Sustainability, Agri, Food and Environmental Research, (ISSN: 0719-3726), 9(1), 2021: 1-12
http://dx.doi.org/10.7770/safer-V0N0-art2377

Vegetative characteristics of elite seedling mango germplasm in two districts of Punjab.
Características vegetativas del germoplasma de plántulas de mango de élite en dos distritos de Punjab

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ABSTRACT

The present investigations were carried out in full grown mango trees under Amritsar and Gurdaspur conditions of the Punjab. The various vegetative characters were studied. The considerable differences were observed among the germplasm under study. The highest measure for plant height and canopy volume had been exhibited by the genotype AKS-1. Genotype AR-1 exhibited a wide range of tangible diversity in trunk circumference (410.00 cm). The highest tree spread was measured in genotype AKS-1 (15.50m). The petiole length of the evaluated genotypes ranged from 2.00 to 4.50 cm. Conclusively all the genotypes were differ in vegetative character.

Key words: *Mangifera indica* L,vegetative morphology,genotype variability, Punjab.

RESUMEN

Las presentes investigaciones se llevaron a cabo en árboles de mango adultos en las condiciones de Amritsar y Gurdaspur del Punjab. Se estudiaron los distintos caracteres vegetativos. Se observaron diferencias considerables entre el germoplasma en estudio. La medida más alta para la altura de la planta y el volumen

del dosel había sido exhibida por el genotipo AKS-1. El genotipo AR-1 exhibió una amplia gama de diversidad tangible en la circunferencia del tronco (410,00 cm). La mayor extensión de árboles se midió en el genotipo AKS-1 (15,50 m). La longitud del pecíolo de los genotipos evaluados osciló entre 2,00 y 4,50 cm. En conclusión, todos los genotipos se diferenciaron en el carácter vegetativo.

Palabras clave: *Mangifera indica* L, morfología vegetativa, variabilidad del genotipo, Punjab.

INTRODUCTION

Mango (*Mangifera indica* L.) is the most important fruit of tropical and subtropical agro climatic regions of the world. Its domestication in the Indian sub-continent dates back to at least 4000 years; however, importance to its plantation was given during the dynasty of Mughals (Navprem*et al.*,2012). Fruit is utilized at all stages of its development. Ripe fruits are utilized in preparing squash, jam, jelly, custard powder, mango leather (Ambpapad) and mango toffee. Its wood is used for making furniture, packing boxes, match boxes and also as a source of fuel. It is the national fruit of India, Pakistan and the Philippines and the national tree of Bangladesh. Therefore, it is rightly acknowledged as the king of fruits in India. The very little attention has been given to the description of the vegetative morphological characters of the different cultivars. The morphological descriptors used allowed the rapid and efficient characterization of mango plants. Vegetative character greatly differs from one genotype to other genotype in mango which can be used as identification when plants are not in bearing stage (Singh and Khan 1939).The variation in Vegetative characters can be consider as good tool for differentiation in the varieties. Morphological traits are visually evaluated in most cases. Therefore, a study was made to evaluate and study the characters of genetic resources of mango in different areas and to conserve them *in situ*, in their wild habitats. Morphological character have significant role for documentation of the examined genotypes, which would assist with presenting, choose and improve the current mango cultivars. Objective of this study was to characterize the tree and leaf characteristics of twenty five elite seedling mango germplasm, locally available at central and sub-mountain zones of Punjab.

MATERIALS AND METHODS

In the present investigation, one hundred genotypes of mango were selected and coded with location wise abbreviation as mention in Table 1.

Table 1
Collected sites (codes and abbreviations).

Collector Code	Abbreviation
AA	Amritsar Attari.
AKCA	Amritsar Khalsa College
AP	Amritsar Pairewal
AUG	Amritsar AugarAulakh
AGKB	Amritsar Ghukewali
ABG	Amritsar Bhure Gill
AKS-1	Amritsar KotliSakka
AR	Amritsar Rayya
GQ	Gurdaspur Qadian,
GJ	Gurdaspur Jawahar Bagh
GRB	Gurdaspur Ranjit Bagh

Among the selected genotypes, twenty five elite promising mango accessions were selected on the basis of desirable horticultural traits for final evaluation in a randomized block design (RBD) with three replications during the period 2012 to 2013. Morphological data for various quantitative traits were collected manually from three uniformly grown fully matured trees. For qualitative parameters the evaluation was done with the help of 'Mango Descriptor', IPGRI, Rome (2006). The recorded data were analysed to assess the genetic divergence using computer software Windostat 9.3 version.

The tree height was measured with the help of calibrated bamboo stick from ground level to the highest point of the tree

The tree spread was measured with the measurement tape from north-south direction and east-west direction with tree trunk as the central point and was recorded in 'm'.

The canopy volume was calculated from tree spread by using the formula given by Westwood (1978).

$$V = \frac{4}{3}\pi r^2 h$$

Where, h = height of the tree

R = sum of EW + N Trunk

The leaf length, breadth and petiole length of the selected genotypes was randomly taken from all the directions and centre of the tree with the help of scale and recorded in centimeters. It was noted in the month of October after the cessation of growth.

RESULTS

Tree height: The data recorded on tree height of different seedling mango germplasm are presented in Table 2. The perusal of the data clearly indicates a wide range of significant variability in respect of tree height amongst the evaluated germplasm of seedling mango. The range of tree height was observed to be 5.20 to 16.50 m. Highest tree height was measured in the genotype AKS-1 to the tune of 16.50 m. Genotype GJB-1 was next to it having the tree height 14.00 m. The next was genotype GQ-3 with height of 13.40 m. The genotype AA-15, AP-1, AA-16, AA-101, AA-4, AA-9, AGKB-64, AR-1, AKCA-14, AA-3, AA-7, AA-19, AA-8 and AA-1 having tree height 12.90, 12.60, 12.40, 12.30, 12.20, 12.20, 12.20, 12.20, 12.10, 12.10, 12.10, 12.10, 12.00 and 12.00 m. The other genotypes AUG-1, AA-20, AA-42, AA-39, ABG-1, AA-2 and AA-29 recorded the tree height of 11.40, 11.30, 11.20, 11.20, 11.10, 11.00 and 10.40 m respectively. Whereas the minimum tree height of 5.20 m was recorded in germplasm GRB-1.

Trunk circumference: The data recorded on trunk circumference of different seedling mango germplasm are shown in Table 2. Various genotypes exhibited a wide range of tangible diversity in trunk circumference. The trunk circumference was measured to be the maximum (410.00 cm) in genotype AR-1 closely followed by AUG-1 (390.10 cm) and AKS-1 (310.00 cm) followed by AA-1, AA-7, AA-4, AP-1, AA-9, AA-39, GQ-3, GJB-1, AA-8, AA-101, AA-15, AA-42 and AA-19 having trunk circumference 290.10, 280.10, 270.20, 230.50, 210.20, 210.00, 195.40, 190.20, 190.10, 190.00, 190.00, 190.00 and 190.00 cm respectively. Next in order were the genotype ABG-1, AGKB-64, AA-29, AA-20, AA-16, AKCA-14, AA-2 and AA-3 having

trunk circumference of 185.10, 180.80, 170.90, 170.20, 170.10, 170.00, 120.10 and 130.10 cm respectively, whereas the minimum trunk circumference of (110.00 cm) was recorded in genotype GRB-1.

Tree spread: Tree spread of the evaluated genotypes differ significantly (Table 2). The range of tree spread was found to be 2.7 to 15.50 m. The highest tree spread was measured in genotype AKS-1 (15.50m) followed by AGKB-64, AR-1, AA-19, AA-8, AA-15, AA-4, AA-39 and AA-7 having tree spread 11.00, 11.00, 11.00, 10.80, 10.00, 8.00, 7.00 and 7.00 m respectively. Next in order were AA-9, AA-16, AA-20, AA29, AA-1, AA-42 and AA-2 having tree spread 6.70, 6.50, 6.50, 6.50, 6.50, 6.00 and 6.00 m respectively. The other genotypes ABG-1, AUG-1, GJB-1, AA-101, AKC-14, AA-3, AP-1 and GQ-3 having tree spread of 5.80, 5.80, 5.50, 5.30, 5.00, 4.50, 4.00 and 3.50 m. The tree spread was recorded to be least (2.70 m) in genotype GRB-1.

Canopy volume: Considerably large variation in the canopy volume was observed in different seedling mango genotypes under evaluation (Table 2). Canopy volume ranged from 18.80 to 2061.30 m^3. Maximum canopy volume 2061.30 m^3 was measured in genotype AKS-1 followed by genotypes AGKB-64, AR-1, AA-19, AA-8, AA-15, AA-4 and AA-7 having canopy volume 765.10, 765.00, 762.00, 721.10, 670.80, 404.40 and 303.90 m^3 respectively. Next in order were the genotypes AA-9, AA-39, AA-16, AA-1 AA-20, AA-29, GJB-1, AA-42 and AA-2 having canopy volume of 284.50, 284.10, 268.30, 263.60, 244.80, 227.40, 220.20, 209.70 and 205.90 m^3 respectively.

The other genotypes AUG-1, ABG-1, AA-101, AKCA-14, AA-3, AP-1 and GQ-3 having canopy volume 198.50, 191.40, 175.60, 157.30, 127.40, 104.80 and 85.00 m^3 respectively. The minimum (18.80 m^3) canopy volume was measured in genotype GRB-1.

Crown shape: The different evaluated seedling mango germplasm exhibited a wide range of morphological diversity with respect to their shape of crown (Table 2). The difference in crown shape were recorded clearly by visualizing its shape from four directions. The crown of genotypes AA-2, AA-3, AA-4, AA-16, AA-20, AA-29, AA-39, AA-42, AA-101, AKCA-14, AP-1, AR-1, AUG-1, GJB-1, GRB-1 and GQ-3 having oblong type of crown shape. However, the genotypes AA-1, AA-8, AA-9, AA-15, AA-19 and AKS-1 have broadly pyramidal type of crown shape, genotypes AA-7, ABG-1 and AGKB-64 having semi-circular type of crown shape.

Tree growth habit: Likewise the crown shape, tree growth habit also showed high variability in different seedling mango germplasm under evaluation (Table 2). The differences were recorded clearly by visualizing the tree growth habit from four direction. The tree growth habit of genotypes AA-2, AA-3, AA-4, AA-16, AA-20, AA-29, AA-39, AA-42, AA-101, AKCA-14, AP-1, AR-1, AUG-1, GJB-1, GRB-1 and GQ3 having erect type crown shape. However, the genotypes AA-7, AA-8, AA-9, AA-15, AA-19, ABG-1 and AGKB-64 having spreading and genotypes AA-1 and AKS-1 having dropping type of tree growth habit.

Leaf length: The data recorded on the leaf length of different seedling mango germplasm are presented in Table 2. The leaf length was recorded to be maximum (28.20 cm) in genotype AA-19 closely followed by AR-1 with leaf length of 28.00 cm. However, these two were statistically *at par* to each other and showed significant variation from remaining mango accessions. AA-8, AA-39, AA-7, AA-101, AGKB-64, AA-3 and AA-20 having leaf length of 27.10, 27.00, 26.00, 25.70, 25.10, 25.00 and 25.00 cm respectively. Next in order were AUG-1, AA-16, GJB-1, AA-9, ABG-1, AA-2, AKS-1, AA-4 and GQ3 recorded the leaf length of 24.80, 24.60, 24.40, 24.10, 24.10, 24.10, 24.10, 24.00 and 24.00 cm respectively. The other genotypes AA-1, GRB-1, AP-1, AA-15, AA-42 and AKCA-14 having the leaf length of 23.70, 23.40, 22.10, 21.20, 20.10 and 17.10 cm respectively. Minimum leaf length (16.10 cm) was recorded in genotype AA-29.

Leaf breadth: The data with regard to leaf breadth of different seedling mango germplasm are presented in Table 2. The leaf breadth ranged from 3.70 cm to 6.40 cm. Considerable variation also observed form this parameter. The leaf breadth was recorded to be the maximum 6.40 cm in genotypes GRB-1 closely followed by AR-1 with the leaf breadth 6.10 cm followed by AKS-1, AA-15, AA-19, AA-39, AGKB-64, AA-101, GQ-3, AA-29, AA-16, AA-8 and AA-7 having leaf breadth of 5.70, 5.70, 5.50, 5.50, 5.30, 5.10, 5.10, 5.10, 5.00, 5.00 and 5.00 cm respectively. The next on order were the genotype AA-3, AP-1, AA-2, AA-1, AA-42, AA-9, ABG-1, AKCA-14, GJB-1, AA-4 and AUG-1 having leaf breadth of 4.90, 4.80, 4.70, 4.70, 4.50, 4.50, 4.10, 4.10 4.00, 4.00 and 4.00 cm respectively. The leaf breadth was recorded to be least (3.70 cm) in genotype AA-20.

Petiole length: The data recorded on petiole length of different seedling mango germplasm reveal recognizable differences among the mango accessions (Table 2). The petiole length of the evaluated genotypes ranged from 2.00 to 4.50 cm. The

petiole length was recorded to be the maximum 4.50 cm in genotype GRB-1 followed by AKS-1, AA-3, ABG-1, AA-2, AA-8, AA-1, AA-39, GJB-1, AUG-1, AR-1 and AA-19 having petiole length 3.80, 3.80, 3.70, 3.70, 3.70, 3.70, 3.50, 3.20, 3.20, 3.20 and 3.20 cm respectively. Next in order were genotypes AA-16, AA-42, AP-1, AA-101, AA-15, AA-4, AA-9, AGKB-64, AA-7, AKCA-14, AA-20 and AA-29 having petiole length 3.10, 3.10, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 3.00, 2.80, 2.40 and 2.40 cm. The petiole length was recorded to be least (2.00 cm) in genotype GQ-3.

Leaf blade shape: The leaf blade shape of different seedling mango germplasm under evaluation showed visible differences (Table 1). The leaves of genotypes AP-1, AR-1, AUG-1, GJB-1, GRB-1, GQ-3, AA-19, AA-29, AA-42 and AA-101 having oblong type of leaf blade shape, whereas the genotype AA-1, AA-2, AA-3, AA-4, AA-7, AA-8, AA-9, AA-15, AA-16, AA-20, ABG-1, AA-39, AGKB-64, AKS-1 and AKCA-14 having lanceolate type of leaf blade shape.

Leaf apex shape: The germplasm under evaluation showed variation in the leaf apex shape (Table 2). The clear differences were recorded simply by visualizing the leaf apex shape. The leaves of genotype AP-1, AR-1, AUG-1, GJB-1, GRB-1, AA-4, AA-7, AA-19, AA-29, AA-42, AA-101 and AGKB-64 having acute type of leaf apex shape. Where as the genotype AA-1, AA-2, AA-3, AA-8, AA-9, AA-15, AA-16, AA-20, AA-39, AKCA-14, AKS-1, ABG-1 and GQ-3 and having acuminate type of leaf apex shape.

Leaf base shape: The leaf base shape of different genotypes under evaluation registered visible differences (Table 2), the difference were recorded clearly by visualizing the leaf base shape. All the genotypes under evaluation have obtuse type of leaf base shape.

Sustainability, Agri, Food and Environmental Research, (ISSN: 0719-3726), 9(1), 2021: 1-12
http://dx.doi.org/10.7770/safer-V0N0-art2377

Table 2: Vegetative morphology: description of vegetative characters in elite mango genotypes.

Selection number	Collector code	Tree characters						Leaf characters					
		Tree height (m)	Trunk circumference (cm)	Tree spread (m)	Canopy volume (m^3)	Crown shape	Tree Growth Habit	Leaf length (cm)	Leaf breadth (cm)	Petiole length (cm)	Leaf blade shape	Leaf apex shape	Leaf base shape
1	AP- 1	12.60	230.50	4.00	104.80	Oblong	Erect	22.10	4.80	3.00	Oblong	Acute	Obtuse
2	AKCA - 14	12.10	170.00	5.00	157.30	Oblong	Erect	17.50	4.10	2.80	Lanceolate	Acuminate	Obtuse
3	GJB -1	14.00	190.20	5.50	220.20	Oblong	Erect	24.40	4.00	3.20	Oblong	Acute	Obtuse
4	AA -101	12.30	190.00	5.30	175.60	Oblong	Erect	25.70	5.10	3.00	Oblong	Acute	Obtuse
5	AA-15	12.90	190.00	10.00	670.80	Broadly Pyramidal	Spreading	21.20	5.70	3.00	Lanceolate	Acuminate	Obtuse
6	AA-4	12.20	270.20	8.00	404.40	Oblong	Erect	24.00	4.00	3.00	Lanceolate	Acute	Obtuse
7	AA -16	12.40	170.10	6.50	268.30	Oblong	Erect	24.60	5.00	3.10	Lanceolate	Acuminate	Obtuse
8	AA -42	11.20	190.00	6.00	290.70	Oblong	Erect	20.10	4.50	3.10	Oblong	Acute	Obtuse
9	GRB-1	5.20	110.00	2.70	18.80	Oblong	Erect	23.40	6.40	4.50	Oblong	Acute	Obtuse
10	AA-3	12.10	130.10	4.50	127.40	Oblong	Erect	25.00	4.90	3.80	Lanceolate	Acuminate	Obtuse
11	GQ-3	13.40	195.40	3.50	85.00	Oblong	Erect	24.00	5.10	2.00	Oblong	Acuminate	Obtuse
12	AA-20	11.30	170.20	6.50	244.80	Oblong	Erect	25.00	3.70	2.40	Lanceolate	Acuminate	Obtuse
13	AUG.1	11.40	390.10	5.80	198.50	Oblong	Erect	24.80	4.00	3.20	Oblong	Acute	Obtuse
14	AA-9	12.20	210.20	6.70	284.50	Broadly Pyramidal	Spreading	24.10	4.50	3.00	Lanceolate	Acuminate	Obtuse
15	ABG-1	11.10	185.10	5.80	191.40	Semi-circular	Spreading	24.10	4.10	3.70	Lanceolate	Acuminate	Obtuse
16	AGKB-64	12.20	180.80	11.00	765.00	Semi-circular	Spreading	25.10	5.30	3.00	Lanceolate	Acute	Obtuse
17	AA-29	10.40	170.90	6.50	227.40	Oblong	Erect	16.10	5.10	2.40	Oblong	Acute	Obtuse
18	AA-39	11.20	210.00	7.00	284.10	Oblong	Erect	27.00	5.50	3.50	Lanceolate	Acuminate	Obtuse
19	AA-2	11.00	120.10	6.00	205.90	Oblong	Erect	24.10	4.70	3.70	Lanceolate	Acuminate	Obtuse
20	AR-1	12.20	410.00	11.00	765.10	Oblong	Erect	28.00	6.10	3.20	Oblong	Acute	Obtuse
21	AA-8	12.00	190.10	10.80	721.10	Broadly Pyramidal	Spreading	27.10	5.00	3.70	Lanceolate	Acuminate	Obtuse
22	AA-1	12.00	290.10	6.50	263.60	Broadly Pyramidal	Drooping	23.70	4.70	3.70	Lanceolate	Acuminate	Obtuse
23	AA-7	12.10	280.10	7.00	303.90	Semi-circular	Spreading	26.00	5.00	3.00	Lanceolate	Acute	Obtuse
24	AKS-1	16.50	310.00	15.50	2061.30	Broadly Pyramidal	Drooping	24.10	5.70	3.80	Lanceolate	Acuminate	Obtuse
25	AA-19	12.10	190.00	11.00	762.00	Broadly Pyramidal	Spreading	28.20	5.50	3.20	Oblong	Acute	Obtuse
Range		5.20–16.50	110.00-390.10	2.70-15.50	18.80-2061.30	--	--	16.10-28.00	3.70-6.40	2.00-4.50	--	--	--
Mean		11.92	213.77	7.12	392.08	--	--	23.98	4.90	3.20	--	--	--
S. Em. (±)		0.146	1.372	0.158	4.032	--	--	0.152	0.113	0.072	--	--	--
C.D. at 5%		0.293	2.759	0.318	8.106	--	--	0.305	0.226	0.145	--	--	--

DISCUSSION

Tree and Leaf Characteristics: Data represented in Table – 1 reflect wide variability with respect different tree characters among the twenty five evaluated genotypes. The maximum tree height (16.50 m) was recorded in genotype AKS-1, while genotype GRB-1 exhibited the shortest tree (5.20 m). Trees of genotypes AA-8, AA-1, AUG-1, AA-20, AA-42, AA-39, ABG-1, AA-2 and AA-29 also were relatively shorter ones. The present research work lends supports from the previous findings of Singh and Sharma (2005), which worked on sucking type of mango strains and found similar range in respect of tree height under sub-mountain zone of eastern Punjab. With respect to trunk circumference 'AR-1' recorded the maximum trunk girth (410.00 cm) followed by AUG-1, AKS-1, AA-1 and AA-7 having trunk circumference of 390.10, 310.00, 290.10 and 280.10 cm, respectively, where as GRB-1 recorded the minimum (100.00 cm) trunk circumference. The maximum tree spread was measured in genotype AKS-1 (15.50 cm) followed by AGKB-64, AA-8, AA-4, AA-9 and ABG-1 having tree spread of 11.00, 10.80, 8.00, 6.70 and 5.80 m, respectively, whereas GRB-1 had the minimum tree spread (2.70 m). As far as canopy volume is concerned the maximum was measured in genotype AKS-1 (2061.30 m^3), followed by genotypes AGKB-64, AA-15, AA-9 and AUG-1, having canopy volume of 765.10, 670.80, 284.50, and 198.50, respectively. Whereas, GRB-1 had the minimum canopy volume 18.80 m^3. As canopy volume was derived from tree height, tree spread and trunk circumference, it shows similar trends, as that found in these parameters. The genotypes AA-16, AA-20 and GQ-3 having oblong type of crown shape. However, genotypes AA-1, AA-9 and AKS-1 exhibited broadly pyramidal type of crown shape and the genotypes AA-7, ABG-1, AA-9 and AGK-64 had semi-circular type of crown shape. As far as tree growth habit is concerned genotypes AA-2, AA-3, AA-4 and GQ-3 have erect type of growth habit. However, genotypes AA-9, AA-15 and AGKB-64 have spread type of tree growth habit. Genotypes AA-1 and AKS-1 have drooping type of tree growth habit. The maximum leaf length (28.20 cm) was recorded in genotype AA-19, followed by AA-8, AA-7, AA-101, AUG-1, AA-1 and AA-42 genotypes having leaf length of 27.10, 26.00, 25.70, 24.80, 23.70 and 20.10 cm, respectively, whereas genotype AA-29 had the minimum leaf length (16.10 cm). On the other hand, leaf breadth was recorded as the minimum for accession AA-20 (3.20 cm) and it was the maximum for GRB-1 (6.40 cm). Petiole length varied from 2.00 to 4.50 cm in evaluated germplasm, with the maximum and minimum for GRB-1 (4.50 cm) and GQ -3 (2.00 cm), respectively. This result has been corroborated with the findings of Rajan*et al.* (2010) and Rymbai*et al*. (2014). Majority of the genotypes revealed oblong type leaf blade shape, whereas acute and acuminate type leaf apex shapes were almost equally distributed among the evaluated genotypes. All the genotypes under present study had obtuse leaf base shape. Similar observations regarding the variation in leaf blade shape were also reported by Mussane (2010) and Rajwana*et al.* (2011). The differences in various

quantitative as well qualitative attributes of tree and leaf among the evaluated germplasm might be due to genetic behaviour of individual genotype and difference in their ages.

As conclusions, the overall outcomes of the present investigation it is evident that the germplasm with desirable traits can be proved to be good genetic material for the utilization in future breeding programmes for improving the mango varieties in Punjab. The genotype AKS-1 recorded the highest tree height and canopy volume. Hence, genotypes such as AKS-1, GJB-1, GQ-1, AA-19, AA-29, AA-39, AA-42, AA-101, ABG-1, AGKB-64, AR-1 and AUG-1 can be included for future systematic breeding as well as hybridization programme of mango to inculcate and/or concentrate favourable attributes among the improved progenies.

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Sustainability, Agri, Food and Environmental Research, (ISSN: 0719-3726), X(X), 202X
http://dx.doi.org/

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