6-July	-	-

has the longer duration of flushing pattern in which flushing started in February and continued upto September during both the experimental years. However, in cv. Langra, it started in February and continued upto June. In case of cv. Amrapali, emergence of flushes started in March and continued up to August whereas, flushing in cv. Alphonso started in February and continued upto May and again flushes appeared during July month.

Diversity in flushing pattern of selected cultivars under same agro-climatic conditions are in agreement with the findings of Chacko (3) who reported that vegetative growth patterns of mango trees vary greatly depending upon variety. Differences in flushing pattern in these cultivars might be due to inbuilt potential which proved to be different in all cultivars under same agro-climatic conditions. Differences in month wise emergence of flushes in mango cultivars might also be due to difference in genetic makeup and environmental factors.

In the present study, *Baramasi* produced flowers five times in a year. Environmental factors played very effective role in floral induction and flushing of mango. Variation in phenological characters among the cultivars might be due to variation in climatic conditions because every cultivar have different climatic requirement. Apart from the environmental factors, individual genetic characteristics have direct effect on the performance of cultivars. This information could be used for breeding programs to improve mango productivity by producing fruits throughout the year.

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