Indian J. Plant Genet. Resour. 28(3): 296-302 (2015)
DOI 10.5958/0976-1926.2015.00038.8

Performance of Certain Mango Varieties and Hybrids in East Coast of India

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(Received: 27 August 2014; Revised: 22 August 2015; Accepted: 24 August 2015)

Mango varieties and hybrids were evaluated for flowering behaviour, fruit maturity, yield and physico-chemical properties during 2011-14 at the research farm of Central Horticutural Experiment Station, Bhubaneswar. December was the critical month for panicle initiation, whereas January was the major period for peak bloom under the eastern tropical coastal region. In Dashehri, Langra, Mallika, Neelgoa and Sabri there was a marginal deviation in panicle initiation during the study period whereas, Arka Neelachal Kesari, Arka Neelkiran, AU-Rumani, Totapuri, and Sindhu showed wide deviation. Manjeera had the highest flowering intensity (85.3 per cent) whereas Amrapali, PKM-2, Arka Aruna and Arka Puneet had moderate intensity. Zardalu had the lowest flowering intensity. The maximum percentage of perfect flower (34.03) was recorded in Neelgoa followed by Arka Anmol and Lat Sundari. Arka Neelachal Kesari was the extra early mango with shortest fruit maturity period (88.3 days), whereas Totapuri had the longest fruit maturity period (142.3 days). Manjeera, Amrapali, Mallika and Lat Sundari were observed to be heavy bearer, whereas Alphonso, Zardalu, Bombay Green and Ratna showed poor yield potential. Sindhu recorded the highest pulp percentage. Amrapali was the sweetest variety with maximum TSS and TSS/acid ratio.

Key Words: Evaluation, Flowering intensity, Mango, Panicle, Perfect flower, Pulp content, Varieties

Introduction

Mango (*Mangifera indica* L.), the fifth most important fruit in the world, is being cultivated in more than 90 tropical and subtropical countries situated in different continents *viz.* Asia, Africa, Australia, North America and South America (Litz, 1997). Mango has been the most important fruit of India due to its wide range of adaptability, diversity, delicacy and nutritive value. It is cultivated in 2.37 million hectares area with the production of 16.19 million metric tonnes and productivity of 6.8 t/ha (Anonymous, 2012). In spite of high demand of fresh mango in the international markets the area, production and productivity of mango have marginally increased during the last five years.

The flowering behaviour, sex expression, yield and fruit quality of mango are primarily influenced by climate, cultivars, rootstock and tree physiology (Reddy *et al*., 2003; Padhiar *et al*., 2011; Parmar *et al*., 2012; Singh *et al*., 2012, 2013; Kumar *et al*., 2014). It has been observed that the flowering pattern of mango varieties expresses differentially under tropical and subtropical conditions (Davenport, 2003). Even in the same region, different weather conditions during different years can affect flowering behaviour. The flowering pattern in tropical climate of India is distinctly different as flowering starts in November and extends up to February. Variation in the flowering pattern under different climatic conditions is attributed to physiology of flowering. Under tropical condition emergence of flowering flushes depend on shoot age, whereas low temperature induces flowering in sub-tropics (Davenport and Nunz-Elisea, 1997). Mango is andromonoecious as plant bears both perfect and male flowers in the same panicle. The distribution pattern and intensity of both types of flowers vary with cultivar, bloom time and environmental factors (Singh, 1960).

Flowering behaviour, sex expression, yield and physico-chemical attributes of mango varieties are important determinants of assessing their performance. Since these attributes are influenced by climate, an evaluation programme of mango varieties was conducted to compare their relative performance so that the best performating varieties/hybrids could be recommended for the eastern coastal region of India.

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Materials and Methods

Studies were conducted on 12-15 years old mango varieties and hybrids during 2011-12, 2012-13 and 2013-14 at the research farm of Central Horticultural Experiment Station, Bhubaneswar, Odisha. The research site is situated at an altitude of 45m between 20°27' N latitude and 85°40' E longitude. The climate of the location is tropical, hot and humid with the average minimum and maximum temperature of 22.2 and 33.7 °C, respectively. The average annual rainfall was 1650 mm and the average relative humidity was 76%. The soils are sandy loam, strongly acidic (pH 4.0-4.5) and low in organic carbon content (0.38-0.47%). The site has hardly 0.5-0.7 m soil depth. The mango block has low N (<200 kg/ha), medium P (10-15 kg/ha) and K contents (150-200 kg/ha). Thirty mango hybrids (Alfazli, Amrapali, Arka Anmol, Arka Aruna, Arka Neelkiran, Arka Puneet, AU Rumani, Ambika, Arunika, H-949, H-1084, H-1739, Pusa Arunima, Mahmud Bahar, Mallika, Manjeera, Neeleshan, Neeleshwari, Neelgoa, Neelphonso, Neeluddin, PKM-1, PKM-2, Prabha Shankar, Ratna, Sabri, Sai Sugandh, Sindhu, Sundar Langra, Swarna Jehangir) and fifteen varieties [Arka Neelachal Kesari, Alphonso, Banganapalli, Bombay Green, Dashehari, Himsagar, Janardan Pasand, Kesar, Langra, Lat Sundari, Navneetham, Pusa Surya (selection), Rajapuri, Suvarnarekha and Totapuri] were evaluated for their flowering behaviour, yield and physico-chemical properties. Flower initiation and full bloom (75% flowering) were observed on four tagged branches (one each towards east, west, north and south directions) in five trees of individual variety. The number of perfect (hermaphrodite) flowers per panicle was recorded at the full bloom in four panicles on each replicate for all the varieties. Reproductive shoots (panicle bearing) per square meter canopy were counted in all the directions in the replicates and flowering intensity was worked out with the following formula:

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

The days between the initial fruit set (mustard stage) and physiological fruit maturity was considered as the maturity period of mango varieties and for this twenty panicles were tagged just after initial fruit set in all the replicates and days were recorded as fruits matured. The average fruit yield was worked out in kg/tree by taking the average fruit yield of six plants each year. Fruits were randomly collected from marked trees at the time harvesting period and analysed for various physico-chemical attributes. Average fruit weight (g), pulp weight (g), stone weight (g) and pulp/stone ratio were determined using standard methods. The pulp percentage was calculated by using following formula:

$$\text{Pulp percentage} = \frac{\text{Fruit wt.} - (\text{peel wt.} + \text{stone wt.}) \times 100}{\text{Fruit wt.}}$$

The TSS was measured with the digital refractometer (0-85%) and acidity was estimated by 0.1N NaOH method and TSS/acid ratio was worked out (AOAC, 1984). Data were subjected to factor analysis (ANOVA) by using OPSTAT package HAU, Hisar and critical difference (CD) and standard error of mean were calculated. The weather data were obtained from the meteorological unit of Odisha University of Agricultural Technology, Bhubaneswar.

Results and Discussion

December and January were the most crucial period for panicle initiation and peak flowering, respectively in majority of the mango varieties. However, Arka Nelachal Kesari had the earliest panicle initiation and peak flowering and Langra, PKM-2, H-1084, H-1739 and Dashehari showed late panicle initiation and peak flowering (Table 1). There was a variation in the date of panicle initiation and peak flowering in mango varieties (data not shown) during the study period. However, the months were remained unchanged. Tandel and Patel (2011) also observed full bloom in Alphonso, Kesar and Rajapuri in January under Gujarat conditions. Peak flowering (full bloom) was observed after 35-42 days of panicle initiation across the varieties. It was observed that except Arka Neelachal Kesari, varieties known for early fruit maturity like Himsagar, Sabri and Prabha Sankar were not necessarily early in flowering but their fruit maturity was relatively faster.

There was a significant variation in flowering intensity among mango varieties (Table 1). Manjeera had the highest intensity and Zardalu had the lowest. Arka Anmol, Arka Puneet, Neeleshan, Amrapali, and Arka Aruna had relatively high intensity of flowering. Alphonso, Alfazli, Ambika, Arunika, Bombay Green, H-1084, Janardan Pasand, Langra, Neeleswari, Pusa Arunima and Ratna had low flower intensity. Remaining varieties had moderate flowering intensity. Kumar *et al.* (2014) also reported variation in flowering intensity

Table 1. Flowering behaviour and fruit maturity in mango varieties and hybrids

Varieties	Panicle initiation	Peak flowering	Flowering intensity (%)	Flowers/ panicle	Perfect flower (%)	Fruit maturity period (days)	Fruit maturity
Alfazli	January	February	10.06	384.67	10.92	132.5	May
Alphonso	December	January	19.20	520.50	4.23	123.4	May
Ambika	December	January	21.01	668.67	9.02	121.5	May
Amrapali	December	January	67.08	929.67	15.45	117.8	May
Arka Anmol	December	January	72.58	610.20	27.63	134.6	May
Arka Aruna	December	January	62.05	1185.67	3.71	127.5	May
Arka Neelachal Kesari	November	December	45.35	912.50	16.16	88.3	April
Arka Neelkiran	December	January	83.44	815.33	4.78	124.6	May
Arka Puneet	December	January	76.82	635.33	5.61	125.5	May
Arunika	January	February	24.64	946.30	19.45	123.6	May
AU Rumani	December	January	21.54	1100.50	27.58	128.6	May
Banganapalli	December	January	58.91	770.80	9.60	137.6	May
Bombay Green	December	January	16.08	334.50	26.00	116.4	May
Dashehari	January	February	25.98	531.67	27.50	106.5	May
Himsagar	December	January	14.86	337.51	4.30	93.6	April
H-949	December	January	56.59	1007.27	19.40	125.4	May
H-1084	January	February	17.59	622.33	3.34	134.4	June
H-1739	January	February	41.71	1380.00	14.5	123.4	May
Janardan Pasand	December	January	12.97	574.33	13.90	129.2	May
Kesar	December	January	49.61	609.67	9.73	118.3	May
Langra	January	February	15.44	1019.00	26.86	112.3	May
Lat Sundari	December	January	55.63	1141.67	27.33	124.6	May
Mahmud Bahar	December	January	21.90	1463.67	17.37	114.2	May
Mallika	December	January	53.98	449.00	3.29	124.4	May
Manjeera	December	January	85.37	709.33	4.62	132.4	May
Navneetham	December	January	32.50	725.60	11.30	115.4	May
Neeleshan	December	January	49.32	2159.33	8.92	124.6	May
Neeleswari	December	January	4.54	499.60	8.96	127.8	May
Neelgoa	December	January	57.76	628.67	34.03	129.4	May
Neelphonso	December	January	31.40	866.00	17.50	131.2	May
Neeluddin	December	January	33.89	546.20	17.25	130.4	May
PKM-1	December	January	37.44	822.40	18.41	123.4	May
PKM-2	January	February	65.61	530.67	13.32	118.4	May
Prabha Sankar	December	January	45.05	1019.33	12.13	95.4	April
Pusa Arunima	December	January	5.72	920.30	5.79	125.4	May
Pusa Surya	December	January	20.73	1270.33	7.90	126.3	May
Ratna	December	January	12.56	658.80	9.68	122.8	May
Sabri	December	January	59.55	605.67	17.0	97.5	May
Sai Sugandh	December	January	54.67	1087.33	16.84	140.3	June
Sindhu	December	January	26.69	1169.33	9.04	112.6	May
Sundar Langra	December	January	59.55	2395.60	7.98	98.4	May
Swarna Jehangir	December	January	54.49	1249.62	7.50	136.5	May
Suvarnarekha	December	January	46.13	496.80	14.72	122.5	May
Totapuri	December	January	48.64	721.67	4.19	142.3	June
Zardalu	December	January	2.90	799.00	9.93	125.4	May
CD *(P=0.05)*	**–**	**–**	**2.86**	**137.24**	**2.40**	**2.87**	**–**
SE(m)	**–**	**–**	**1.01**	**48.75**	**0.85**	**1.02**	**–**

Table 2. Physico-chemical attributes of mango varieties and hybrids

Varieties	Fruit weight (g)	Pulp content (%)	Pulp/stone ratio	TSS/acid ratio
Alfazli	445.0	77.5	6.9	35.5
Alphonso	280.5	65.7	4.8	49.4
Ambika	325.4	69.5	3.4	52.2
Amrapali	224.6	74.2	5.8	72.3
Arka Anmol	225.4	64.5	3.3	20.3
Arka Aruna	440.3	76.2	6.0	39.1
Arka Neelachal Kesari	220.6	67.5	4.1	43.5
Arka Neelkiran	251.2	69.0	4.3	42.3
Arka Puneet	210.9	64.2	3.2	40.5
Arunika	190.2	65.4	4.4	70.6
AU Rumani	187.6	72.5	5.6	42.2
Banganapalli	380.6	68.7	4.3	45.3
Bomabay Green	300.4	74.7	5.8	37.1
Dashehari	182.4	70.4	4.7	52.6
Himsagar	360.2	71.6	5.2	52.8
H-949	220.3	72.2	5.7	42.7
H-1084	230.5	65.2	3.3	37.2
H-1739	231.2	68.4	4.1	63.4
Janardan Pasand	220.3	68.7	4.4	23.8
Kesar	250.4	67.8	4.2	34.2
Langra	310.4	75.8	6.7	46.2
Lat Sundari	220.6	68.2	3.7	26.4
Mahmud Bahar	268.4	67.4	3.5	50.8
Mallika	381.4	76.8	6.7	55.9
Manjeera	389.5	74.2	5.4	40.5
Navneetham	234.6	74.5	6.4	34.5
Neeleshan	380.6	72.6	6.3	43.6
Neeleswari	230.7	76.5	6.8	37.2
Neelphonso	370.5	63.2	4.4	39.7
Neelgoa	305.7	75.1	6.5	37.5
Neeluddin	435.2	69.4	5.5	40.8
PKM-1	295.7	68.2	4.9	40.2
PKM-2	180.6	66.3	4.1	40.9
Prabha Sankar	192.4	68.2	4.2	45.5
Pusa Arunima	285.7	76.4	6.6	55.4
Pusa Surya	360.7	76.0	6.5	40.5
Ratna	300.4	76.5	6.8	65.3
Sabri	185.9	70.4	5.4	36.4
Sai Sugandh	306.2	72.3	5.7	30.4
Sindhu	260.7	78.8	7.1	51.2
Sundar Langra	292.4	75.6	6.6	48.5
Swarna Jehangir	432.4	77.2	6.8	29.4
Suvanarekha	380.6	75.0	6.6	27.9
Totapuri	450.7	74.1	5.4	30.4
Zardalu	230.4	66.6	4.1	33.5
CD (*P=0.05*)	**21.7**	**1.47**	**0.29**	**1.95**
SE(m)	**7.71**	**0.52**	**0.10**	**0.69**

in mango varietes under tropical condition. The high intensity of flowering in some of the mango varieties may be due to the synchronization 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).

Significant variation was observed in the number of flowers per panicle and intensity of occurrence of

perfect flowers (Table 1). Number of flowers per panicle varied from 384.67 in Alfazli to 2395.60 in Sundar Langra. Arka Aruna, H-1739, H-949, Langra, Latsundari, Mahmud Bahar, Prabha Sankar, Pusa Surya, Sai Sugandh, Sindhu and Swarna Jehangir also had high number of flowers per panicle. In contrast, Swarnarekha, Mallika, AU-Rumani and Neeleshan Gujarat had fewer flowers in their panicles. Mango bears male and perfect flowers in the same panicle; however their intensities vary with the varieties, position of panicle and climatic conditions. The per cent of perfect flower varied between 3.72–34.03 per cent in different mango varieties. The maximum percentage of perfect flower was observed in Neelgoa followed by Arka Anmol and Lat Sundari. Arka Aruna, Alphonso, Arka Neelkiran, H-1084, Mallika, Manjeera and Totapuri had relatively less number of perfect flowers. The remaining varieties had moderate intensity perfect flower. The varieties with high per cent of perfect flower would have high sex ratio and vice versa as the sex ratio is the ratio between perfect and male flowers. Studies indicated the varietal difference in the intensity of flower and perfect flower per panicle. Flowering behaviour and sex expression are vital indicators for assessing the potential of varieties under particular climatic conditions. Under tropical eastern region, mango flowering was earlier than subtropical region which indicated role of climate in influencing flowering behaviour (Ravishankar *et al*., 1979). Mango responds to temperature variations more critically than to photoperiods as is evident from variation in flowering behaviour at different places in India (Kumar *et al*., 2014). Many reports substantiate the findings on the variation in perfect flowers with the varieties and growing conditions (Singh and Rajput, 1990; Vijayalakshmi and Srinivasan, 2002; Sweidan *et al.,* 2007; Abourayya *et al*., 2011).

A significant variation in the fruit maturity of mango varieties was observed (Table 1). Arka Neelachal Kesari had the shortest maturity period followed by Himsagar and Prabha Sankar and these varieties mature in April. On the other hand, Totapuri and Sai Sugandh matured in June with the fruit maturity period of more than 140 days. Most of the varieties matured in May with the maturity period of 120-30 days. It is evident that early variety had short fruit maturity period.

Mango varieties varied in their yield potential (Fig 1). Under the tropical coastal climate Manjeera was the most productive variety followed by Lat Sundari, Amrapali, and Mallika. Arka Anmol and Totapuri were also prolific bearers. Data clearly indicated that Alphonso, Zardalu, Bombay Green, Ratna and Kesar were less suited to this climate as they had consistently poor fruit yield. Other mango varieties had average to modium yield potential. Under Gujarat condition Kesar, Totatpuri and Mallika were prolific bearers wheras under Punjab Condition Mallika and Dashehari were relatively more productive mango varieties (Gunjate *et al*., 2009; Chanana *et al*., 2005). Among mango varieties, Alfazli, Arka Anmol, Neeluddin and Totapuri had large fruits weighing more than 400g, whereas Dashehari, Prabha Sankar, AU Rumani, and Arunika had small fruits of less than 200g. The fruit weight of remaining varieties and hybrids varied from 210.9 to 389.5 g. The pulp content and pulp to stone ratio are important characters of table varieties of mango. The highest pulp content (78.8%) and pulp stone ratio (7.1) were recorded in Sindhu followed by Alfazli, Ratna, Neeleswari and Swarna Jehangir. High pulp content and pulp/stone ratio were also recorded in Langra, Mallika, Pusa Arunima and Pusa Surya. Whereas, Arka Anmol, Arka Puneet, H1084, Lat Sundari and Mahmud Bahar had low pulp and pulp/stone ratio. Varieties show variation in pulp content with the growing conditions. The pulp content of mango varieties varied with the climatic conditions (Anil and Radha, 2003; Padhiar *et al*., 2011). The TSS and TSS/acid ratio are the most important parameters to measure the fruit maturity and fruit quality. The highest TSS (21.9 °Brix) and TSS/acid ratio (72.3) were recorded in Amrapali (Fig. 1). However, Arunika, Himsagar, H1739, Mallika, Ratna and Sindhu also had high TSS and TSS/acid ratio (Table 1). Data clearly indicated that Arka Anmol, AU Rumani, Lat Sundari, Totapuri and Alfazli had low TSS (< 15 °Brix) and TSS/acid ratio which indicate that these varieties are not suitable for table purpose. The variation in TSS is climate dependent as Dashehari and Langra had high TSS in the plateau of Madhya Pradesh (Singh *et al*., 2013).

Acknowledgements

We are thankful to Dr IS Yadav, Dr PP Reddy, Dr SD Sikhamani, Dr AS Sidhu for their valuable suggestions to carry out evaluation programme of mango. We sincerely thank Dr OP Vijaya, Dr G Nayak, Dr V Pandey, Dr Vishal Nath and Dr Dinesh Kumar for their help. Authors are thankful to Mrs Suchita Behra for her assistance in taking observations on various parameters. We duly acknowledge anonymous reviewers for their valuable comments.

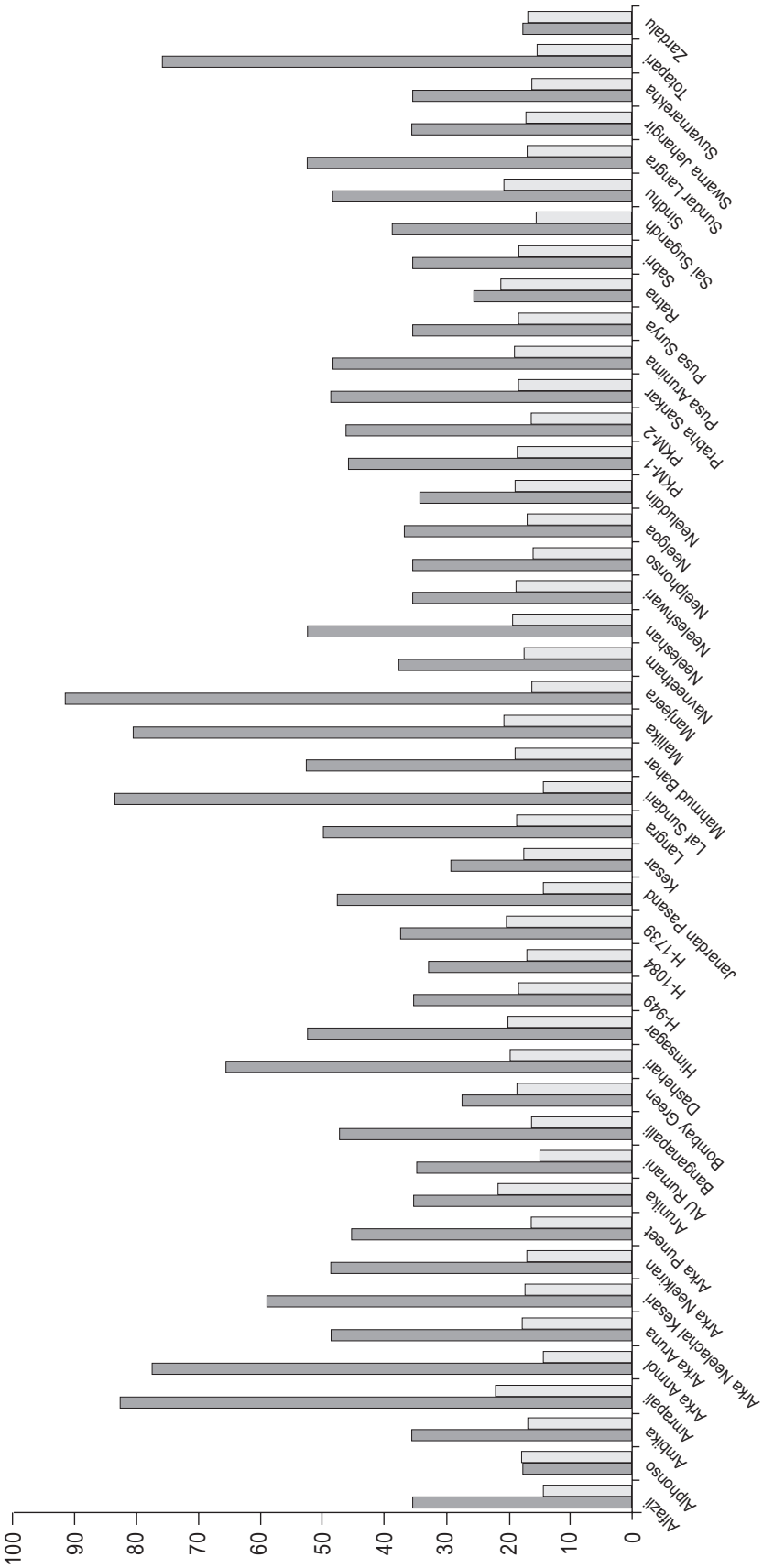

Fig. 1. Variation in fruit yield (Kg/tree) and TSS (Brix) of mango varieties and hybrids

References

Abourayya MS, NE Kassim, MH El-Sheikh and AM Rakha (2011) Comparative study between inflorescence characteristics, pollen viability, germination and dimensions of Tommy Atkins, Kent and Keitt mango cultivars. *Life Sci. J.* **8**: 100-105.

Anil R and T Radha (2003) Physico-chemical analysis of mango varieties under Kerala conditions. *J. Trop. Agri.* **41**: 20-22.

Anonymous (2012) *Indian Horticulture Database*, National Horticulture Board, Govt. of India, Gurgaon.

AOAC (1984) *Official Methods of Analysis*. 14th ed. Association of Official Analytical Chemists, Washington, DC, USA, pp. 160-186.

Chanana YR, JS Josan and PK Arora (2005) Evaluation of somw mango cultivars under north Indian conditions. *Proc. Int. Conference on Mango and Date Palm Culture & Export*. 20-23 June, Faisalabad, Pakistan.

Davenport TL (2003) Management of flowering in three tropical and subtropical fruit tree species. *Hort Sci*. **38**:1331-1335.

Davenport TL and R Nunez-Elisea (1997) Reproductive biology. *In:* RE Litz. (ed.) *The mango, Botany, Production and Uses*. CAB International Univ. Press, Cambridge, New York, pp. 69-146.

Gunjate RT, AR Kumbhar, IM Thimaiah and SM Amin (2009). Growth and fruiting of some mango cultivars under high density plantation in arid conditions of Gujarat (India). *Acta Hort*. **820**: 463-468.

Kumar M, VP Ponnuswami, PK Jeya and S Saraswathy (2014) Influence of season affecting flowering and physiological parameters in mango. *Sci. Res. Esse.* **9**: 2336-2341.

Litz RE (1997) *The Mango, Botany, Production and Uses*. CAB International Univ. Press, Cambridge, New York.

Padhiar BV, SN Saravaiya, KA Tandel, MP Ahir, PP Bhalerao and RR Bhalerao (2011) Performance of fruits of nine mango cultivars under South Gujarat conditions in relation to physical characters. *The Asian J. Hort*. **6**: 293-297.

Parmar VR, PK Shrivastava and BN Patel (2012) Study on weather parameters affecting the mango flowering in south Gujarat. *J. Agromet.* **14**: 351-353.

Reddy YTN, RM Kurian, PR Ramachander, G Singh and RR Kohli (2003) Long-term effects of rootstocks on growth and fruit yielding patterns of 'Alphonso' mango (*Mangifera indica* L.). *Sci. Hort*. **97**: 95–108.

Ravishankar H, MM Rao and Bojappa (1979). Fruit-bud differentiation in mango 'Alphonso' and 'Totapuri' under mild tropical rainy condition. *Sci. Hort*. **10**: 95–99.

Singh AK and CBS Rajput (1990) Effect of GA, BA, and calcium on vegetative growth and flowering in mango (*Mangifera indica* L.). *Res. Dev. Rep.* **7**: 1-11.

Singh NP, N Jerath, G Singh and PPS Gill (2012) Physico-chemical characterization of unexploited mango diversity in sub-montane zone of Northern India. *Indian J. Plant Genet. Resour*. **25**: 261-269.

Singh RN (1960) Studies in the differentiation and development of fruit buds in mango (*Mangifera indica* L.). IV. Periodical changes in the chemical composition of shoots and their relation with fruit-bud-differentiation. *Hort. Adv.* **4**: 48-59.

Singh TK, J Singh and DB Singh (2013) Performance of mango varieties in Kymore plateau of Madhya Pradesh. *Prog. Hort.* **45**: 268-272

Sweidan AM, MM Khattab, GM Haseeb and MA El Kheshin (2007) Evaluation of some mango cultivars under desert conditions at Wadi El-Faregh region, Egypt. *J. Appl. Sci.* **2**: 149-160.

Tandel YN and NL Patel (2011) Effect of chemicals on growth, yield and economics of mango (*Mangifera indica* L.). *Karnataka J. Agri. Sci.* **24**: 362-365.

Vijayalakshmi D and PS Srinivasan (2002) Impact of chemicals and growth regulators on induction of flowering in off year mango cv. Alphonso. *Orissa J. Hort.* **30**: 32-34.