Evaluation of New Mango Varieties in Samtenling, Sarpang

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ABSTRACT

Evaluation of four varieties of mango was carried out at Agriculture Research and Development Centre, Samtenling during 2016-2018 to characterise the varieties with basic morphological traits and to assess their performance under sub-tropical agro-ecological zone. The varieties evaluated were Chinwang, Irwin, Duncan and Tommy Atkin with Amrapali as a check. Description of morphological traits is based on IBPGR mango descriptors. For performance evaluation, yield data and fruit quality analysis were recorded. Significant differences were observed in the quality analysis of fruits from all the varieties tested against the check variety. Maximum fruit weight was recorded in Chinwang variety with the mean weight of 893 gram and minimum was recorded in Amrapali (194 gram). The TSS result from all the four varieties did not show any significant difference (P value 0.0998) with the mean TSS of 13.2. Average yield per tree was also recorded in Chinwang (81kg/ tree) followed by Tommy Atkin (79 kg/tree), Duncan (69 kg/tree) and Irwin (33 kg/tree and lowest yield in the check variety Amrapali (19 kg/tree). Although all varieties were short stature in growth habit, Chinwang was found to be taller (5.2 m) than other varieties (Amrapali (4.7 m), Duncan (4 m), Irwin (3.9 m) and Tommy Atkin (4.0 m)). All four varieties have the potential for further promotion. However, continued multi-location evaluation will determine their performance under different climate and soil conditions.

Keywords: *Growth habit; Physiological characters; Potential, Yield*

1. Introduction

Mango (*Mangifera indica* L.) is also known as the king of fruits and is one of the most important fruit crops from the family anacardiaceae. It is highly valued and can grow from sea level to altitudes up to 1100 m (Chadha, 2014). It is the national fruit of India, Bangladesh and the Philippines. It is said to be originated from the Indo-Burma region. Domestication of mango in India dates back to 4000 B.C. (Mehta, 2017). The genus Mangifera contains almost 49 species which are mostly distributed in its centre of origin. It is believed to have reached China in the 7th century; East Africa in the 10th century and to the Philippines at the beginning of the 15th Century. Later from the South and Southeast Asia, it spread to many tropical and subtropical regions of the world. Now it is cultivated in over 89 countries (Yadav & Singh, 2017). The world area under mango cultivation is almost 6.2 million ha with a total production of 55 million metric tonnes. The

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major mango producing countries are India, China, Thailand, Indonesia, Mexico, Pakistan, Brazil, Bangladesh and Egypt (FAO, 2019). FAOSTAT data for mango include mangosteen and guava but some research states that in most countries, mango accounts for more than 99% of the data (Requena, 2015).

In Bhutan, mango cultivation is confined to wet tropical to dry subtropical regions covering a total area of 402.55 ha with a production of 530 MT (DoA, 2017). The varieties available are Bajo Amchukuli 1, Bajo Amchukuli 2, Bajo Amchukuli 3, and Chausa (DoA, 2020). Globally, mango is one of the most preferred fruits and consumed all across at a rate exceeding 5 kg per capita with a trade value of US$ 60 billion (Requena, 2015). Being a potential crop worldwide, the Department of Agriculture has identified it as one of the prioritized fruit crops with a mandate to increase its production and emphasize research into it.

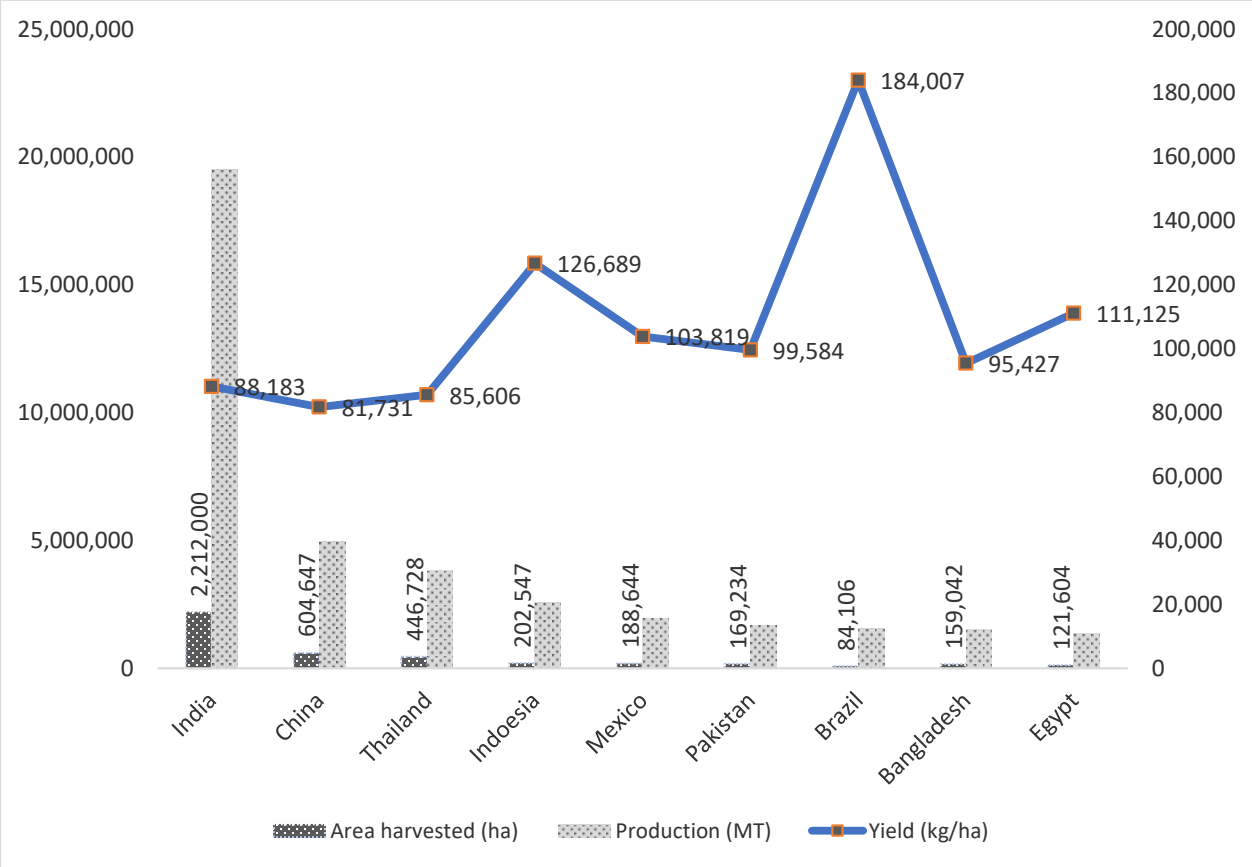

Figure 1. Top mango producing countries (Data source: FAO, 2017).

One of the areas of research is to introduce and evaluate the performance under different agro-ecological zones in the country. Very few known elite varieties are cultivated presently. Few varieties that are released till date are all sourced from India with an alternate bearing habit which is a major drawback in mango production. Moreover, the existing varieties of mango date back to

2002 and 2010 and there is no new variety released thereafter. Therefore, mango germplasm evaluation was carried out at the Agriculture Research and Development Centre (ARDC), Samtenling, on four varieties introduced from Thailand starting from 2004. The evaluation was conducted to determine their performance, assess quality characters of the varieties and to characterise them according to basic morphological traits. The varieties evaluated were Chinwang, Irwin, Duncan and Tommy Atkin.

2. Materials and Method

2.1. Location and experiment details

Evaluation trial was conducted at ARDC Samtenling situated in the wet sub-tropical agro-ecological zone (Latitude of 26.9^{o}N, Longitude 90^{o}E, altitude: 375 masl). It experiences an annual rainfall of 1000-1500 mm with an annual average maximum temperature of 27.6^{o}C and annual average minimum temperature of 20.6 ^{o}C (NCHM, 2017). The scion woods of the four varieties were collected from ARDC Bajo, grafted and systematic plantation was done in 2008. They were tested against the check variety Amrapali. Planting distance of 7m (PP x RR)* was maintained. Recommended fertilizer dose at 250:160:600 g/plant/year (N:P:K) were applied to all the trees conforming to the nutrient content of the soil obtained from soil test results (Table 1). All the treatments were provided with uniform orchard management practices.

Table 1. Soil test result of the trial site.

	N (%)	Texture: Sandy Loam	pH	P (kg)	K (%)
Top soil	0.06 (vL)	Sandy loam	4.15	100.1 (vH)	15.58 (vL)
Sub soil	0.10 (L)	Sandy loam	4.27	114.41(vH)	0.05 (vL)

- vL: very low
- L: low
- vH: very high

(PPxRR)*: plant to plant & row to row distance

2.2. Variety details

The experiment was conducted with a treatment of five varieties (Chinwang, Irwin, Duncan and Tommy Atkin) including Amrapali as check variety. The three varieties viz. Irwin, Tommy Atkin and Duncan are originally from Florida. Irwin cultivar is a Florida selection developed from the parent materials Lippens x Hadens (Olano, Schnell, Quintanilia, & Campbell, 2005). Tommy Atkin developed from seed was originally grown in Broward County in Florida from where one Mr. T. H. Atkins bought and grafted the variety (Campbell, 1973). Duncan is the hybrid between Edward x Pico No. 18 which was bred by David Sturrock from West Palm Beach County of Florida (Sturrock, 1970). Amrapali is a dwarf hybrid from a cross between Dashehari x Neelum developed in India (Das, 2013).

2.3. Fruit quality analysis

Fruit samples were collected from three numbers of trees. Ten numbers of fruits were collected at random and analysed in the laboratory for various quality traits like fruit weight (g), Stone weight (g), pulp weight (g), fruit length (cm), Fruit diameter (cm), pulp percentage (%) and TSS (%). Pulp percentage was calculated by the weight of pulp with peel divided by the total weight of the fruits multiplied by 100.

2.4. Morphological characterisation of fruits and trees

Morphological characterisation of fruits and trees were carried out following the standard guidelines of "descriptors for mango (*Mangifera indica*)" developed by the International Plant Genetic Resources Institute (IPGRI) (IPGRI, 2006). The height of trees was measured from ground level to the top of the tree. Trunk circumference was measured at 50 cm above the ground in mature trees. Similarly, crown diameters were measured as the mean diameter using two directions (north-south and east-west). Morphological traits on fruits assessed were fruit shape, shape of fruit apex, fruit ground colour, fruit flush colour, depth of fruit stalk cavity, fruit neck prominence, slope of ventral shoulder, fruit beak type, fruit sinus type and pulp colour of ripe fruits. Observation on the initiation of flowering, 50% flowering, full bloom and days to fruit ripening were also recorded.

2.5. Yield data collection

The yield of the tree (kg/tree) and the number of fruits per tree were recorded.

2.6. Statistical analyses

All the observations were recorded from three numbers from each of the varieties. Data were recorded in Microsoft Excel worksheet and were analysed using statistical tool STAR 2.0.1and were subjected to one-way analysis of variance (ANOVA) at 5 % level of significance.

3. Results and Discussion

3.1. Fruit quality analysis

Significant differences were observed in almost all the varieties tested against the check variety (Table 2). Highest fruit weight was observed in Chinwang and minimum was recorded in Amrapali. The mean fruit weights of the other three varieties (Irwin, Tommy Atkin and Duncan) were similar but better than Amrapali variety. The stone weight of Chinwang was significantly higher than in other varieties. Significant variations were also found in the pulp weight of Chinwang against all the varieties. Pulp percentage of Chinwang is significantly different from Tommy Atkin and Amrapali but at par with Duncan and Irwin. Similarly, pulp percentage of Tommy Atkin is significantly different from Duncan and Chinwang but at par with Irwin and Amrapali. The highest fruit height was noticed in Chinwang which is significantly different from

the other four varieties. No significant differences were found in the fruit heights of Duncan. Irwin and Tommy Atkin. The check variety with an average fruit height of 9.2 cm is at par with Tommy Atkin but significantly different from the other three varieties. Similarly, a significant difference was also observed in the fruit diameter (*P= 0.025*). The TSS result from all the four varieties did not show any significant difference. The mean TSS observed was 13.2 at significant test level of ($\alpha = 0.01$).

Table 2. Comparison of means on quality properties of the varieties.

Variety	Mean fruit weight (g)	Stone weight (g)	Pulp weight with peel(g)	Pulp percentage (%)	Fruit Height (cm)	Fruit diameter (cm)	TSS (%)
Chinwang	892.86a	61.73a	831.14a	92.99a	17.86a	10.25a	13.59
Duncan	425.97b	35.26b	390.60b	91.73a	11.50b	8.35abc	12.23
Irwin	418.30b	36.35b	381.95b	91.21ab	11.59b	8.15 bc	11.73
Tommy Atkin	401.35b	42.54b	358.80b	87.99 bc	10.27bc	8.49ab	13.33
Amrapali	194.07c	28.15c	165.93c	85.36c	9.23c	6.47c	14.94
Mean	466.51	40.81	425.68	89.86	12.09	8.34	13.16
P-value	0.0006	0.0125	0.005	0.0038	0.000	0.0253	0.0998
CV (%)	23.45	21.27	23.8	1.94	7.89	12.41	9.85

**Means followed by the same letter in the column are not significant (P<0.01)*

For any crop improvement program, quality characters associated with the variety is the most important tool for further selection and breeding of the crop (Desai, Musmade, Ranpise, & Chaudhari, 1994). Fruit weight is one of the important traits that contribute to the yield of fruit plants. Study has shown that there is a strong inherent correlation between the traits like fruit weight, plant height and percent perfect flower on fruit yield in mango (Majumder, Hassan, Rahim, & Kabir, 2012). Studies have further affirmed that fruit weight, fruit diameter, stone size and titrable acidity are major components of mango fruit yield which need to be considered in mango improvement programs (Lal et al., 2017). In hybridization of the crops heritability of traits are important attributes. Heritability studies in mango have shown that there is a heritability of >0.9 for traits like fruit weight, fruit length, width, thickness and TSS (Dinesh, Vasugi, & Venugopal, 2010). One of the consumer preferences is fruit size and taste of the fruits. Studies have also found out that one of the factors that determine the consumer preferences over the variety of the fruits are taste, quality and pulp (Shukla, Chaudhari, & Joshi, 2014). With regular bearing habit and other superior quality, the varieties have the potential for cultivation in increasing production and can be used in crop improvement through breeding.

3.2. Yield

Among the five varieties, the maximum average yield was recorded in Chinwang (Table 3) followed by Tommy Atkin, Duncan and Irwin. The lowest yield is noticed in the check variety Amrapali. However, the yield does not show a significant difference among the three varieties (Chinwang, Tommy Atkin and Duncan), but they are significantly different from Amrapali and Irwin. There is no significant difference in the number of fruits for all the varieties. During the observation on the varieties, it was noticed that all the four varieties were regular bearing while Amrapali is an alternate bearing. Hassan (as cited in Hafiz, Hossain, & Karim, 2018) refers to the regular bearing habit in Amrapali.

Table 3. Comparison of mean yield.

Varieties	**Mean yield (kg per tree)**	**Avg. no. of fruits per tree**
Chinwang	81.35a	121.33
Duncan	69.03a	176.00
Irwin	32.76b	84.00
Tommy Atkin	79.49a	163.33
Amrapali	19.07b	134.33
Mean	57.34	135.80
CV (%)	24.39	27.44
P-value	0.0014	0.972

** Means followed by the same letter in the column are not significant (P<0.01)*

3.3. Observation of quantitative vegetative characters of trees

It is observed that variety Chinwang is vigorous in growth habit (Table 4) followed by Amrapali, Duncan Irwin and Tommy Atkin. Therefore, all the varieties can be considered as short stature plants. The highest spread of tree was noticed in the variety Amrapali (6.06 cm) and it is significantly different from all the four varieties. The average girth of the trunk also varied significantly (*P=0.0022*) with the highest girth recorded in Amrapali (72.80 cm) and least in Duncan (49.20 cm).

Table 4. Mean comparison of vegetative growth of the tree.

Variety	**Canopy height (m)**	**Spread of trees (cm)**	**Girth of trunk (cm)**
Chinwang	5.15a	4.93b	66.50ab
Duncan	4.00b	4.24c	49.20c
Irwin	3.98b	3.79c	53.00c
Tommy Atkin	4.02b	3.91c	57.14bc
Amrapali	4.72a	6.06a	72.80a
Mean	4.38	4.59	59.73
CV (%)	11.34	11.19	14.03

P-value	0.0044	0	0.0022

Plants with heights less than six metres are described as short stature as per the IPBGR descriptor for mango (IPGRI, 2006). These four varieties can be suitable for high-density plantation and intensive farming. High-density planting has been tried in Tommy Atkin varieties at various spacing of 8 x 5 m, 7 x 4 m, 6 x 3 m, 5 x 2 m and 4 x 2 m. The reduction in yield and number of fruits per tree was noticed but the yield per unit area increased by 30% (Sousa et al., 2011). The reduction in the canopy size, girth of trunk and fruit height have been reported by (Gaikwad, Chalak, & Kamble, 2017) as well which provides evidence on the requirement of short stature plant for high-density plantation.

3.4. Morphological characterisation of fruits

Morphological characterisation fruit shape, shape of fruit apex, fruit ground colour, fruit flesh, depth of fruit stalk cavity, fruit neck prominence, slope of the ventral shoulder, fruit beak type, fruit sinus type and pulp colour of ripe fruits for all the five varieties were done following the guidelines of "mango descriptor" developed by IPGRI. The fruits of Chinwang, Irwin and Amrapali are oblong. Tommy Atkin possesses roundish fruit shape with round fruit apex. Similarly, Duncan is obovoid in shape. The ground colour of Chinwang and Amrapali is green with a red blush on Chinwang fruits. The external colour of Irwin and Tommy Atkin is excellent with red ground colour while Duncan fruit turns yellow on ripening with no blush. Acute fruit apex is noticed in Chinwang and Tommy Atkin, obtuse in Duncan and Amrapali, and round in Tommy Atkin. Chinwang, Irwin, Tommy Atkin and Amrapali have shallow fruit sinus while it is absent in Duncan.

All the four varieties have a medium depth of fruit stalk cavity except in Amrapali which possess a shallow depth of fruit stalk cavity. All the varieties have perceptible fruit beak. The pulp colour is golden yellow in Chinwang, orange in Irwin, light yellow in Duncan and Tommy Atkin, and rich dark orange in Amrapali. The pulp of Chinwang at an immature state has an apple-like texture with less or no sour taste and can be eaten at the raw firm stage. The pulps of all the varieties are fibreless except in that of Tommy Atkin. Chinwang, Duncan and Tommy Atkin have prominent fruit neck while a slight fruit neck prominence was noticed in Irwin and Amrapali. Ventral shoulders of all the varieties are raised and rounded except in Duncan which ends in a long curve. Similar description for Tommy Atkin with oval to oblong fruit shape with a broadly round tip and dark red blush was made by Campbell (1973). Roundly oval fruit shape with yellow to golden yellow fruit colour, soft texture with fibreless flesh and steeply sloping shoulder was also reported by Sturrock (1969).

3.5. Flowering behaviour of the varieties

From the flowering habit (Table 5), Chinwang and Tommy Atkin come to harvest in the first week of June, Duncan and Irwin in the 2nd week of June while the check variety matures in the 3rd week

of June. A similar observation was made for the three varieties Duncan, Tommy Atkin and Irwin by Crane, Balerdi, and Maguire (2006) where maturity was observed in the months of June and July. Amrapali has been observed to mature in the 3rd week of July (Chanana, Josan, & Arora, 2005).

Table 5. Observation of flowering behaviour of the varieties.

Variety	Initiation of flowering	50% flowering	Full Bloom	Fruit maturity
Chinwang	1st week of Jan	3rd week of Feb	Feb end	1st week of June
Duncan	2nd week of Jan	3rd week of Feb	Feb end	2nd week June
Irwin	Jan end	3rd week of Feb	1st week of March	2nd week June
Tommy Atkin	Jan end	Feb end	1st week of March	1st week of June
Amrapali	Jan end	3rd week of Feb	1st week of March	3rd week of June

4. Conclusion

All the four varieties are superior in quality as compared to the check variety (Amrapali) in most of the characters except in TSS. Results show no significant difference in the TSS. Fruit weight and pulp percentage are the important attributes that contribute to yield parameters and they are the recorded highest in Chinwang variety. Key consumer preference traits are fruit size and pulp percentage which all the four varieties showed excellent qualities with significant difference from the check variety. Consumers are also attracted to the size and colour of the fruits. The variety Irwin and Tommy Atkin have a red colour with medium size fruits. Further, all four varieties are high yielding as compared to check variety. It is apparent from this study that tree statures of all the varieties are short, and are suitable for high-density planting. Considering the results, all the four varieties can be considered as potential varieties that can be promoted in farmer's field. However, further evaluation through multi-location trials will help determine their performance under different climate and soil conditions. With good attributes in these varieties, study on their propagation methods can also be another area of research. Consumer preferences can also be studied as well as their market potential.

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