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Studies on physio-morphology, floral biology and fruit characteristics of mango

D. A. N. Majumder, L. Hassan[1], M. A. Rahim[2] and M. A. Kabir[3]
Department of Biotechnology, [1]Department of Genetics and Plant Breeding, [2]Department of Horticulture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and [3]Department of Horticulture, Hajee Md. Danesh Sci. & Tech. University, Dinajpur-5200, Bangladesh. Email: dilrumajumder@yahoo.com

Abstract

Plant, inflorescences and fruit characteristics of 60 mango genotypes were studied during the period 2007 to 2008. There were distinct variations among the findings of the gemplasm on plant, leaf, inflorescence fruit characters and yield. Wide variations were observed in relation to the % flowering shoot, % perfect flower**,** % fruit set per panicle, number of harvested fruits per plant, individual fruit weight, % edible portion and % total soluble solid ranging from 24.00 to71.33%, 8.10 to19.17%, 9.07 to 29.27%, 21.33 to 60.33, 365.33 to 219.00g, 45.22 to 79.83% and 16.90 to 28.26%, respectively. The germplasm MI28 was top of the list in case of number of panicle, number of main branch per panicle, percent perfect flower and fruit harvest per plant. The maximum and minimum number of fruit set per panicle was noted in MI28 and MI92, respectively. The maximum percentage of fruit harvest per panicle was found in MI94 (5.46) but the germplasm MI28 gave the highest number of fruit per plant (60.33). Moreover, the germplasm MI09 had the highest percentage of edible portion (79.83).

Keywords: *Mangifera indica,* Physio-morphology, Inflorescences, Fruit characteristics

Introduction

Mango (*Mangifera indica* L.), a member of the family Anacardiaceae, is one of the choicest fruits in the world (De Candolle, 1904 and Popenoe, 1927). It has medium calorific and high nutritional values. Mango grows in almost all parts of Bangladesh but the commercial and good quality grafted mangoes with known varietal identity are mostly confined in its North-Western districts. But the eastern area does not produce commercially any reputed variety. Moreover, studies relating to the performance of such varieties grown in those areas are scanty. The general impression is that elite mango varieties do not perform well when grown in the eastern areas. So, the need exists to assess the performance of elite varieties under that area. Again, characterization is an important aspect for documentation of the performance of the studied cultivars, which would help to introduce, select and improve the existing mango varieties. Therefore, an attempt was made to study the physio-morphology, inflorescences, fruit set and yields of 60 germplasm in the mango orchard of BAU- Germplasm Centre, Mymensingh.

Materials and Methods

The present experiment was conducted in a pre-established orchard named Germplasm (GP) Centre of Fruit Tree Improvement Project (FTIP, Department of Horticulture, Bangladesh Agricultural University, Mymensingh during October 2007 to September 2008. The experiment was conducted on 8-10 years old mango plants of 60 mango germplasm. The experiment was laid out in a RCBD with three replications, where a single uniform tree constituted the unit of replication. Both the distances between plant to plant and row to row were 6 m. Irrigation was given after fruit set and thereafter at a fortnight interval. Fertilizers @ 21-15 kg FYM, 750 g urea, 400 g TSP, 250 g MP, 250 g Gypsum and 15 g Zinc sulphate were applied per plant in two splits as per recommendation by Hossain (1989). Mature fruits were collected randomly from the selected plants. Ten fruits from each of the selected germplasm were taken in the laboratory for reading their physical characteristics like shape of fruit, external appearance, skin texture, fruit weight, length, breath, thickness, days to maturity, percent fruit harvest per panicle, number of fruit harvest per plant, weight of harvested fruit, edible portion, non-edible portion and stone weight. Data on different morphological parameters from 60 mango genotypes were recorded according to the descriptors for mango (IPGRI, 2003). The total soluble solids content of mango pulp was estimated by using Abbe Refreactometer.

Results and Discussion

Plant characteristics

As evident from results (Table 1) a total of 23 genotypes showed ellipsoid plant shape and the rest of the genotypes were spheroid. The mango plants under the study showed two types of growth habit viz., spreading upright and intermediate. Most of the genotypes showed spreading and dense type growth habit and rest were upright and intermediate in nature. The mango plants under the study showed two types of bearing habit viz., alternate and regular. Only 9 genotypes showed regular type bearing habit in nature. In respect of plant height, significant variation was observed among genotypes. Hodgson (1967) found fruit trees were of three growth habit such as upright, spreading and open. The tallest plant (578.22 cm) was observed in genotype MI58 followed by MI24 (540.35 cm) and MI29 (540.29 cm). The shortest plant (211.31cm) was recorded in genotype MI98.

Table 1. Plant characteristics of 60 mango genotypes

Genotypes	Form/ Shape of plant	Growth habit of plant	Density of branches	Bearing habit	Plant height (cm.)
MI01	Ellipsoid	Intermediate	Sparse	Regular	313.80
MI02	Ellipsoid	Intermediate	Sparse	Alternate	345.98
MI03	Spheroid	Spreading	Dense	Alternate	229.09
MI04	Ellipsoid	Intermediate	Sparse	Regular	295.69
MI08	Ellipsoid	Spreading	Dense	Alternate	291.87
MI09	Ellipsoid	Intermediate	Sparse	Alternate	355.37
MI12	Spheroid	Spreading	Dense	Alternate	303.02
MI16	Ellipsoid	Upright	Sparse	Alternate	370.03
MI19	Ellipsoid	Intermediate	Dense	Alternate	365.58
MI20	Ellipsoid	Intermediate	Dense	Regular	373.76
MI21	Ellipsoid	Intermediate	Sparse	Alternate	377.33
MI22	Spheroid	Spreading	Dense	Alternate	386.82
MI23	Spheroid	Spreading	Dense	Alternate	391.47
MI24	Spheroid	Spreading	Dense	Alternate	540.35
MI25	Spheroid	Spreading	Sparse	Alternate	524.45
MI26	Ellipsoid	Intermediate	Dense	Alternate	441.85
MI27	Spheroid	Spreading	Dense	Alternate	517.13
MI28	Spheroid	Intermediate	Dense	Regular	295.70
MI29	Ellipsoid	Upright	Sparse	Alternate	540.29
MI33	Ellipsoid	Upright	Sparse	Alternate	444.64
MI38	Spheroid	Spreading	Dense	Alternate	361.20
MI39	Spheroid	Spreading	Dense	Alternate	270.44
MI40	Spheroid	Spreading	Dense	Alternate	246.32
MI41	Spheroid	Spreading	Dense	Alternate	285.89
MI43	Spheroid	Spreading	Dense	Regular	314.05
MI44	Ellipsoid	Intermediate	Sparse	Alternate	255.71
MI45	Ellipsoid	Intermediate	Sparse	Alternate	285.15
MI46	Ellipsoid	Intermediate	Sparse	Alternate	312.63
MI47	Ellipsoid	Intermediate	Sparse	Alternate	410.39
MI48	Ellipsoid	Intermediate	Sparse	Alternate	440.84
MI49	Spheroid	Spreading	Dense	Regular	246.20
MI50	Spheroid	Upright	Sparse	Alternate	339.04
MI51	Spheroid	Spreading	Dense	Alternate	355.22
MI52	Spheroid	Spreading	Dense	Alternate	277.96
MI54	Ellipsoid	Intermediate	Dense	Alternate	422.77
MI58	Ellipsoid	Upright	Sparse	Alternate	578.22
MI60	Ellipsoid	Upright	Sparse	Alternate	483.96
MI61	Spheroid	Spreading	Sparse	Alternate	390.51
MI64	Spheroid	Spreading	Dense	Alternate	250.54

Table 1 Contd.

Genotypes	Form/ Shape of plant	Growth habit of plant	Density of branches	Bearing habit	Plant height (cm.)
MI70	Spheroid	Spreading	Dense	Alternate	328.59
MI74	Spheroid	Spreading	Sparse	Alternate	375.31
MI75	Spheroid	Spreading	Dense	Alternate	287.25
MI77	Spheroid	Spreading	Sparse	Alternate	371.08
MI80	Ellipsoid	Upright	Sparse	Alternate	409.11
MI81	Spheroid	Spreading	Dense	Alternate	403.26
MI82	Spheroid	Spreading	Dense	Alternate	228.28
MI83	Spheroid	Spreading	Sparse	Alternate	258.46
MI84	Spheroid	Spreading	Dense	Alternate	328.83
MI85	Spheroid	Spreading	Sparse	Alternate	226.05
MI86	Spheroid	Spreading	Dense	Alternate	308.41
MI88	Spheroid	Spreading	Dense	Regular	365.16
MI90	Spheroid	Spreading	Dense	Alternate	322.79
MI91	Ellipsoid	Upright	Sparse	Alternate	389.99
MI92	Ellipsoid	Upright	Sparse	Alternate	399.18
MI93	Ellipsoid	Upright	Sparse	Alternate	291.23
MI94	Spheroid	Spreading	Dense	Regular	410.76
MI95	Spheroid	Spreading	Dense	Regular	447.08
MI96	Spheroid	Spreading	Sparse	Alternate	397.24
MI97	Spheroid	Spreading	Dense	Alternate	408.53
MI98	Spheroid	Spreading	Dense	Alternate	211.31
Range	-	-	-	-	211.31-578.22
Mean	-	-	-	-	356.66
CV%	-	-	-	-	9.36%
SE	-	-	-	-	19.27
LSD(0.01%)	-	-	-	-	71.34

Leaf characteristics

The result showed significant variation in leaf characters of mango genotypes (Table 2). Leaf length, leaf width and petiole length varied from 113.16 to 35.82 cm, 3.59 to 9.76 cm and 2.53 to 5.33 cm, respectively. Leaf area varied significantly among the genotypes. The genotype MI24 had the highest leaf area (74.32 cm^2) which was statistically different from rest of the genotypes. The lowest leaf area was recorded in genotype MI98 (Table 2).

Inflorescence characteristics

The inflorescence colour in most of the varieties varied from light green to light green with red patch (Table 3a) and the position varied from terminal axillaries to terminal. Duration of flowering ranged from 17.67 to 35.33 days. Majumder and Sharma (1990) reported that the flowering time varied with the varieties and growing locations. The maximum percentage of flowering shoot was recorded in the accession MI28 (71.33 %) and the maximum panicle (2.77) was also found in the accession MI28. Islam *et al.* (1995) also observed variation in number of panicles per shoot among different mango varieties. The number of main branches per panicle ranged from 21.57 to 52.53 and the germplasm MI94 had the highest number (52.53) of main branches per panicle (Table 3b). The percent of perfect flower ranged from 8.10 to 19.77%. Mukherjee (1997) reported that the ratio of male to perfect flower was strongly influenced by environmental and cultural factors. The highest percentage of fruit set (29.27%) was recorded in MI28. The maximum dropping (88.43%) was recorded in MI39 (Table 3b).

Table 2. Leaf characteristics of 60 mango genotypes

Genotypes	Length of lamina (cm)	Width of lamina (cm)	Length of petiole (cm)	Area of leaf (cm^2)	Leaf shape	Leaf margin
MI01	18.28	5.56	4.22	68.52	Lanceolate	Flat
MI02	16.70	3.59	2.65	58.31	Lanceolate	wavy
MI03	21.21	4.85	5.33	69.83	Elliptic-anceolate	Wavy
MI04	16.93	4.87	2.84	66.62	Oblong-anceolate	Flat
MI08	15.68	4.02	2.74	61.05	Lanceolate	Wavy
MI09	16.73	4.81	3.22	64.53	Lanceolate	Flat
MI12	16.01	4.32	2.87	59.31	Lanceolate	Flat
MI16	23.81	5.08	3.98	64.77	Lanceolate	Flat
MI19	18.38	5.01	5.21	57.38	Elliptic-Laceolate	Wavy
MI20	22.65	6.49	4.72	64.78	Oblong-anceolate	Crinkled
MI21	18.40	5.15	4.05	60.11	Elliptic-lanceolate	Wavy
MI22	17.49	4.87	4.21	67.79	Elliptic Lanceola	Flat
MI23	21.46	3.97	4.66	60.99	Ellip-Lance.	Wavy
MI24	35.82	9.76	4.88	74.32	Oblo-Lance.	Wavy
MI25	27.47	6.21	3.30	65.29	Lanceolate	Flat
MI26	21.59	5.14	4.15	61.02	Ellip-Lance.	Wavy
MI27	31.77	5.99	4.35	71.39	Lanceolate	Flat
MI28	15.44	5.17	3.70	54.19	Lanceolate	Wavy
MI29	17.50	4.95	2.66	59.62	Lanceolate	Wavy
MI33	13.16	4.84	2.66	55.75	Lanceolate	Flat
MI38	14.83	4.14	2.96	54.91	Lanceolate	Flat
MI39	14.92	4.67	3.84	55.96	Lanceolate	Flat
MI40	18.87	4.57	3.66	56.42	Lanceolate	Wavy
MI41	13.77	5.00	2.74	53.65	Ellip-Lance.	Flat
MI43	18.56	4.67	3.53	62.39	Lanceolate	Flat
MI44	17.21	4.85	3.82	58.80	Oblo-Lance.	Flat
MI45	13.78	4.98	2.77	53.55	Oblo-Lance.	Flat
MI46	15.99	4.62	2.77	56.52	Lanceolate	Flat
MI47	14.62	5.52	2.99	56.39	Oblo-Lance.	Flat
MI48	16.82	4.49	2.92	55.29	Lanceolate	Flat
MI49	19.50	4.34	2.86	57.65	Lanceolate	Flat
MI50	15.43	3.89	3.52	52.82	Lanceolate	Flat
MI51	16.87	3.86	3.59	53.95	Lanceolate	Flat
MI52	17.33	4.51	3.54	55.07	Ellip-Lance.	Wavy
MI54	18.48	5.86	3.77	57.12	Ellip-Lance.	Flat
MI58	32.65	6.21	4.55	71.89	Lanceolate	Flat
MI60	19.63	5.84	4.59	62.41	Elliptic	Wavy
MI61	30.38	6.25	4.70	71.30	Ellip-Lance.	Wavy
MI64	15.85	4.82	3.72	54.70	Ellip-Lance.	Wavy
MI70	21.59	5.69	3.59	61.65	Lanceolate	Flat
MI74	16.24	5.75	3.84	58.67	Lanceolate	Wavy
MI75	19.88	5.12	3.51	61.65	Lanceolate	Wavy
MI77	22.39	5.75	3.99	63.27	Lanceolate	Flat
MI80	17.78	5.75	3.73	62.55	Lanceolate	Flat
MI81	19.49	5.43	3.11	61.71	Ellip-Lance.	Flat
MI82	23.50	5.64	4.61	63.02	Lanceolate	Flat
MI83	17.03	5.07	4.01	58.44	Ellip-Lance.	Flat
MI84	19.08	5.72	3.89	55.00	Lanceolate	Wavy
MI85	16.73	4.90	4.05	59.45	Ellip-Lance.	Flat
MI86	17.84	4.89	4.17	59.08	Lanceolate	Flat
MI88	13.98	5.03	3.56	53.09	Lanceolate	Flat
MI90	28.39	6.55	3.69	66.06	Lanceolate	Flat
MI91	18.84	6.10	3.85	61.68	Ellip-Lance	Flat

Table 2 Contd.

Genotypes	Length of lamina (cm)	Width of lamina (cm)	Length of petiole (cm)	Area of leaf (cm^2)	Leaf shape	Leaf margin
MI92	18.40	4.87	4.10	55.41	Lanceolate	Flat
MI93	23.48	5.91	3.60	62.38	Lanceolate	Flat
MI94	17.04	5.66	3.77	54.84	Lanceolate	Flat
MI95	25.19	6.82	4.15	65.44	Lanceolate	Flat
MI96	18.13	5.60	3.48	61.60	Lanceolate	Flat
MI97	19.73	3.94	2.53	55.15	Lanceolate	Flat
MI98	15.86	3.79	2.75	52.59	Lanceolate	Wavy
Range	13.16-35.82	3.59-9.76	2.53-5.33	52.59-74.32	-	-
Mean	19.38	5.17	3.69	60.30	-	-
CV (%)	7.83	7.35	6.48	5.71	-	-
SE	0.88	0.22	0.14	1.99	-	-
LSD (0.01%)	3.24	0.812	0.51	7.37	-	-

Table 3a. Inflorescence characteristics of 60 mango genotypes

Genotypes	Position of inflorescence	Colour of inflorescence	Type of flower	Duration of flowering (days)	Flowering shoot (%)
MI01	Terminal	Light green	Tetramerous	34.00	67.33
MI02	Terminal	Light green	Tetramerous	29.33	67.33
MI03	Terminal & Axillaries	Light green	Pentamerous	22.00	61.67
MI04	Terminal & Axillaries	Green with red patches	Tetra &Pentamerous	21.00	53.67
MI08	Terminal & Axillaries	Green with red patches	Pentamerous	18.67	46.33
MI09	Terminal	Light green	Pentamerous	18.33	48.67
MI12	Terminal & Axillaries	Green with red patches	Pentamerous	24.33	57.33
MI16	Terminal	Green with red patches	Pentamerous	33.33	31.33
MI19	Terminal & Axillaries	Green with red patches	Pentamerous	19.00	51.33
MI20	Terminal & Axillaries	Green with red patches	Pentamerous	31.00	43.00
MI21	Terminal & Axillaries	Light green	Pentamerous	20.33	39.67
MI22	Terminal & Axillaries	Green with red patches	Pentamerous	25.67	32.00
MI23	Terminal	Green with red patches	Pentamerous	20.67	32.67
MI24	Terminal & Axillaries	Green with red patches	Tetra& Pentamerous	20.67	41.33
MI25	Terminal & Axillaries	Green with red patches	Pentamerous	34.67	44.67
MI26	Terminal	Green with red patches	Pentamerous	20.00	32.00
MI27	Terminal & Axillaries	Green with red patches	Pentamerous	35.33	52.33
MI28	Terminal & Axillaries	Green with red patches	Pentamerous	29.67	71.33
MI29	Terminal	Light green	Tetra & Pentamerous	19.67	33.67
MI33	Terminal	Dark red	Tetra& Pentamerous	19.67	61.00
MI38	Terminal & Axillaries	Light green	Pentamerous	22.00	38.00
MI39	Terminal	Light brick red	Pentamerous	18.67	32.33
MI40	Terminal & Axillaries	Light green	Tetra& Pentamerous	25.33	31.00
MI41	Terminal & Axillaries	Light green	Tetra& Pentamerous	23.33	34.00
MI43	Terminal	Green with red patches	Tetra& Pentamerous	18.67	31.00
MI44	Terminal	Green with red patches	Pentamerous	18.33	33.67
MI45	Terminal	Green with red patches	Pentamerous	31.33	39.67
MI46	Terminal	Light green	Pentamerous	17.67	56.67
MI47	Terminal	Light green	Pentamerous	29.33	36.00
MI48	Terminal	Green with red patches	Tetra & Pentamerous	22.67	33.33
MI49	Terminal & Axillaries	Green with red patches	Pentamerous	23.67	36.33
MI50	Terminal	Light red	Pentamerous	30.00	32.33
MI51	Terminal & Axillaries	Green with red patches	Pentamerous	22.67	33.67
MI52	Terminal & Axillaries	Light green	Pentamerous	22.00	32.67
MI54	Terminal & Axillaries	Light green	Pentamerous	22.00	32.67

Table 3a. Contd.

Genotypes	Position of inflorescence	Colour of inflorescence	Type of flower	Duration of flowering (days)	Flowering shoot (%)
MI58	Terminal & Axillaries	Green with red patches	Tetra& Pentamerous	24.33	34.00
MI60	Terminal	Light green	Pentamerous	23.00	43.00
MI61	Terminal	Light green	Tetra& Pentamerous	17.67	35.33
MI64	Terminal & Axillaries	Green with red patches	Tetra& Pentamerous	31.00	47.67
MI70	Terminal & Axillaries	Light red	Pentamerous	26.00	36.67
MI74	Terminal & Axillaries	Green with red patches	Pentamerous	27.33	46.67
MI75	Terminal & Axillaries	Green with red patches	Tetra& Pentamerous	26.33	47.00
MI77	Terminal	Green with red patches	Pentamerous	30.00	31.67
MI80	Terminal & Axillaries	Green with red patches	Tetra& Pentamerous	21.33	24.00
MI81	Terminal	Light green	Pentamerous	30.33	64.33
MI82	Terminal	Green with red patches	Pentamerous	24.33	59.33
MI83	Terminal & Axillaries	Dark red	Pentamerous	23.67	31.33
MI84	Terminal	Green with red patches	Tetra&Pentamerous	24.67	29.67
MI85	Terminal & Axillaries	Light green	Pentamerous	25.67	40.33
MI86	Terminal & Axillaries	Dark red	Pentamerous	21.67	30.00
MI88	Terminal & Axillaries	Green with red patches	Tetra & Pentamerous	22.00	58.33
MI90	Terminal	Light green	Pentamerous	27.33	35.33
MI91	Terminal & Axillaries	Green with red patches	Pentamerous	30.67	36.67
MI92	Terminal & Axillaries	Green with red patches	Pentamerous	29.00	60.67
MI93	Terminal	Green with red patches	Pentamerous	21.00	33.67
MI94	Terminal	Green with red patches	Pentamerous	20.67	34.33
MI95	Terminal & Axillaries	Green with red patches	Pentamerous	21.67	32.00
MI96	Terminal & Axillaries	Green with red patches	Pentamerous	33.33	33.33
MI97	Terminal & Axillaries	Green with red patches	Pentamerous	30.00	36.67
MI98	Terminal & Axillaries	Green with red patches	Pentamerous	23.33	62.33
Range	-	-	-	17.67-35.33	24.00-71.33
Mean	-	-	-	24.68	42.41
CV (%)	-	-	-	10.98	7.97
SE	-	-	-	1.57	1.95
LSD(0.01 %)	-	-	-	5.79	7.22

Table 3b. Panicle characteristics of 60 mango genotypes

Genotypes	Number of Panicle per shoot (no)	Length of the panicle (cm)	Number of main branch per panicle (no)	Percent perfect flower	Percent fruit set per panicle	Dropping at Initial stage (%)
MI01	2.67	42.17	49.93	17.27	24.93	74.31
MI02	2.63	22.17	33.67	11.17	26.37	72.85
MI03	1.83	31.05	25.37	9.67	18.60	76.75
MI04	1.67	39.79	30.03	10.13	11.00	77.42
MI08	1.60	31.08	31.57	15.23	24.74	81.19
MI09	1.37	26.76	29.47	17.30	13.97	79.09
MI12	1.63	29.48	50.20	15.47	20.40	87.26
MI16	1.53	33.26	32.50	12.90	23.40	86.41
MI19	1.50	33.06	21.93	13.33	10.43	80.65
MI20	1.23	27.61	24.77	14.30	9.73	77.88
MI21	1.37	24.34	22.73	14.73	19.23	87.48
MI22	1.47	26.14	28.20	8.53	17.67	79.44
MI23	1.30	32.52	26.63	11.70	26.33	73.91
MI24	2.70	28.35	22.63	16.33	20.17	78.90
MI25	2.20	30.30	24.30	9.27	18.63	74.75

Table 3b. Contd.

Genotypes	Number of Panicle per shoot (no)	Length of the panicle (cm)	Number of main branch per panicle (no)	Percent perfect flower	Percent fruit set per panicle	Dropping at Initial stage (%)
MI26	1.40	31.32	25.40	12.60	13.83	72.27
MI27	1.23	28.57	23.83	9.93	28.80	75.05
MI28	2.77	26.27	52.20	19.17	29.27	69.90
MI29	1.90	32.50	27.20	15.00	11.47	80.22
MI33	2.47	27.98	23.50	12.27	27.00	82.40
MI38	1.23	25.85	31.57	8.40	22.07	81.79
MI39	1.57	33.20	38.37	9.37	10.40	88.43
MI40	1.53	27.87	22.31	12.10	16.70	86.59
MI41	1.23	26.08	44.47	14.33	16.50	71.89
MI43	1.63	32.24	24.53	12.33	22.30	84.53
MI44	2.23	32.34	21.93	10.17	11.83	73.97
MI45	2.37	38.75	50.97	11.10	20.67	70.13
MI46	2.30	24.79	25.60	12.67	24.60	69.20
MI47	2.07	17.75	25.60	13.23	14.03	84.92
MI48	2.47	27.64	22.27	8.10	19.37	83.20
MI49	2.50	36.57	49.87	9.10	20.43	86.55
MI50	2.07	23.25	22.77	9.57	11.47	82.66
MI51	1.40	32.54	21.57	9.37	15.40	77.95
MI52	1.63	37.41	26.33	13.43	17.03	71.13
MI54	1.23	37.46	22.70	14.97	27.50	72.87
MI58	1.37	38.80	21.93	9.87	11.77	82.59
MI60	1.23	24.35	25.23	10.57	15.73	82.57
MI61	1.60	38.42	33.13	16.20	25.73	69.42
MI64	2.07	29.71	36.47	12.20	21.23	75.02
MI70	1.50	30.71	30.90	12.07	27.80	70.61
MI74	1.70	37.97	29.00	13.20	19.33	74.61
MI75	1.80	27.04	30.87	9.80	10.87	87.80
MI77	1.60	34.00	21.93	13.23	15.20	85.94
MI80	2.10	27.65	27.67	15.17	18.53	81.04
MI81	2.27	30.21	49.37	9.93	25.10	87.41
MI82	1.37	38.57	43.57	8.23	19.60	85.16
MI83	1.87	29.96	32.97	9.53	17.20	84.46
MI84	2.50	29.83	29.63	10.10	10.87	85.36
MI85	1.37	37.91	37.13	10.73	16.60	78.32
MI86	1.23	34.13	26.57	8.77	26.23	80.87
MI88	1.50	34.42	30.67	9.90	11.00	83.79
MI90	1.23	24.47	25.00	8.73	18.23	87.74
MI91	2.40	31.28	27.17	14.40	26.73	70.51
MI92	1.13	35.14	31.07	12.07	9.07	81.61
MI93	1.63	27.66	22.13	9.50	20.17	71.16
MI94	1.67	26.57	52.53	18.43	26.33	75.88
MI95	1.30	29.12	51.73	16.33	10.23	74.38
MI96	1.37	24.18	24.50	9.60	10.20	79.52
MI97	1.23	38.52	27.77	9.63	11.20	70.72
MI98	1.57	28.79	22.63	10.90	9.47	77.15
Range	1.13-2.77	17.75-42.17	21.57-52.53	8.10-19.17	9.07-29.27	69.90-88.43
Mean	1.74	30.79	30.78	12.06	18.50	78.96
CV(%)	7.89	11.17	4.08	12.44	7.35	4.80
SE	0.08	1.99	0.73	0.87	0.79	2.19
LSD (0.01%)	0.29	7.35	2.69	3.21	2.90	8.10

Fruit characteristics

Maximum number of days (178.67) was required for fruit maturity of the germplasm MI28, which was significantly different from those of the other germplasm (Table 4a). These results were found similar to the observation of Hossain (1989) who reported that mango under Bangladesh conditions takes about four to six month to reach maturity after flowering. These findings differed from that of Sardar *et al.* (1998) who consented that harvesting time varied from 92 to 134 days in some popular mango cultivars under the climatic conditions of Rajshahi. This might be due to environmental fluctuation over the year and the locality. Mukherjee (1997) observed the yellowish green to bright yellow skin colour of the fruits of ripened mango and also reported that fruit colour at maturity was dependent on genotype. The highest percentage of fruit harvested per panicle was in MI94 (5.46 %) but the highest number of fruits was observed in MI28 (60.33). The highest weight of harvested fruits was found in MI94 (25.04), which was closely preceded by MI28 (23.12kg).The shape of fruit of mango genotypes was classified into four groups' viz., Elliptic, Oblong, Round and Roundish. The heaviest fruit (365.33 g) was recorded in MI16. 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. MI16 produced the longest fruit (11.50 cm) followed by MI24 (10.74 cm) and MI27 (10.49 cm). The average breadth of different mango germplasm was found to vary from 10.96 to 5.37 cm (Table 4b). The thickest fruit (9.71cm) was in MI16, whereas MI60 occupied lowest thickness (4.29 cm).

Table 4a. Fruit characteristics of 60 mango genotypes

Genotypes	Fruit shape	Skin texture	Days to maturity (days)	Fruit harvest/panicle	No. of harvested fruit/plant
MI01	Elliptic	Smooth	172.00	4.50	54.33
MI02	Oblong	Intermediate	171.33	4.32	53.33
MI03	Elliptic	Intermediate	135.67	3.22	46.67
MI04	Elliptic	Smooth	162.67	4.88	58.33
MI08	Oblong	Smooth	140.00	2.02	41.33
MI09	Oblong	Smooth	129.00	4.25	53.33
MI12	Oblong	Smooth	117.00	4.55	56.33
MI16	Oblong	Rough	141.67	1.62	24.00
MI19	Round	Rough	135.00	2.37	32.00
MI20	Elliptic	Smooth	161.67	2.23	51.33
MI21	Oblong	Smooth	154.67	2.10	43.67
MI22	Elliptic	Intermediate	136.67	1.68	24.00
MI23	Oblong	Smooth	121.33	3.90	42.33
MI24	Elliptic	Smooth	121.67	4.76	54.00
MI25	Oblong	Smooth	173.33	4.28	54.33
MI26	Roundish	Smooth	134.00	4.25	34.00
MI27	Elliptic	Smooth	127.67	2.05	51.00
MI28	Elliptic	Smooth	178.67	5.23	60.33
MI29	Elliptic	Smooth	137.67	1.59	23.33
MI33	Oblong	Smooth	130.33	1.95	27.00
MI38	Elliptic	Smooth	125.00	3.37	53.33
MI39	Oblong	Rough	129.67	1.92	36.00
MI40	Round	Smooth	145.33	3.41	44.00
MI41	Elliptic	Intermediate	131.00	1.56	23.33
MI43	Elliptic	Intermediate	175.00	2.09	25.33
MI44	Oblong	Rough	137.00	4.84	39.67
MI45	Oblong	Smooth	128.00	4.22	50.00
MI46	Elliptic	Smooth	160.67	4.22	52.00
MI47	Round	Smooth	132.00	2.72	33.00
MI48	Oblong	Rough	136.00	2.45	23.67
MI49	Elliptic	Smooth	171.33	2.03	39.00
MI50	Round	Smooth	140.33	1.06	23.00

Table 4a. Contd.

Genotypes	Fruit shape	Skin texture	Days to maturity (days)	Fruit harvest/panicle	No. of harvested fruit/plant
MI51	Round	Smooth	146.33	3.48	23.67
MI52	Oblong	Smooth	157.67	3.83	36.67
MI54	Elliptic	Smooth	131.00	2.20	37.33
MI58	Roundish	Smooth	127.00	1.58	21.33
MI60	Oblong	Smooth	125.67	1.78	23.67
MI61	Elliptic	Smooth	138.67	3.37	49.00
MI64	Oblong	Smooth	119.33	4.39	53.00
MI70	Round	Intermediate	142.33	3.27	31.00
MI74	Elliptic	Smooth	121.67	3.22	52.00
MI75	Oblong	Smooth	169.00	2.30	23.00
MI77	Elliptic	Smooth	123.00	3.29	23.00
MI80	Elliptic	Intermediate	150.33	2.69	38.67
MI81	Oblong	Smooth	168.00	2.60	36.67
MI82	Elliptic	Smooth	123.67	2.83	26.00
MI83	Oblong	Smooth	128.00	2.35	24.00
MI84	Roundish	Smooth	131.00	2.35	24.00
MI85	Elliptic	Smooth	148.00	3.29	37.00
MI86	Elliptic	Intermediate	162.00	2.04	26.33
MI88	Oblong	Smooth	127.00	3.23	35.00
MI90	Roundish	Rough	169.67	2.10	35.00
MI91	Oblong	Smooth	156.33	3.12	54.67
MI92	Oblong	Rough	140.33	3.48	44.33
MI93	Round	Smooth	123.33	1.86	24.67
MI94	Elliptic	Smooth	120.00	5.46	59.33
MI95	Elliptic	Smooth	148.00	4.31	54.33
MI96	Oblong	Smooth	120.33	3.28	28.67
MI97	Elliptic	Smooth	120.00	1.80	22.33
MI98	Roundish	Smooth	122.67	2.33	48.00
Range	-	-	117.00-78.67	1.56-5.46	21.33-60.33
Mean	-	-	141.07	3.04	38.68
CV (%)	-	-	7.09	13.55	11.29
SE	-	-	5.78	0.24	2.52
LSD(0.01)	-	-	17.71	0.88	9.33

Table 4b. Fruit characteristics of 60 mango genotypes

Genotypes	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Fruit thickness (cm)	Wt. of harvested fruit/ Plant	Pulp texture	Pulp colour	Fibrousness
MI01	245.00	8.65	5.37	5.50	13.11	Firm	Light orange	Scarce
MI02	327.33	9.25	8.42	7.17	7.68	Soft	Light orange	Abundant
MI03	327.00	9.41	7.21	6.02	11.51	Firm	Yellow	Abundant
MI04	317.00	9.66	9.44	7.81	17.99	Firm	Yellow	Scarce
MI08	236.33	7.78	7.40	5.31	15.56	Juicy	Yellow	Scarce
MI09	338.00	10.11	7.32	7.25	11.29	Firm	Yellow	Scarce
MI12	245.67	8.65	6.45	5.74	18.35	Juicy	Yellow	Scarce
MI16	365.33	11.50	10.96	9.71	8.02	Firm	Yellow	Abundant
MI19	323.33	8.69	9.40	5.63	8.83	Firm	Yellow	Abundant
MI20	244.00	8.93	6.29	5.71	11.02	Soft	Yellow	Scarce
MI21	219.00	8.59	6.33	6.70	9.67	Soft	Light yellow	Scarce
MI22	242.00	7.94	9.48	7.11	7.64	Firm	Yellow	Abundant
MI23	245.33	7.86	6.23	5.27	8.08	Soft	Bright yellow	Scarce
MI24	353.00	10.74	7.88	8.23	18.68	Soft	Yellow	Scarce
MI25	317.33	9.97	7.36	6.79	10.74	Soft	Yellow	Abundant

Table 4b. Contd.

Genotypes	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Fruit thickness (cm)	Wt. of harvested fruit/Plant	Pulp texture	Pulp colour	Fibrousness
MI26	324.00	8.75	6.40	5.78	8.39	Soft	Yellow	Scarce
MI27	319.00	10.49	8.51	6.19	7.91	Soft	Yellow	Scarce
MI28	249.33	8.27	6.46	5.85	23.12	Soft	Bright yellow	Scarce
MI29	233.00	8.14	6.37	5.84	7.83	Soft	Yellow	Scarce
MI33	234.33	8.34	7.07	6.35	8.57	Juicy	Yellow	Abundant
MI38	253.67	8.53	7.56	6.64	7.94	Juicy	Orange	Scarce
MI39	264.67	8.73	7.91	7.04	10.19	Firm	Orange	Much
MI40	287.00	7.79	6.17	5.81	14.88	Juicy	Yellow	Abundant
MI41	242.00	8.73	6.76	6.63	7.27	Soft	Yellow	Abundant
MI43	332.33	9.39	6.28	5.49	9.06	Juicy	Yellow	Much
MI44	257.33	8.46	7.33	5.18	10.36	Firm	Orange	Scarce
MI45	256.67	8.80	7.60	6.51	13.64	Firm	Yellow	Scarce
MI46	355.00	10.12	9.71	5.63	23.47	Firm	Orange	Scarce
MI47	255.67	9.99	6.52	5.63	7.44	Soft	Yellow	Scarce
MI48	243.00	9.15	5.61	5.90	7.48	Soft	Yellow	Scarce
MI49	217.67	7.45	6.46	6.82	7.36	Soft	Yellow	Scarce
MI50	313.00	9.63	6.59	7.38	7.11	Soft	Yellow	Abundant
MI51	314.67	9.01	7.35	6.47	7.67	Juicy	Yellow	Much
MI52	355.00	8.63	7.17	5.83	11.73	Soft	Orange	Scare
MI54	321.67	10.33	5.55	5.10	12.01	Soft	Yellow	Scare
MI58	256.33	9.12	5.63	5.51	8.17	Soft	Yellow	Scare
MI60	332.33	8.67	5.90	4.29	8.30	Soft	Yellow	Scare
MI61	320.00	8.25	6.38	5.19	10.72	Soft	Orange	Scare
MI64	248.67	8.65	7.74	8.22	10.92	Juicy	Yellow	Abundant
MI70	332.00	10.07	9.19	8.28	10.96	Firm	Yellow	Scare
MI74	247.33	9.08	7.72	5.49	17.64	Juicy	Orange	Abundant
MI75	320.67	7.77	6.89	5.88	8.49	Soft	Cream	Scare
MI77	320.33	8.32	6.50	6.86	9.51	Firm	Orange	Much
MI80	273.00	8.15	5.87	6.29	6.33	Firm	Orange	Abundant
MI81	325.00	8.46	7.88	5.66	9.42	Soft	Yellow	Abundant
MI82	266.00	8.64	6.10	5.26	7.30	Juicy	Pale yellow	Abundant
MI83	239.00	8.32	6.80	6.56	6.76	Firm	Yellow	Scare
MI84	229.00	6.86	5.80	4.97	6.93	Soft	Orange	Scare
MI85	263.67	8.37	6.63	5.85	11.46	Firm	Pinkish yellow	Scare
MI86	254.00	8.15	5.48	5.30	7.21	Soft	Yellow	Scare
MI88	257.67	8.20	7.39	7.15	8.99	Firm	Yellow	Scare
MI90	236.33	8.28	6.08	5.60	11.47	Soft	Yellow	Much
MI91	233.33	8.53	8.53	6.74	8.37	Soft	Orange	Much
MI92	273.67	9.54	6.37	5.80	12.14	Firm	Orange	Much
MI93	231.67	9.48	5.82	5.19	6.47	Juicy	Yellow	Scare
MI94	313.33	10.47	9.36	8.51	25.04	Firm	Yellow	Much
MI95	355.33	9.63	8.55	8.69	16.30	Firm	Yellow	Much
MI96	233.00	8.46	7.34	7.70	7.64	Firm	Orange	Abundant
MI97	273.67	10.28	10.09	6.95	7.18	Soft	Bright yellow	Scare
MI98	337.33	8.20	6.24	7.14	7.41	Soft	Yellow	Scare
Range	365.33-219.00	11.50-6.86	10.96-5.37	9.71-5.10	25.04-6.33	-	-	-
Mean	283.36	8.92	7.19	6.36	10.71	-	-	-
CV (%)	6.12	8.05	5.16	7.26	9.86	-	-	-
SE	10.01	0.42	0.21	0.27	0.61	-	-	-
LSD(0.01)	37.08	1.54	0.79	0.99	2.26	-	-	-

Pulp characteristics

Among the 60 genotypes 28 showed soft pulp texture and 21 genotypes showed firm and rest genotype were juicy type pulp textures (Table 5). Most of the genotypes had yellow pulp color. Very few genotypes showed abundant or much fibrous, while most of them were least fibrous. Per cent edible portion of fruit is an important character for selecting quality fruit. The present study, edible portion significantly varied from 45.22 to 79.83% (Table 5). The highest percentage of non-edible portion (54.78%) was obtained from MI39, whereas the germplasm MI09 had the lowest percentage of non-edible portion (20.17%). The present investigation is in partial agreement with the research findings of Kabir *et al.* (2007) who recorded 20.95 to 55.06% non-edible portion from 12 mango germplasm. Total soluble solid contents were measured at the eating ripe stage, and it was observed that the variation in TSS among the germplasm was highly significant. MI28 contained the highest TSS (28.26% Brix) and MI20 contained the lowest TSS (16.90% Brix)). The present findings agreed with the results of Kabir *et al*. (2007) who found 16.25 to 27.65 % Brix while studying 12 mango germplasm under Mymensingh conditions.

Table 5. Pulp and stone characteristics of 60 mango genotypes

Genotypes	Edible portion (%)	Non-edible portion (%)	Total soluble solid (%)	Weight of stone (gm)	Length of Stone (cm)	Breadth of the stone (cm)	Thickness of stone (cm)	Veins of the stone
MI01	69.31	30.69	27.50	23.65	9.63	3.01	1.42	Depressed
MI02	72.17	27.83	23.33	45.71	7.43	4.29	1.75	Elevated
MI03	68.46	31.54	26.24	37.20	5.73	3.60	2.30	Elevated
MI04	76.92	23.08	20.08	50.62	6.66	4.18	1.85	Depressed
MI08	73.66	26.34	24.09	50.03	9.30	4.60	2.26	Level
MI09	79.83	20.17	21.08	51.92	9.59	5.13	2.37	Depressed
MI12	69.21	30.79	24.87	53.62	7.27	4.76	2.34	Level
MI16	70.78	29.22	24.77	47.01	12.93	5.84	1.95	Elevated
MI19	73.91	26.09	18.75	44.07	6.94	3.95	1.85	Depressed
MI20	79.52	20.48	16.90	38.44	7.59	3.20	1.62	Elevated
MI21	61.58	38.42	23.33	36.12	6.68	3.78	1.96	Elevated
MI22	71.73	28.27	21.62	47.06	7.33	5.82	2.09	Elevated
MI23	59.40	40.60	21.97	40.09	7.73	3.38	2.22	Depressed
MI24	78.00	22.00	21.32	36.55	11.62	3.70	2.64	Elevated
MI25	62.98	37.02	23.42	41.96	7.71	4.02	2.03	Depressed
MI26	69.56	30.44	22.35	33.09	7.53	3.93	1.75	Elevated
MI27	78.00	22.00	16.91	27.67	10.88	3.30	1.71	Elevated
MI28	76.07	23.93	28.26	27.08	5.50	3.28	1.64	Elevated
MI29	57.96	42.04	21.93	28.68	5.81	3.81	2.27	Elevated
MI33	52.40	47.60	22.15	77.08	6.09	3.38	1.71	Depressed
MI38	65.24	34.76	22.88	36.62	5.88	3.60	2.30	Elevated
MI39	45.22	54.78	24.88	111.61	11.54	4.66	2.86	Elevated
MI40	52.71	47.29	22.34	75.55	6.02	4.65	2.32	Elevated
MI41	66.64	33.36	22.92	25.50	5.72	3.84	1.61	Depressed
MI43	66.05	33.95	23.20	24.06	6.24	3.33	1.69	Depressed
MI44	57.98	42.02	25.20	43.57	7.24	3.74	2.23	Elevated
MI45	54.74	45.26	22.94	37.60	5.75	3.92	2.27	Elevated
MI46	67.63	32.37	22.14	34.29	12.24	4.61	2.25	Depressed
MI47	70.17	29.83	21.07	72.97	8.94	5.48	2.27	Elevated
MI48	55.72	44.28	24.68	34.25	6.23	3.96	1.59	Elevated
MI49	66.28	33.72	22.68	40.63	7.64	3.71	1.96	Elevated
MI50	64.50	35.50	22.11	43.16	5.41	5.18	1.99	Elevated
MI51	54.51	45.49	22.55	51.68	6.54	5.79	2.54	Elevated
MI52	56.81	43.19	22.10	44.84	7.83	3.86	1.87	Elevated
MI54	73.85	26.15	20.25	21.33	7.82	4.10	1.72	Elevated
MI58	55.66	44.34	21.35	31.44	5.34	3.45	1.76	Level
MI60	48.64	51.36	22.16	49.85	8.89	3.66	2.38	Depressed

Table 5. Contd.

Genotypes	Edible portion (%)	Non-edible portion (%)	Total soluble solid (%)	Weight of stone (gm)	Length of Stone (cm)	Breadth of the stone (cm)	Thickness of stone (cm)	Veins of the stone
MI61	58.06	41.94	27.54	39.51	6.75	3.79	1.75	Elevated
MI64	65.87	34.13	23.56	35.79	6.86	3.51	2.39	Elevated
MI70	59.97	40.03	23.68	65.54	9.25	5.72	2.27	Elevated
MI74	66.65	33.35	24.70	45.43	7.71	3.80	2.20	Elevated
MI75	55.69	44.31	26.18	26.47	7.78	3.85	1.66	Elevated
MI77	62.08	37.92	24.70	35.74	9.09	4.86	2.46	Level
MI80	65.71	34.29	25.40	23.64	5.64	3.48	1.80	Depressed
MI81	53.44	46.56	23.09	44.05	9.45	4.76	2.73	Depressed
MI82	46.44	53.56	26.96	96.11	6.77	3.80	1.79	Elevated
MI83	61.43	38.57	25.83	38.25	6.82	3.68	2.06	Elevated
MI84	53.68	46.32	26.05	52.47	6.69	4.48	1.80	Elevated
MI85	52.04	47.96	25.39	87.04	5.44	3.48	1.70	Elevated
MI86	58.85	41.15	24.33	65.30	12.53	5.51	1.60	Elevated
MI88	65.72	34.28	22.70	30.65	8.30	4.59	1.76	Level
MI90	57.33	42.67	25.49	31.60	5.87	4.01	2.41	Elevated
MI91	69.93	30.07	24.11	61.37	8.66	4.35	2.35	Elevated
MI92	52.76	47.24	24.21	73.43	11.13	4.71	2.55	Elevated
MI93	56.05	43.95	23.64	40.16	5.58	3.90	1.98	Elevated
MI94	77.26	22.74	19.22	30.88	9.83	4.88	2.55	Elevated
MI95	74.03	25.97	17.56	38.17	9.92	4.85	2.37	Elevated
MI96	68.70	31.30	18.26	50.22	9.52	4.61	2.20	Elevated
MI97	66.09	33.91	23.33	60.04	10.62	3.78	1.99	Elevated
MI98	48.36	51.64	21.96	92.07	8.03	4.72	1.84	Depressed
Range	45.22-79.83	20.17-54.78	16.90-28.26	21.33-111.61	5.34-12.93	3.01-5.84	1.42-2.86	-
Mean	63.67	36.33	23.07	46.02	7.80	4.20	2.06	-
CV (%)	2.9	5.09	4.85	4.35	5.88	9.17	8.62	-
SE	1.07	1.07	0.65	1.16	0.27	0.22	0.10	-
LSD(0.01)	3.96	3.96	2.39	4.28	0.98	0.82	0.38	-

Stone characteristics

The results showed that MI39 produced the heaviest stone (111.61 g) followed by MI82 (96.11g) and MI98 (92.07 g) (Table 5). The lightest was observed in MI54 (21.33 g). The results of the present study are in partial agreement with the research findings of Haque *et al* (1993) who recorded 21.14 to 98.53 g stone weight. Average number of stone length of different germplasm exhibited wide variations. MI16 had the longest stone (12.93 cm.) but MI58 produced the smallest stone (5.34 cm). The widest stone (5.84 cm) was noted in MI16 and the thinnest stone (1.42 cm) was found in MI01 (Table 5). Saha *et al*. (1998) observed similar variation on the stone sizes of mango. Most of the genotypes showed elevated veins on stone; only five genotypes showed level type veins and rest were depressed type veined stone. Among the genotypes only fourteen had no fibre on the stone and maximum genotypes showed fibrousness in stone. Considering all of the characteristics under study, some promising genotypes viz. MI94, MI46, MI28 and MI24 were selected for further evaluation with a view to develop new variety(s) of mango.

Conclusion

The development of mango variety through the selection is important. The study on physio-morphological, floral biological and fruit characteristics of mango showed that there have variations among the germplasm. This gives the opportunity to select germplasm on the basis of desirable characters. The improved variety of mango may be developed using the variability of collected genotypes.

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