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Studies on the growth and flowering of different mango (*Mangifera indica* L.) cultivars under Western Uttar Pradesh conditions

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Abstract

The evaluation of new cultivars adaptation and yield potential of mango (*Mangifera indica* L.) provides tools to assist and improve the mango production in different climates conditions. The study was conducted to evaluate the phenological and reproductive development of different mango cultivars. The variables were total plant height, plant spread, stem girth, date and time of panicle emergence, panicle length, date of start of flowering, date of full bloom flowering duration and fruits physical characteristics. The maximum plant height was observed in Neelum (111.13 cm and 180.33 cm) while, the average plant spread was found to be maximum in Langra (119.83 cm and 170.54 cm) in the East-West direction and (118.74 cm and 169.76 cm) in the North-South direction while, the lowest plant spread in the East-West and North-South direction was recorded in Dashehari (97.90 cm and 155.64 cm) and (97.00 cm and 149.52 cm) during both the years of investigation, respectively. Results pertaining to panicle emergence suggest that Burma Surkh, Mithwa Malda, Langra, Bombay green and Mallika had very early emergence of panicle (before 30th January). Flowering duration among mango cultivars differed significantly and it ranged between 11.33 -19.00 days and 12.00-19.00 days during both the years of experiment, respectively. It is concluded that some varieties like Langra, Burma Surkh, Bombay green, Samar-e-Behist Chausa, Sorav and Ratol were superior in most of the traits.

Keywords: phenological, yield potential, variables, flowering duration

Introduction

Mango (*Mangifera indica* L.) is the most popular fruit crop in the orient particularly in India, where it is considered as the best choice among all indigenous fruits. It is a tropical fruit originated from Indo-Burma region and grown almost all part of the world. India leads in area and production of mango in the world. This fruit occupies an area of 2.239 million hectares out of total fruit area of 6.405 million hectares and the production is 18.779 million tones out of total fruit production of 91.443 million tons in the country ^[1]. Mango has been reported to have extensive diversity due to allopolyploidy, outbreeding, continuous grafting and phenotypic differences in different mango growing regions arising from the variations in the agro-climatic conditions ^[12]. The growth of the mango trees is usually given by cycles with short repetitions throughout the year and it is depending on the cultivar, climate conditions and management ^[4]. The knowledge about the growth pattern of the mango trees is essential for establishing effective methods to handle the culture and it allows the phenotypic characteristics expressions of each genetic material. Among the mango trees phenophases, the flowering is a complex phenomenon as long as its duration and it may be extended earlier by natural conditions or artificial inductions, it depends on climatic conditions and previous crop productivity. The mango trees have higher productions in regions with cold and/or dry period preceding flowering, humid soil and maximum air temperature between 30 °C and 33 °C during the fruit development. Temperatures above 35 °C cause injury in plants and temperatures from 8 °C to 10°C during the cold period of the year may be regarded as the lower limit for the successful mango production ^[11, 17]. A temperature regime of 25 °C during the day and 15 °C during the night as prevails during this period was found to be the optimum for flower induction ^[19]. Prior to flowering, farmers do not irrigate in order to enhance drought stress to support flower induction. Flowering intensity of mangoes was found to negatively correlate with relative water content ^[10]. The knowledge of the phenology of other mango cultivars can be used for genetic breeding or even for cultivation in new planting areas and on the range of processes linked to agronomic management of the supply chain, it is important to know the periodic biological events involving the development of this species.

Looking to above fact, it was realized to ascertain the performance of different cultivars of mango growing under the agro-climatic conditions of Uttar Pradesh for different phenological

and reproductive development among mango cultivars. The information generated from this study will enable the effective utilization of mango genetic resources especially breeding programme for improvement of this crop.

Materials and Methods

The present investigation was conducted at Horticultural Research Centre (HRC) of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, during the rainy-winter to spring season of 2015 and 2016. The experiment was carried out on twenty important mango cultivars namely, Amrapali, Ramkela, Ratol, Ramkela, Dashehari, Gulab Jamun, Mithwa Malda, Mallika, Neelum, Bombay Green, Totapari, Rasgula, Langra, Samar-e-Behist Chausa, Alphonso, Husanara, Burma Surkh, Sukharu, Kedkadiya, Himayat Pasand, Gorjeet, Surya and Sorav, available at the experimental orchard of the Horticultural Research Centre (HRC) of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh. Plants of these mango cultivars were fairly old, healthy and free from diseases and pests. These plants were maintained under uniform cultural practices to ensure yield of quality fruits. Observations were made on vegetative, flowering and fruit characteristics among the different mango cultivars. The collected data on different parameters were analyzed by using analysis of variance (ANOVA) based on randomized block design (RBD).

Results and Discussion

Growth parameters

The height of plant is one of the most important quality parameters which reflect the growth and quality of mango plant. Among the cultivars, the maximum plant height was

recorded in Neelum (111.13 cm and 180.33 cm) followed by Husanara (109.07 cm and 179.83 cm) and Kedkadiya (108.43 cm and 179.03 cm). However, minimum plant height was recorded in Bombay Green (102.93 cm and 174.02 cm). The variation in plant height among the different varieties could be due to the variation in genetic make-up under the present set of environmental and edaphic conditions [5]. High variability in plant height amongst the mango varieties have also been determined by Majumder *et al.*, [9] and Joshi *et al.*, [5]. The data with respect to plant spread indicated that the average East-West spread was found to be maximum in Langra (119.83 cm and 170.54 cm) while, the lowest average East-West spread was recorded in Dashehari (97.90 cm and 155.64 cm) during both the years of study. As far as the data pertaining to North-South spread, similar results were obtained as was recorded in East-West spread. The cultivar Langra had recorded maximum plant spread (118.74 cm and 169.76 cm) while, minimum North-South spread was recorded in Dashehari (97.00 cm and 149.52 cm). This variation with respect to plant spread among the different cultivars may be due to spreading and intermediate spreading habit of the cultivar. Similar results have also been reported by Reddy *et al.*, [13] and Sharma and Singh [16]. Perusal of data recorded on stem girth for different mango varieties indicated that, Ramkela, Sorav, Ratol, Alphonso, Mallika, Langra and Dashehari gave significant higher stem girth as compared to the other varieties. The variation in vegetative growth characters with respect to stem girth among mango varieties might be due to variation in genetic make-up. The more or less similar result has been reported by Reddy *et al.*, [13] and Dalal *et al.*, [3].

Growth Parameters

Treatments	Plant height (cm)		Plant spread (cm)			
	2015	2016	2015		2016	
			E-W	N-S	E-W	N-S
Amrapali	104.53	174.83	111.45	110.50	163.65	162.27
Ramkela	106.53	176.63	112.80	111.90	163.84	162.84
Ratol	106.50	175.60	98.50	97.60	156.21	149.82
Dashehari	108.07	177.91	97.90	97.00	155.64	149.52
Gulab Jamun	108.37	178.47	106.02	105.10	161.72	156.52
Mithwa Malda	104.47	174.77	104.21	103.18	160.81	152.16
Malika	106.47	175.57	107.93	107.01	162.62	158.43
Neelum	111.13	180.33	109.32	108.40	162.98	159.54
Bombay Green	102.93	174.02	111.03	110.31	163.11	161.98
Totapari	106.05	175.18	115.22	114.13	166.12	164.32
Rasgula	106.00	175.05	114.20	113.11	165.16	164.66
Langra	103.97	174.07	119.83	118.74	170.54	169.76
Samar-e-Behist Chausa	104.97	175.00	114.11	113.02	163.02	164.12
Husanara	109.07	179.83	110.48	110.24	159.02	161.82
Alphonso	103.87	174.07	101.70	102.61	159.41	151.93
Sorav	104.31	174.17	117.03	115.94	169.74	166.56
Burma Surkh	107.83	177.13	115.46	114.56	166.39	164.92
Sukharu	108.11	178.27	118.43	116.34	169.84	167.12
Kedkadiya	108.43	179.03	114.20	113.11	165.19	164.28
Himayat Pasand	107.11	177.02	118.83	118.34	170.03	168.56
Gorjeet	106.17	175.27	116.22	115.32	168.12	166.02
Surya	106.81	177.00	111.14	110.35	163.55	162.13

Flowering and fruiting characteristics

Significant differences were observed among the mango cultivars with respect to date and time of panicle emergence. The date of panicle emergence was found to be earliest in variety Burma Surkh (27th January-08th February and 28th January-09th February) while, late panicle emergence was noticed in varieties Ramkela (05th February-11th February and

02nd February-10th February). As far as the time of panicle emergence is concerned, it was revealed that earliest time for panicle emergence was taken by variety Ramkela (4.00 days and 5.33 days) followed by Amrapali (4.67 days and 5.67 days) and Samar-e-Behist Chausa (4.67 days and 5.67 days). However, the cultivar Burma Surkh (10.67 days and 10.00 days) took maximum time for panicle emergence. The

seasonal cyclic change of growth, flower, fruit and their development differ between cultivars and geographical location. The variation observed in terms of panicle initiation might be due to the differences in genetic composition of parental mango cultivars. 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 three months during winter. The reproductive flushes are also usually asynchronous in tropics. Synchronized flowering flushes, throughout the canopy in sub tropics, are primarily due to lower night temperature (5-10 °C). In places of less night temperature (10-18 °C) as in tropics, asynchronous reproductive flushes are common. Fruit bearing stem do not initiate new lateral shoots until several months after separation of fruit and rachis from the stem [7]. Such delayed vegetative growth can reduce the potential for new shoots to flower during the next flowering season. The panicle length was observed highest in cultivar Samar-e-Behist Chausa (36.26 cm and 36.14 cm) which differed significantly with the panicle length of other cultivars. However, minimum panicle length was recorded in Totapari (15.45 cm and 16.14 cm). The variation in size and shape of panicles in mango cultivars might be due to genetic composition and more specifically the physiological condition of the shoot on which panicle arise. 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 meter had distinct variation in eight mango cultivars and hybrids under agro-climatic conditions of Odisha. In the experiment, the earliest flowering (05th March and 04th March) was observed in cultivar Bombay Green closely followed by Rasgulla (07th March and 05th March) and Mithwa Malda (08th March and 07th March), whereas the flowering occurred late in cultivar Kedkadiya (15th March and 17th March). The differences in time of appearance of flowers in different cultivars might be due to genetic constitution of a particular cultivar. The present findings support the observations made by [17] who stated that Bombay Green being the earliest maturing cultivar flowered earliest in north Indian conditions among the commercial cultivars grow in the region. Flowering duration indicates the period required for opening of first flower to opening of last flower on a particular panicle. Among the varieties evaluated, the flowering was completed rapidly in the variety Bombay Green (11.33 days and 12.00 days) followed by Mithwa Malda (11.33 days and 12.33 days) and Ramkela (12.00 days and 12.33 days). Whereas, the varieties Burma Surkh required maximum days (19.00 days and 19.00 days) for complete flowering. The duration of flowering in mango is dependent

on maturity of shoot and prevailing weather conditions. Mango produces flowers on the shoot terminals. Flowers are also borne on the older flushes of more than two years. The flowers dominate the terminals and if fruit are set, the vegetative growth does not occur from these terminals until the crop is harvested. If the flowers fail to set the fruit or fruit drop occur prematurely, the terminals produce vegetative growth immediately. Schnell and Knight [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. They observed significant differences in flowering responses among cultivars and concluded that the repeatability of each of the flower phenology characters was high indicating that much of this variation is heritable and useful for further breeding. The fruit size in terms of fruit length and breadth among the mango cultivars showed wide and significant variation. Among the mango varieties, fruit length was found highest in Sorav (12.47 cm and 11.86 cm), which was found statistically significantly higher as compare to the other varieties while, the lowest fruit length was recorded in variety Ratol (7.02 cm and 7.36 cm). The other cultivars had intermediate fruit length. The fruit breadth was found maximum in Rasgulla (8.02 cm and 8.06 cm), which was statistically significant higher over other varieties, followed by Gulab Jamun (7.32 cm and 7.36 cm) and Mallika (7.28 cm and 7.33 cm). However, the minimum fruit breadth was recorded in variety Surkharu (5.07 cm and 5.11 cm). Change in geographical location or inherent genetic variations could be the major reason for variation in fruit length and breadth among different cultivars. Similar results were obtained by [15] in mango under Punjab condition. The results of present study are also in accordance with the findings of [7] who concluded that the fruit size of mango cultivars differed in fruit length and breadth according to their genetic makeup.

Conclusion

There were distinct variations for different vegetative and flowering characters among mango cultivars under study. On the basis of results obtained it may be concluded that the varieties like Langra, Burma Surkh, Bombay Green, Samar-e-Behist Chausa, Sorav and Ratol were superior in most of the characters. The information generated from this study will be useful for various stakeholders like breeders for improvement of varieties by selecting the suitable parental material, food processors by selecting the varieties with suitable nutritional value, etc. This research work can be further validated by evaluating these varieties with suitable molecular markers.

Flowering characteristics

Treatments	Date of panicle emergence		Time of start of panicle emergence (Days)		Panicle length (cm)		Date of start of flowering		Duration of flowering (Days)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
	Amrapali	02 February-07 February	04 February-11 February	4.67	5.67	28.09	27.80	10 March	10 March	15.00
Ramkela	05 February-11 February	02 February-10 February	4.00	5.33	18.99	18.83	15 March	16 March	12.00	12.33
Ratol	03 February-11 February	03 February-12 February	7.00	6.33	19.55	19.26	13 March	15 March	17.67	18.00
Dashehari	01 February-08 February	03 February-11 February	6.67	6.00	20.33	19.91	09 March	09 March	13.33	15.00
Gulab Jamun	01 February-10 February	02 February-11 February	8.67	8.33	24.98	24.86	10 March	10 March	12.00	12.33
Mithwa Malda	28 January-10 February	29 January-08 February	10.33	9.67	27.54	26.69	08 March	07 March	11.33	12.33
Malika	30 January-07 February	30 January-08 February	7.67	7.00	31.16	30.67	10 March	10 March	17.00	17.67
Neelum	04 February-10 February	04 February-09 February	5.33	5.67	31.09	30.04	08 March	07 March	12.00	12.33
Bombay Green	30 January-06 February	29 January-07 February	6.67	6.33	19.18	18.65	05 March	04 March	11.33	12.00
Totapari	03 February-13 February	03 February-13 February	9.00	8.67	15.45	16.14	11 March	12 March	14.33	16.00

Rasgulla	01 February-09 February	01 February-10 February	7.67	7.33	27.82	27.07	07 March	05 March	18.00	18.33
Langra	30 January-07 February	30 January-10 February	7.67	7.00	21.58	21.68	09 March	08 March	14.00	15.67
Samar-e-Behist Chausa	02 February-07 February	01 February-09 February	4.67	5.67	36.26	36.14	09 March	08 March	13.00	14.67
Husanara	04 February-14 February	03 February-10 February	8.33	8.00	23.23	22.96	12 March	13 March	15.33	16.67
Alphonso	02 February-10 February	02 February-11 February	7.33	7.00	21.25	20.86	10 March	11 March	13.67	15.33
Sorav	05 February-14 February	06 February-13 February	8.00	7.67	28.57	27.94	11 March	12 March	15.67	17.00
Burma Surkh	27 January-08 February	28 January-09 February	10.67	10.00	21.09	20.64	11 March	11 March	19.00	19.00
Surkharu	03 February-14 February	02 February-13 February	9.33	9.00	25.15	25.33	09 March	08 March	16.67	17.33
Kedkadiya	04 February-13 February	05 February-15 February	7.33	7.00	17.33	17.69	15 March	17 March	12.67	14.67
Himayat Pasand	03 February-12 February	04 February-14 February	8.00	7.67	21.06	20.56	13 March	15 March	17.00	17.67
Gorjeet	02 February-12 February	03 February-14 February	8.00	8.00	21.72	21.70	09 March	08 March	13.33	15.00
Surya	01 February-12 February	02 February-13 February	10.00	9.33	18.14	18.47	08 March	07 March	18.67	18.33

Fruiting Characteristics

Treatments	Fruit length (cm)		Fruit width (cm)	
	2015	2016	2015	2016
Amrapali	8.40	8.44	5.85	5.90
Ramkela	7.17	7.21	6.53	6.58
Ratol	7.02	7.36	5.65	5.70
Dashehari	9.83	9.98	5.83	5.88
Gulab Jamun	9.25	9.09	7.32	7.36
Mithwa Malda	9.33	9.17	6.42	6.46
Malika	10.98	10.52	7.28	7.33
Neelum	10.95	10.41	6.15	6.20
Bombay Green	8.95	8.68	6.00	6.05
Totapari	8.72	8.45	5.18	5.23
Rasgulla	9.80	9.53	8.02	8.06
Langra	9.48	9.41	6.48	6.53
Samar-e-Behist Chausa	10.53	10.00	6.33	6.38
Husanara	8.28	8.26	5.35	5.59
Alphonso	8.63	8.51	6.47	6.51
Sorav	12.47	11.86	7.13	7.18
Burma Surkh	9.38	9.26	5.82	5.86
Surkharu	8.23	8.11	5.07	5.11
Kedkadiya	7.60	7.98	7.08	7.13
Himayat Pasand	7.52	7.69	6.40	6.45
Gorjeet	7.67	8.04	6.23	6.28
Surya	7.17	7.34	6.18	6.23

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