

Variability in morphological parameters of Jamun (*Syzygium cumini* Skeels) genotypes

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ABSTRACT

The study was conducted at the Experimental Farm, Division of Fruit crops, ICAR-IIHR, Bengaluru to assess the variability in morphological traits of Jamun genotypes. The experiment was laid out in a randomized block design with three replications. Result showed that all the genotypes expressed considerable variability with respect to the morphological characters. The genotype Dharwad market sample-2 was showing the highest plant height (618.3 cm). The genotype Andaman collection-4 recorded highest (21.56 cm) leaf length and lowest (9.83 cm) value recorded in the genotype Kaveri pattnam-2. The inter nodal length of the genotype Dharwad -2 recorded the highest value of 7.2 cm and the Dharwad-13 recorded the lowest value of 2.66 cm. The petiole length of the genotype Patna recorded the highest value of 3.00 cm and the Andaman -4 recorded the lowest value of 0.43 cm. Among the genotypes, Dharwad-6 was showing the distinctive from other genotypes in cluster analysis.

Keywords: *Syzygium cumini* Skeels, Genotypes, Morphological and Variability

INTRODUCTION

Jamun botanically called as *Syzygium cumini* Skeels, belongs to the family Myrtaceae (Chase *et al.*, 2009). The jamun also known as Indian blackberry, Java plum, Jambu, black plum and Jambul, Kalajam, Phalinda and Rajamun, damson plum, duhat plum, *etc.* (Sharma *et al.*, 2012). *S. cumini* is native to India, Burma, Ceylon and to the Andaman Islands and it is available throughout Indian plains as well as in Kumaon hills up to 1,600 m. It is found grown as a wild and semi-wild in tropical and subtropical parts of India *viz.*, Punjab, Haryana, Uttar Pradesh, Maharashtra, Rajasthan, Gujarat, Madhya Pradesh and Bihar. It is a multipurpose tree of both food and medicinal values (Inamdar *et al.*, 2000). All parts of the tree such as fruits, leaves, seeds, and bark are used in Indian medicine system like Ayurveda, Homeopathy, Sidda and Unani (AYUSH) *etc.* Different parts of the jamun were also reported for its antioxidant, anti-inflammatory, anti-microbial, and anti-ulcerogenic (Ghosh *et al.*, 2017 and Ayyanar *et al.*,

2012). Before the discovery of insulin, in the treatment of diabetes *S. cumini* was used either alone or in combination with other hypoglycaemic plants even in Europe (Helmstadter, 2008). Seeds contain an alkaloid 'jambosin' and glycoside 'jambolin' which can reduce diastatic conversion of starch into sugars (Yamini *et al.*, 2022).

There are no major varieties in jamun; there exist a large number of local seedling strains of this crop which provide great scope for the selection of better types. A lot of variations is available with respect to plant and fruit parameters. These variations can be useful to evolve quality genotype. Hence, the present study was aimed to characterize the jamun genotypes to know the existing variability.

MATERIALS AND METHODS

The study was conducted at Research field, Division of Fruit Crops, ICAR-IIHR, Bengaluru on five years old Jamun genotypes. Different morphological attributes like plant height, canopy spread, leaf characters, new flush colour, intermodal length, petiole length, leaf anthocyanin and phenol

were recorded as per jamun DUS guidelines. The observations were recorded among three trees of each genotype and each tree was considered as a replication. It was analyzed as randomized complete block design (RCBD).

RESULTS AND DISCUSSION

Results presented in Table-1 showed significant variability in morphological parameters of all the genotypes studied. As per jamun DUS guidelines plant showing three types of spreading nature, *i.e.*, spreading, semi-spreading and upright. Most of the genotypes were grouped under upright growth habit. The plant height of the accessions was highly variable. Dharwad market sample-2 recorded the highest plant height (618.3 cm) and KHA-32 genotype was showed the lowest (155 cm) plant height (Table 1). The stem girth of the genotype Kaveripattanam- 4(a) showing highest value (80.43 cm) and lowest was recorded be in genotype KHA-32 (19.66 cm). In present study variations in plant height and stem girth was influenced by the age of the plant. The existence variation in morphological characters of jamun was reported by Inamdar *et al.* (2000) also reported similar results. The canopy spread in North-South direction was highest in Dharwad market sample-2 (513.33 cm) and lowest (161.66 cm) in the genotype KHA-32. The genotype Dharwad market sample-2 showed the highest (498.33 cm) canopy spread in E-W direction and lowest in KHA-32 (19.66 cm). Anushma and Anuradha (2018) reported a similar report on jamun. The leaf length of the genotypes showed more variability. The genotype Andaman-4 recorded highest (21.56 cm) leaf length value and lowest (9.83 cm) value recorded in the genotype Kaveri pattanam-2. Anushma and Anuradha (2018), reported the mean leaf lamina length ranged from 11.63 cm (IIHRJ-14) to 15.53 cm (IIHRJ-10). The genotype Chinnapalli recorded the highest mean value of leaf width 8.23 cm and it was on par with Andaman-4 (7.9cm) and the genotype Madhya Pradesh-2 and Madhya Pradesh-5 recorded the lowest value of 3.80 cm (Table 1). The variation between the genotypes for different morphological characters may be attributed to the differences in the genetic makeup of these genotypes.

The internodal length of the genotypes Dharwad -2 recorded the highest value of 7.2 cm and the

Dharwad-13 recorded the lowest value of 2.66 cm. The petiole length of the genotype Patna recorded the highest value of 3.00 cm and the Andaman-4 recorded the lowest value of 0.43 cm. The new shoot length of the genotype Savadatti recorded the highest value of 28.33 cm and the Khanapur-32 recorded the lowest value of 10.33 cm. The genotype Srisailam-18 recorded the highest number of leaves/new shoot 17 and the Dharwad market sample-3 recorded the lowest value of 6. Similar findings were reported by Swamy *et al.* (2017) and Kumar *et al.* (2022) in Jamun.

The lowest tender leaf anthocyanin content (11.26 mg/100g) was recorded in Dharwad -7, whereas the highest leaf anthocyanin content (69.26 mg/100g) in Madhya Pradesh-3. The lowest leaf phenols content (138.4 mg/100g) was recorded in Kaveri pattanam-4, whereas the highest leaf phenols content (3538 mg/100g) in Kaveri pattanam-2.

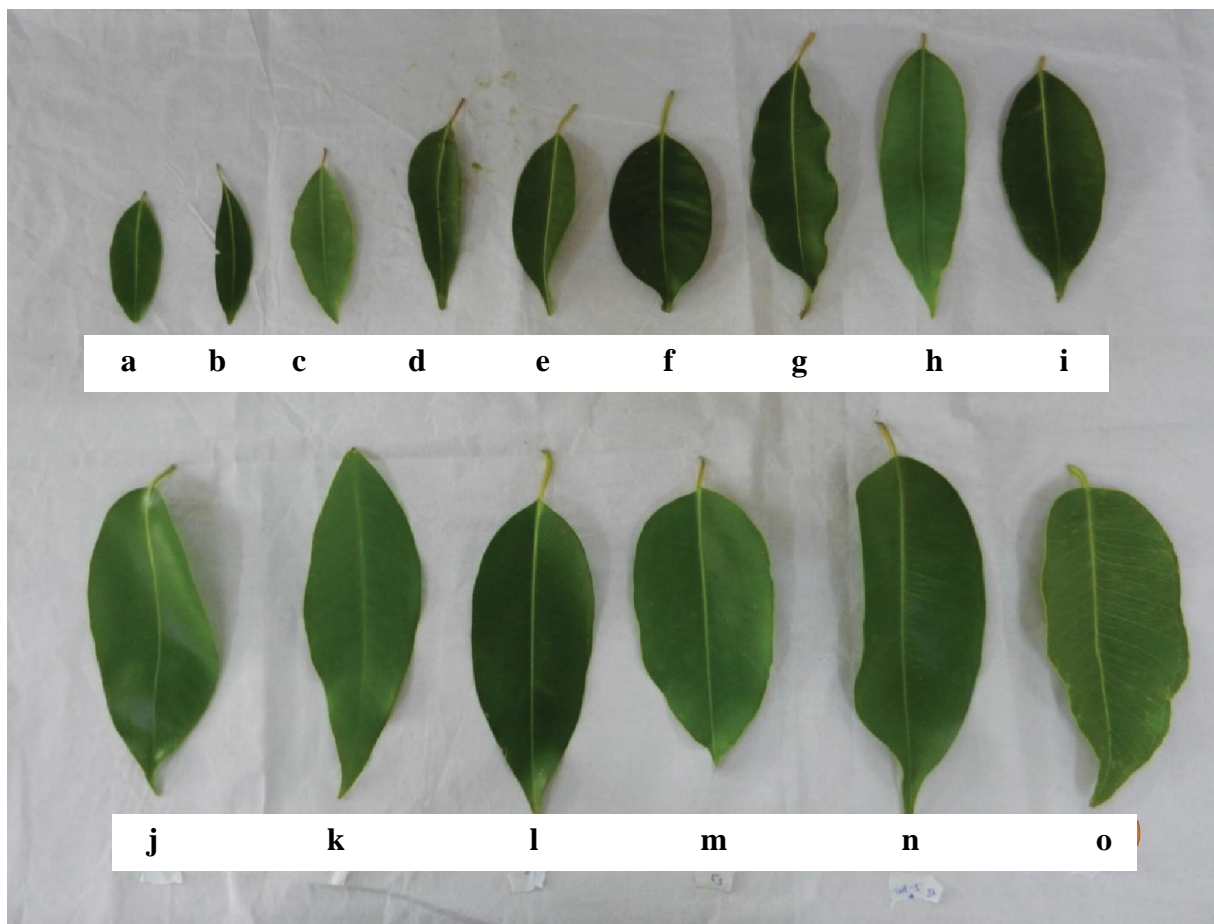
Grouping of genotypes based on plant characters were done which resulted in 5 non-overlapping clusters. Cluster wise listing of germplasm according to plant characters are given in Table 3 and Fig.1. Cluster-I had maximum number of genotypes (22) and Cluster II had the minimum number of genotypes (1) and this genotype seems to be morphologically distinctive from other clusters with reference to morphological parameters. Cluster wise summary mean of plant characters (Table 4) will indicate the mean range of different traits and genotypes was grouped based on which similar parameters.

The cluster mean of plant height ranged from 284.4 cm to 591.67 cm Cluster IV (591.67 cm) recorded the highest plant height and the Cluster V (284.4 cm) recorded the lowest plant height (Table 4). The cluster mean value of stem girth was ranged from 32.71cm to 74.33cm. The Cluster IV has the maximum girth of 74.33cm and the minimum girth of 32.71cm was recorded in Cluster V (Table 4). The cluster mean value of N-S ranged from 219.17 cm to 481.67 cm. The Cluster IV has the maximum north-south canopy of 481.67cm and the minimum of 219.17cm was recorded in Cluster V (Table 4). The cluster mean value of E-W ranged from 227.07 cm to 480.42 cm. The Cluster IV has the maximum east-west direction of 480.42cm and the minimum of 227.07 cm was recorded in Cluster V (Table

Variability in Jamun



Plate 1. Nature jamun plants



a. Kaveri pattnam-4(a); **b.** Mp-5; **c.** Kaveripattnam-1; **d.** Hurulichikkinahalli; **e.** Kaithnal; **f.** IC-715; **g.** Collection-4a; **h.** Dharwad market sample-4; **i.** JNR-2; **j.** Dharwad market sample-2; **k.** Andaman collection-4; **l.** Collection-9; **m.** JNR-1; **n.** Collection-8; **o.** CHK.

Plate 2. Variability of jamun leaves for shape and size

Table 1: Variation of plant characters of jamun genotypes

Genotype	IC Number	Plant height (cm)	North - South (cm)	East –West (cm)	Stem girth (cm)	Spreading nature
Dhoopdal	IC-0621955	423.33	423.33	420.00	56.33	semi spreading
Selection-45	IC-0621954	426.66	393.33	388.33	49.56	semi spreading
Selection-58	IC-0621956	435.00	420.00	416.66	50.16	Spreading
Savadatti	IC-0621957	393.33	376.66	393.33	55.66	semi spreading
Kaithnal	IC-0621952	455.00	425.00	452.50	62.83	semi spreading
AJG-85	IC-0621953	465.00	441.66	428.33	58.53	semi spreading
IC-715	IC-0587715	421.66	445.00	465.00	59.06	Upright
Konkan Bahadoli	IC-0621958	467.50	395.00	407.50	59.93	semi spreading
Dharwad -2	IC-0621961	425.00	395.00	410.00	61.70	semi spreading
Dharwad -2a	NA	347.50	287.50	287.50	47.13	semi spreading
Dharwad -3a	NA	428.33	425.00	420.00	63.56	semi spreading
Dharwad -4a	NA	365.00	348.33	306.66	43.63	Upright
Dharwad -7	NA	471.66	455.00	443.33	70.96	semi spreading
Dharwad -12	IC-0631356	475.00	450.00	465.00	65.10	semi spreading
Chinnapalli	IC-0621967	470.00	455.00	438.33	67.93	semi spreading
Goma priyanka	IC-0621959	476.66	418.33	401.66	52.50	semi spreading
Paiyur -4	IC-0621969	457.50	405.00	415.00	61.33	Upright
Kaveri pattanam -4	IC-0621971	471.66	368.33	388.33	61.93	Upright
Dharwad -5	NA	418.33	408.33	428.33	50.16	semi spreading
Andaman -4	IC-0621973	503.33	371.66	366.66	40.56	Upright
Dharwad -3	NA	530.00	335.00	350.00	40.43	Upright
Dharwad -4	IC-0631354	235.00	176.66	178.33	70.56	Upright
Dharwad -6	IC-0621963	450.00	443.33	445.00	56.86	Upright
Dharwad -8	NA	447.50	402.50	420.00	56.86	Upright
Dharwad -9	NA	360.00	331.66	315.00	50.40	Upright
Dharwad -10	IC-0631355	416.66	353.33	353.33	50.36	semi spreading
Dharwad -11	IC-0621965	422.50	420.00	415.00	50.60	Upright
Dharwad -13	IC-0621966	480.00	423.33	371.66	60.23	Upright
Kaveri patnam-1	IC-0621970	515.00	391.66	420.00	60.03	Upright
Kaveri pattanam-2	IC-0631357	361.66	220.00	246.66	36.96	Upright
Hirehally	IC-0621968	448.33	335.00	335.00	51.43	Upright
Huruli chikkanahally	IC-0621972	500.00	385.00	391.66	62.16	Upright
Dharwad market sample -1	IC-0621960	480.00	416.66	416.66	57.10	Upright
Dharwad market sample -2		618.33	513.33	498.33	74.33	Upright
Dharwad market sample -3	IC-0621962	546.66	463.33	488.33	75.33	Upright
Dharwad market sample -4	NA	488.33	460.00	445.00	63.63	Upright
Patna	IC-0621975	528.33	478.33	466.66	70.66	semi spreading
Lucknow	IC-0621976	458.33	421.66	396.66	57.23	Upright
Jayanagar-1	IC-0621977	493.33	443.33	431.66	53.83	Upright
Jayanagar-2	IC-0621978	673.33	471.66	468.33	76.96	semi spreading
Chikkodi	IC-0621979	476.66	315.00	338.33	53.96	Upright
Madhya Pradesh-1	IC-0621980	476.66	401.66	386.66	53.66	Upright
Madhya Pradesh-2	IC-0621981	481.66	446.66	430.00	57.23	Upright
Madhya Pradesh-3	IC-0621982	453.33	365.00	358.33	53.76	Upright
Madhya Pradesh-5	IC-0621983	496.66	490.00	476.66	73.63	Upright
Kaveri pattanam -4 (a)	IC-0621971	522.50	507.50	470.00	80.43	Upright
Khanapur-1	IC-0631358	401.66	306.66	371.66	36.00	Upright
Khanapur -24	IC-0631365	241.66	208.33	190.00	30.50	semi spreading
Khanapur -32	IC-0631366	155.00	161.66	145.00	19.66	Spreading
Srisailam-18	IC-0631370	248.33	173.33	170.33	25.83	Upright
Range		155 to 618.3	161.6 to 513.3	199.6 to 498.3	19.6 to 80.43	
SEm±		28.59	34.79	36.78	5.43	-
C.D@5%		80.38	97.79	103.38	15.26	-

Table 2: Variation in leaf characters of Jamun genotypes

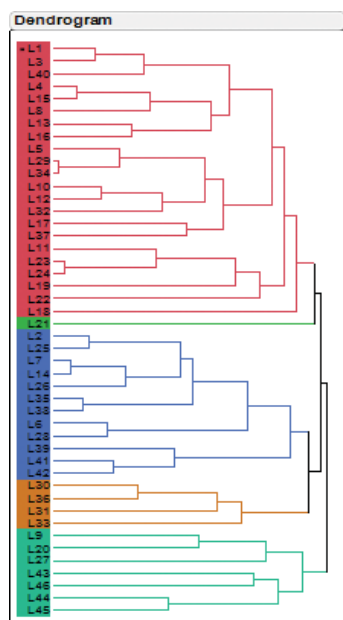
Genotype	IC Number	Leaf length (cm)	Leaf breadth (cm)	Internodal length (cm)	Petiole length (cm)	New shoot length (cm)	No. of leaves/new shoot	Tender leaf anthocyanin (mg/100g)	Leaf phenols (mg/100g GAE)
Dhoopdal	IC-0621955	14.56	6.86	5.76	2.70	22.33	13.00	23.40	972.17
Selection-45	IC-0621954	13.26	6.33	4.26	2.20	15.00	9.33	12.03	791.55
Selection-58	IC-0621956	13.76	6.60	5.03	2.30	22.33	11.00	12.46	844.55
Savadatti	IC-0621957	14.73	6.23	4.60	2.13	28.33	9.33	15.00	589.90
Kaithnal	IC-0621952	14.90	5.93	4.06	2.20	22.00	6.66	21.27	983.44
AJG-85	IC-0621953	12.83	5.40	4.46	2.33	22.00	11.33	12.10	664.11
IC-715	IC-0587715	12.16	5.76	5.13	1.66	20.66	8.33	31.53	812.39
Konkan Bahadoli	IC-0621958	11.73	6.03	3.73	2.00	23.66	8.00	23.35	1,055.07
Dharwad -2	IC-0621961	16.10	7.06	7.20	2.50	28.00	10.33	18.61	767.61
Dharwad -2a	NA	13.33	5.40	4.00	2.60	26.00	10.33	27.73	990.22
Dharwad -3a	NA	12.90	6.56	3.53	1.76	24.33	10.33	24.80	949.52
Dharwad -4a	NA	14.26	6.36	4.40	2.13	26.00	7.66	26.61	764.37
Dharwad -7	NA	14.56	6.73	4.83	2.00	21.66	9.66	11.26	1,590.48
Dharwad -12	IC-0631356	15.06	6.50	3.40	2.63	25.66	12.00	29.88	1,646.87
Chinnapalli	IC-0621967	13.10	8.23	4.93	2.00	25.00	9.00	21.16	463.92
Gomapriyanka	IC-0621959	12.23	6.80	4.60	2.30	22.33	9.00	26.41	389.80
Paiyur -4	IC-0621969	14.83	6.83	3.83	2.06	25.33	8.67	35.52	401.20
Kaveri pattanam -4	IC-0621971	14.23	7.53	5.00	2.30	21.66	8.33	33.69	138.40
Dharwad -5	NA	14.13	5.50	2.93	1.26	27.00	10.66	17.27	588.88
Andaman -4	IC-0621973	21.56	7.90	5.33	0.43	28.00	10.33	15.88	477.88
Dharwad -3	NA	17.40	7.53	3.50	1.90	26.00	10.00	13.87	632.80
Dharwad -4	IC-0631354	15.13	5.16	3.80	2.00	25.66	10.00	16.80	817.89
Dharwad -6	IC-0621963	14.90	5.93	5.63	2.56	23.66	9.66	16.77	722.40
Dharwad -8	NA	14.33	6.83	4.66	2.08	26.00	8.00	13.82	631.54
Dharwad -9	NA	15.93	7.43	5.00	2.73	23.33	8.33	40.76	717.47
Dharwad -10	IC-0631355	14.60	7.10	4.26	2.60	22.33	7.33	38.35	1,154.52
Dharwad -11	IC-0621965	12.66	5.83	5.06	2.33	19.33	8.33	31.47	2,285.62
Dharwad -13	IC-0621966	10.83	6.06	2.66	2.26	18.33	7.66	20.53	2,447.44
Kaveri patnam-1	IC-0621970	10.00	3.96	2.96	1.43	21.33	9.33	18.37	1,165.27
Kaveri pattanam-2	IC-0631357	9.83	4.75	3.43	1.80	20.00	9.33	34.65	3,538.37
Hirehally	IC-0621968	13.33	6.90	3.96	2.46	25.00	14.00	30.52	840.08
Huruli chikkanahally	IC-0621972	11.26	4.83	3.63	2.66	20.00	11.33	30.10	2,611.91
Dharwad market sample -1	IC-0621960	15.66	6.16	5.40	1.86	19.66	8.33	44.03	2,806.36
Dharwad market sample -2		14.50	6.06	6.73	1.53	15.33	10.00	26.54	2,306.23
Dharwad market sample -3	IC-0621962	17.73	7.40	4.33	1.76	16.66	6.00	38.50	2,229.93
Dharwad market sample -4	NA	14.83	6.10	3.66	1.40	18.46	11.00	47.02	2,319.20
Patna	IC-0621975	14.50	6.80	5.13	3.00	17.26	8.00	33.71	2,209.48
Lucknow	IC-0621976	15.83	6.36	4.33	1.60	22.33	8.00	35.36	2,521.02
Jayanagar-1	IC-0621977	11.66	5.70	3.00	1.56	18.30	9.66	34.70	2,415.22
Jayanagar-2	IC-0621978	15.83	6.83	5.13	1.86	19.16	9.00	40.81	2,187.43
Chikkodi	IC-0621979	15.03	5.70	5.46	1.43	20.10	10.33	33.27	2,312.52
Madhya Pradesh-1	IC-0621980	12.96	5.16	3.16	1.56	17.36	8.00	45.88	2,250.16
Madhya Pradesh-2	IC-0621981	10.80	3.80	3.06	1.06	17.66	10.66	16.86	1,341.85
Madhya Pradesh-3	IC-0621982	14.16	7.43	5.00	1.93	22.20	11.66	69.26	1,893.60
Madhya Pradesh-5	IC-0621983	12.83	3.80	4.60	1.46	20.00	8.66	50.79	1,777.13
Kaveri pattanam -4 (a)	IC-0621971	10.76	4.13	3.13	1.10	21.40	10.33	17.32	1,837.67
Khanapur-1	IC-0631358	14.00	5.83	4.23	1.14	17.33	15.33	45.24	2,287.80
Khanapur -24	IC-0631365	13.80	6.33	4.86	2.26	14.00	12.00	26.49	2,100.01
Khanapur -32	IC-0631366	14.60	6.80	5.90	1.66	10.33	10.66	38.20	2,299.87
Srisailam-18	IC-0631370	13.33	5.33	5.70	1.60	12.50	17.66	33.57	2,403.66
Range		9.8-21.5	3.8-8.23	2.6-7.2	0.43-3	10.3-28.3	6.0-17.6	11.2-69.2	138.4-3538
SEm±		1.09	0.62	0.81	0.33	2.32	1.33	3.03	159.39
C.D@5%		3.06	1.74	NS	0.95	6.53	3.74	8.65	454.36

Table 3: Cluster wise grouping of genotypes

Clusters	Genotypes
Cluster-I	Dhoopdal, Selection-58, Savadatti, Kaithnal, Dharwad -2, Dharwad -3aDharwad -4a, Dharwad -7, Chinnapalli, Paiyur -4, Kaveripattanam -4,Dharwad -5, Andaman collection -4, Dharwad -3, Dharwad -8, Dharwad -9, Dharwad -10, Dharwad market sample -1, Dharwad market sample -4Lucknow, Chikkodi and Madhya Pradesh-3.
Cluster-II	Dharwad-6
Cluster-III	Selection-45, AJG-85, Konkan Bahadoli, Goma priyanka, Dharwad -11, Dharwad -13, Huruli chikkanahally, Jayanagar-1, Madhya Pradesh -1, Madhya Pradesh -2, Madhya Pradesh -5 and Kaveri pattanam -4 (a).
Cluster-IV	Dharwad market sample -2, Dharwad market sample -3, Patna and Jayanagar-2.
Cluster-V	Dharwad -2a, Dharwad -4, Kaveri pattanam-2, Khanapur-1, Khanapur-24,Khanapur-32 and Srisailam-18.

Table 4: Cluster wise summary mean of plant characters

Characters	Cluster -1	Cluster -2	Cluster -3	Cluster -4	Cluster -5
Plant height (cm)	446.74	450.00	475.76	591.67	284.40
North-South (cm)	394.43	443.33	430.49	481.67	219.17
East-West (cm)	395.11	445.00	416.6	480.42	227.07
Stem girth (cm)	55.94	56.87	59.36	74.33	32.71
Leaf length (cm)	15.07	14.90	11.99	15.64	13.13
Leaf breadth (cm)	6.77	5.93	5.33	6.78	5.66
Internodal length (cm)	4.67	5.63	3.78	5.33	4.56
Petiole length (cm)	1.97	2.57	1.91	2.04	1.87
New shoot length (cm)	23.75	23.67	19.62	17.11	17.98
Number of leaves / new shoot	9.45	9.67	9.36	8.25	12.19

**Fig. 1: Showing grouping with reference to morphological characters of jamun genotypes**

4).The cluster IV genotypes (Dharwad market sample -2, Dharwad market sample -3, Patna and Jayanagar-2) were highly vigorous and cluster V had least vigorous types.

The cluster mean of leaf length ranged from 11.99 cm to 15.64 cm. The Cluster IV recorded the highest mean value of 15.64 cm and the Cluster III recorded the lowest mean value of 11.99 cm (Table 4). The cluster mean value of leaf breadth ranged from 5.33 cm to 6.78 cm. Cluster IV recorded the highest mean value of 6.78 cm and the Cluster III recorded the lowest value of 5.33 cm (Table 4). The cluster mean value of internodal length was ranged from 3.78 cm to 5.63 cm. The Cluster III recorded lowest value of 3.78 cm and the Cluster II recorded the highest value of 5.63 cm (Table 4). The cluster mean value of petiole length ranged from 1.87 cm to 2.57 cm. The Cluster V recorded lowest value of 1.87 cm and the Cluster II recorded the highest value of 2.57 cm (Table 4). The cluster mean value of new shoot length was ranged from

Table 5: Correlation analysis of different morphological and leaf biochemical characters of Jamun genotypes

Characters	Plant height (cm)	North - South (cm)	East – West (cm)	Stem girth (cm)	Leaf length (cm)	Leaf breadth (cm)	Internodal length (cm)	Petiole length (cm)	New shoot length (cm)	Number of leaves/new shoot	Anthocyanin in tender leavesmg/100g	Phenol in leaves mg/100g
Plant height (cm)	1											
North - South (cm)	0.831**	1										
East –West (cm)	0.846**	0.970**	1									
Stem girth (cm)	0.679**	0.757**	0.742**	1								
Leaf length (cm)	0.068	-0.041	-0.009	-0.048	1							
Leaf breadth (cm)	0.047	-0.007	-0.006	-0.090	0.648**	1						
Internodal length (cm)	-0.101	-0.080	-0.075	-0.095	0.454**	0.410**	1					
Petiol length (cm)	-0.131	-0.039	-0.056	0.076	-0.076	0.297*	0.151	1				
New shoot length (cm)	0.126	0.149	0.193	0.217	0.267	0.246	-0.123	0.162	1			
Number of leaves/new shoot	-0.323**	-0.417**	-0.387**	-0.434**	-0.079	-0.155	0.088	-0.181	-0.177	1		
Anthocyanin in tender leaves mg/100g	0.019	-0.077	-0.071	-0.056	0.039	0.056	0.092	-0.064	-0.347*	0.041	1	
Phenol in leaves mg/100g	0.044	-0.094	-0.118	-0.074	-0.208	-0.346	-0.033	-0.187	-0.663**	0.125	0.505**	1

** . Correlation is significant at the 0.01 level.

* . Correlation is significant at the 0.05 level.

17.11 cm to 23.75 cm. The Cluster IV recorded lowest value of 17.11 cm and the Cluster I recorded the highest value of 23.75 cm (Table 4). The cluster mean value of number of leaves/new shoot ranged from 8.25 to 12.19. The Cluster IV recorded lowest value of 8.25 and the Cluster V recorded the highest value of 12.19 (Table 4).

The plant height was highly positively correlated with North-South (0.831), East-West (0.846) and stem girth (0.679). But negatively correlated with number of leaves per new shoot (-0.323) (Table-5). The plant canopy North-South was significantly highly positively correlated with East-West (0.970), stem girth (0.757) and negatively correlated with number of leaves per new shoot (-0.417). The plant canopy East-West was highly positively correlated with stem girth (0.742) and negatively correlated with number of leaves per new shoot (-0.387) (Table-5). Leaf length was highly positively correlated with leaf breadth (0.648) and positively correlated with internodal length (0.454). Leaf breadth was positively correlated with internodal length (0.410) and petiole length (0.297). New shoot length was negatively correlated with anthocyanin content in tender leaf (-0.347) and highly negatively correlated with phenol in leaves (-0.663) (table-5). Anthocyanin in tender leaf was positively correlated with phenol in leaves (0.505).

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