Original Research Article

Varietal Characterization and Quality Assessment of Mango Hybrid and their Parents through Morphological and Biochemical Markers

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A B S T R A C T

Although, India is the largest mango producing country in the world and also is the home of more than 1,000 mango cultivars but the productivity of mango in our country is low. Hence improvement work for the development of mango cultivars with higher yield and productivity is the utmost importance. For successful improvement work, proper identification of genetic resources or the parental materials is the basic need. Hence, the aim of study was to identify, characterize and recommend mango cultivars to broaden the varietal spectrum. The selected samples were described for various characteristics of tree growth (tree height, shape, foliage colour and density), leaf (leaf length, leaf width, leaf area and leaf shape), fruit (length, width, weight, colour and their attractiveness) and biochemical attributes (total soluble solids, titrable acidity, TSS/acidity ratio, chlorophyll content & beta-carotene). Of the 8 hybrids with their parentage, only three hybrids (Hybrid 60-1, Alfazli and Prabhashankar) and one parentage Fazli showed distinctive fruit characters and market potential. The studies helped to develop suitable morphological and biochemical markers for improvement of mango germplasm to establish suitable varieties for domestic and export markets.

Keywords

Varietal identification, Description, Improvement, Morphology, Biochemical

Article Info

Accepted: 07 March 2019
Available Online: 10 April 2019

Introduction

Mango (Mangifera indica L) is the most popular fruit crop in India. It occupies relatively same position as that enjoyed by apple in temperate America or Europe. Due to its popularity and importance, it is ‘known as king’ of fruits belongs to family Anacardiaceae, order Sapindales (Jha et al., 2010). It is believed to have originated in Indo-Burma region (Popenoe, 1927; Mukherjee, 1951; De Candolle, 1904). India is leading at the top with mango production of 18.24 million tons with 42.2% of world's total mango production (NHB, 2014). Production of mango in Bihar is 13 lakh tons which constitutes around 34% of the total fruit production of the state with productivity of 9.2 MT/ha (NHB, 2014).

Consumption of tropical and sub tropical this fruits have increased significantly in the world due to their nutritional and bioactive properties (Poovarodom et al., 2010) but the production of quality mango is not increasing at a level, required to compete in the
One of the most important causes of above problem is the lack of genetic diversity in addition to pests and diseases. Hence, Improvement in plant material can be done by adopting hybridization, genetic mutation, selection of chance seedlings, chromosome doubling etc., with in species or varieties (Mian and Nasir, 1989). However, in mango breeding, hand pollination is surprisingly unrewarding, as success rate of three fruits per 1000 pollinations have been recorded (Mukherjee et al., 1968). Therefore, only three present commercial cultivars in India have evolved from controlled breeding like Mallika, Amrapalli, Ratna (Chadha and Pal, 2004).

One should recognize that all the germplasm available is useful one way or other (Knight, 1993). If it is lacking marketable value, then it may be suitable for some other purposes, like disease resistance, climatic adaptation, home gardening etc. (Campbell, 1995). Therefore, germplasm is a source of variation for new assortment and the time has come to conserve these precious genetic resources and to improve the yield and range of available varieties through collection of local indigenous germplasm. For germplasm collection, varietal characterization is an important component of mango improvement and breeding. It lays the foundation for further scientific progress in developing new cultivars. Since morphological and biochemical characterization of mango germplasm is difficult and lacks expertise, it has never been addressed properly, though mango remains the second most important fruit crop of India.

The objectives of the study were to identify, characterize and recommend mango germplasm to broaden the varietal spectrum and increasing the mango harvesting window, by selecting late maturing germplasm with good fruit characteristics. Another goal was to select key morphological and biochemical markers in mango as future guidelines for varietal identification and breeding work.

**Materials and Methods**

The present investigations were carried out in the Horticultural garden of Department of Horticulture (Fruit and Fruit Technology), Bihar Agricultural University, Sabour-Bhagalpur during 2015-16. This particular district is the hot spot for mango genotype and hybrid production. Eight hybrids and eight genotypes of mango evaluated in the present study (Table 1 and Fig. 1). Accessions were characterized based on mango descriptors listed (IPGRI, 2006).

**Morphological parameters**

**Tree growth descriptors**

Data concerning to tree and growth description was tree height, foliage density, foliage colour and tree shape. Tree Height was measured from ground level to tip of the highest shoot. If the Plant height is less than 6 m, 6.1–9.0 m, 9.1–12.0 m, greater than 12 meter is considered as short, medium, tall and very tall respectively. The foliage density, foliage colour and tree shape was recorded during the month of December according to NBPGR descriptor of mango.

**Leaf descriptors**

The observation on leaf length, leaf width, leaf area and shape was recorded from fully expanded leaves. Leaf length was measured from apex to base of lamina, leaf width from the broad area of leaf lamina and leaf area by using portable leaf area meter of three leaves from each treatment and the average were calculated. Leaf shape was recorded as per the descriptor of NBPGR.
Fruit descriptors

The fruits were harvested at full maturity. Five fruits were selected randomly from each cultivar of all replications and their ultimate lengths and width were recorded with the help of slide calipers in mm and weighted carefully with the help of electronic balance and average of each observation was worked out.

Biochemical parameters

Fruit quality

The total soluble solids (TSS) of the mango juice obtained from all the mango hybrids and their parentage studied were estimated in Brix at harvest using a digital refractometer (Atago, Tokyo, Japan).

The total titrable acidity component was measured by the Titration method (AOAC, 2000) as described previously by (Kumari et al., 2015). TSS/Acidity of the fruit was calculated by dividing the average value of TSS to that of the acidity.

Leaf quality

The chlorophyll content (chlorophyll a and b) of the leaves were analyzed by using the method of Barnes et al., (1992) and beta carotene content was estimated by S. Ranganna (2011).

Results and Discussion

Morphological parameters

Data concerning to growth descriptors like tree height, tree shape, foliage color and foliage density, leaf descriptor like leaf shape, fruit descriptor like fruit colour and their attractiveness of mango hybrids and their parents were presented in Table 2.

The data regarding to leaf descriptor like leaves length, width, area was recorded under different hybrids and genotype given in Table 3. A critical examination of the data shows that there was significant variation for leaf length, leaf area whereas non significant variation for leaf width. The maximum leaf length (29.26 cm) and area (145.36 cm²) was recorded in the hybrid Alfzli and width (8.73 cm) was in Fazli and lowest leaf length, width and area was found in Gulabkhas (16.43 cm), (8.73 cm) and (50.63 cm²) respectively. The current study showed considerable variations in leaf morphological characters among the eight hybrids and their parentage (Tables 2 and 3). Variations in leaf characteristics are reported to be due to genetic divergence of mango cultivars (Shivashankara and Mathai, 2000; Sharma et al., 1999, Reddy et al., 2000 and Rymbai et al., 2014) and environmental effect.

The data with respect to fruit weight, length and width under different hybrids and genotype were also given in Table 3. A careful scrutiny of the data indicates that there was a significant variation in fruit weight, length and width among different hybrids and their parentage. The highest fruit weight (490.66 g), fruit length (136.44 mm) and fruit width (88.57 mm) was produced by Fazli.

The minimum fruit weight (135.55 g), fruit length (77.32 mm) and fruit width (56.65 mm) was noted in hybrid Sabri. We suggest that the use of only fruit traits can give a good perspective about mango diversity. Mango for commercial exploitation should exhibit low fibre content in fruits with short fibres; high length, width, thickness and weight of fruits; and high contents of pulp (Human and Rheeder, 2004). (Lodh et al., 1974) and (Iqbal et al., 1995) also reported the variation of fruit weight among the different mango varieties. This variation may be due to genetic or physiological factors. A wide range of
variation was observed among the germplasm in respect of fruit length and breadth.

**Biochemical parameters**

The data concern to total soluble solids (TSS) content, titrable acidity and TSS acidity ratio in mango juice fruit for different hybrids and genotype of mango were provided in Table 4. The scrutiny of data clearly indicates that the variants differed significantly with respect to TSS content, titrable acidity and TSS/Acidity in fruits and chlorophyll a and b and beta carotene in leaf. The maximum TSS content (22.6°Brix) and TSS/Acidity (173.1) was recorded in Amrapali whereas highest acidity was found in Prabhashankar (0.39 %). Minimum value for TSS, titrable acidity, TSS/Acidity was obtained in Fazli (17.0 °Brix), Gulabkhas (0.13 %), Prabhashankar (56.92) respectively. The TSS of fruit juice gives a rough idea of the sweetness because TSS includes all type of soluble solids. The improvement in TSS content of fruits may be due to the increased hydrolysis of polysaccharides into sugars and also due to enhanced mobilization of carbohydrates from organic acids.

The results of the present investigation showed close conformity with the findings of Kumar and Singh (2005) and Sengupta et al., (2006). Acidity of the fruits gives a blend, acidity and flavour provide quality to the fruits. The acidity of the fruit is directly related to ripening of the fruit though it is a genetical character of the individual variety. Acidity decreased with the maturity and ripening of fruits. Kumar et al., (1992) suggested that this might be due to the conversion of acids into salts and sugars by enzymes particularly invertage.

**Table.1** Details of 8 hybrids Mango (*Mangifera indica* L.) with their parentage

| Treatments | Name of Hybrids/ parents | Parentage | Year |
|------------|--------------------------|-----------|------|
| H1         | Mahmood bahar            |Bombai X Kalapadi | 1951 |
| H2         | Prabhashankar            |Bombai X Kalapadi | 1951 |
| H3         | Alfazli                  |Alphonso X Fazli | 1980 |
| H4         | Sabri                    |Gulabkhas X Bombai | 1989 |
| H5         | Jawahar                  |Gulabkhas X Mahmood bahar | 1980 |
| H6         | Sunderlangra             |Langra X Sunderprasad | 1980 |
| H7         | Hybrid 140               |Langra X Amrapalli | - |
| H8         | Hybrid 60 -1             |Sunderprasad X Langra | - |
| G1         | Bombai                  |            |      |
| G2         | Kalapadi                |            |      |
| G3         | Alphonso                |            |      |
| G4         | Fazli                   |            |      |
| G5         | Gulabkhas               |            |      |
| G6         | Langra                  |            |      |
| G7         | Amrapali                |            |      |
| G8         | Sunderprasad            |            |      |
### Table 2: Plant morphological characters with observation

| Traits                  | Observation recorded | Mango Hybrids with their parentage |
|-------------------------|----------------------|-------------------------------------|
|                         |                      | H-1 | H-2 | H-3 | H-4 | H-5 | H-6 | H-7 | H-8 | G-1 | G-2 | G-3 | G-4 | G-5 | G-6 | G-7 | G-8 |
| Tree height             |                      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Very Tall               | -                    | -   | -   | ✓   | -   | -   | -   | -   | -   | ✓   | -   | -   | -   | -   | -   | -   | -   | -   |
| Tall                    | -                    | ✓   | -   | -   | -   | -   | ✓   | -   | -   | -   | -   | -   | -   | -   | -   | ✓   | -   | -   |
| Medium                  | ✓                    | -   | -   | -   | ✓   | -   | -   | -   | ✔   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| Short                   | -                    | -   | -   | -   | -   | ✓   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| Tree shape              |                      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Semicircular            | ✓                    | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| Oblong                  | -                    | ✓   | -   | -   | -   | -   | -   | -   | ✔   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| Broadly pyramidal       | -                    | -   | ✓   | ✓   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| Foliage colour          |                      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Dark green              | ✓                    | ✓   | ✓   | ✓   | ✓   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| Green                   | -                    | -   | -   | -   | ✓   | -   | -   | ✓   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| Pale green              | -                    | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| Foliage density         |                      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Dense                   | ✓                    | ✓   | ✓   | ✓   | ✓   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| Intermediate            | -                    | -   | -   | -   | -   | ✓   | -   | -   | -   | ✓   | -   | -   | -   | -   | -   | -   | -   | -   |
| Sparse                  | -                    | -   | -   | -   | -   | -   | ✓   | -   | -   | -   | ✔   | -   | -   | -   | -   | -   | -   | -   |
| Leaf shape              |                      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Lanceolate              | -                    | -   | ✓   | ✓   | -   | -   | -   | ✓   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| Oblong lanceolate       | ✓                    | ✓   | -   | -   | -   | ✓   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| Fruit colour            |                      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Yellow orange           | -                    | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| Golden yellow           | -                    | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| Greenish yellow         | ✓                    | ✓   | ✓   | ✓   | ✓   | ✓   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| Fruit attractiveness    |                      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Attractive              | -                    | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| Non attractive          | ✓                    | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |

Abbreviations: H-1 (Mahmood Bahar); H-2 (Prabhashankar); H-3 (Alfazli); H-4 (Sabri); H-5 (Jawahar); H-6 (Sunderlangra); H-7 (Hybrid 140); H-8 (Hybrid 60-1); G-1 (Bombai); G-2 (Kalapadi); G-3 (Alphonso); G-4 (Fazli); G-5 (Gulabkhas); G-6 (Langra); G-7 (Amrapali); G-8 (Sunderprasad)
Table 3: Leaf and fruit quantitative traits of mango hybrids and their parents

| Mango hybrids and their parents | Leaf length (cm) | Leaf width (cm) | Leaf area (cm²) | Fruit weight (g) | Fruit length (mm) | Fruit width (mm) |
|--------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Mahmood bahar                  | 16.96           | 5.06            | 51.15           | 246.60          | 91.12           | 72.96           |
| Prabhashankar                  | 20.80           | 4.93            | 62.08           | 339.33          | 108.90          | 78.84           |
| Alfazli                        | 29.26           | 7.56            | 145.36          | 458.10          | 129.64          | 80.56           |
| Sabri                          | 21.30           | 5.86            | 65.22           | 225.20          | 135.55          | 77.32           |
| Jawahar                        | 19.43           | 4.83            | 60.40           | 240.00          | 103.58          | 56.65           |
| Sunderlangra                   | 24.66           | 6.40            | 74.18           | 339.33          | 124.66          | 68.91           |
| Hybrid 140                     | 22.70           | 5.73            | 66.49           | 225.20          | 92.20           | 63.28           |
| Hybrid 60 -1                   | 21.03           | 6.46            | 67.25           | 402.60          | 124.66          | 87.46           |
| Bombai                         | 21.13           | 6.10            | 66.63           | 253.66          | 85.90           | 66.46           |
| kalapadi                       | 22.36           | 4.20            | 65.64           | 252.86          | 89.53           | 71.28           |
| Alphonso                       | 17.56           | 4.46            | 54.47           | 203.30          | 80.23           | 63.13           |
| Fazli                          | 28.20           | 8.73            | 127.08          | 490.66          | 136.44          | 88.57           |
| Gulkabkhas                     | 16.43           | 4.03            | 50.63           | 202.00          | 86.70           | 60.64           |
| Langra                         | 23.53           | 5.40            | 64.83           | 230.66          | 92.50           | 66.50           |
| Amrapali                       | 21.06           | 5.06            | 67.25           | 229.33          | 111.10          | 71.31           |
| Sunderprasad                   | 18.46           | 5.16            | 56.31           | 196.80          | 96.00           | 70.50           |
| SE diff. Mean                  | 2.24            | 0.69            | 1.04            | 29.32           | 4.96            | 2.79            |
| CD at 5 %                      | 4.60            | 1.42            | 2.13            | 60.17           | 10.18           | 5.74            |
| CV %                           | 12.73           | 15.09           | 1.80            | 12.20           | 5.32            | 4.77            |

Table 4: Fruit quality content of mango hybrids and their parents

| Mango hybrids and their parents | TSS (°Brix) | Acidity (%) | TSS/ Acidity |
|--------------------------------|-------------|-------------|--------------|
| Mahmood bahar                  | 20.50       | 0.26        | 78.80        |
| Prabhashankar                  | 22.20       | 0.39        | 56.92        |
| Alfazli                        | 17.80       | 0.27        | 65.92        |
| Sabri                          | 21.26       | 0.31        | 68.58        |
| Jawahar                        | 19.90       | 0.25        | 79.60        |
| Sunderlangra                   | 19.43       | 0.21        | 92.52        |
| Hybrid 140                     | 17.30       | 0.30        | 57.66        |
| Hybrid 60 -1                   | 22.33       | 0.15        | 135.55       |
| Bombai                         | 22.03       | 0.20        | 110.15       |
| kalapadi                       | 19.23       | 0.30        | 64.10        |
| Alphonso                       | 19.50       | 0.33        | 59.33        |
| Fazli                          | 17.00       | 0.31        | 54.83        |
| Gulkabkhas                     | 22.30       | 0.13        | 171.05       |
| Langra                         | 20.10       | 0.21        | 95.57        |
| Amrapali                       | 22.60       | 0.13        | 173.33       |
| Sunderprasad                   | 18.59       | 0.20        | 92.95        |
| SE diff. Mean                  | 0.62        | 0.019       | 60.30        |
| CD at 5 %                      | 1.28        | 0.038       | 15.20        |
| CV %                           | 3.95        | 7.66        | 5.02         |
Fig. 1 Sixteen mango hybrids with their parentage for morphological and biochemical analysis

Fig. 2 Chlorophyll and beta carotene content of leaf for biochemical analysis

The data with respect to chlorophyll a and b content and beta carotene of mango leaf owing to different mango hybrid and their parentage were estimated and expressed as mg/g and mg/100g respectively. The data so obtained were illustrated graphically in Figure 2. A careful scrutiny of data reveals that there was a significant variation for chlorophyll a
and b and beta carotene content of leaf. The maximum Chlorophyll a (2.22 mg/g) and b (0.747 mg/g) was found in Amrapali which was significantly followed by Alfazli (2.20 mg/g). The lowest chlorophyll a (1.29 mg/g) was estimated in Prabha Shankar and b in Jawahar (0.463 mg/g). The maximum value (0.538 mg/100g) of beta carotene was recorded in Sunder Langra and Hybrid 60-1 and lowest value (0.213 mg/100g) in Alphonso.

In mango, the pigment content is influenced by different seasons, cultivars, growth and maturity stages of leaves (Pandey and Tyagi, 1999; Nii et al., 1995). The cultivars with high chlorophyll content can produce higher biomass and increase photosynthesis (Hassan et al., 2009). Whereas, Chen et al., (2010) reported that there was no relationship between total chlorophyll and photosynthesis in matured leaves of mango cultivars. The variation of β-carotene content between the different varieties was also revealed in this study. The β-carotene content of mango is related to several factors including the genetic, the stage of maturity, climate or geographic site production and cultivation techniques used by Muoki et al., (2009) and Nestel et al., (2006).

On the basis of fruit character among the hybrids of mango, Hybrid 60-1, Alfazli and Prabhashankar gives better result in fruit weight, fruit length and fruit width whereas among the parents Fazli gives better result. On the basis of fruit quality Hybrid 60-1 gives better result in terms of TSS, acidity and TSS/acidity ratio among the hybrids while Amrapali, Gulabkhas and Bombai gives better result among the parents. Amrapali also having highest chlorophyll a and b content in their leaves whereas beta carotene recorded maximum in Hybrid 60-1. Since the present experiment confirm that wide variation is present among different mango cultivars regarding morphological and biochemical characters, hence these morpho-chemical characters can be used as an efficient tool for proper identification of different cultivars well before the commencement of that cultivar to bearing stage, which will ultimately helps the mango breeders for shortening the improvement period.

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How to cite this article:

Syed Razaul Islam, Kumari Karuna, Abha Kumari, Abhay Mankar and Feza Ahmad. 2019. Varietal Characterization and Quality Assessment of Mango Hybrid and their Parents through Morphological and Biochemical Markers. Int.J.Curr.Microbiol.App.Sci. 8(04): 697-706. doi: https://doi.org/10.20546/ijcmas.2019.804.075