

MORPHOLOGICAL CHARACTERIZATION OF LEMON GERMPLASMS

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ABSTRACT

An investigation was carried out at the Department of Horticulture, Bangladesh Agricultural University, Mymensingh to characterize lemon germplasm collected from different parts of Bangladesh. Sixty nine genotypes were evaluated using different morphological traits. Both qualitative and quantitative characters showed a high degree of variation among analyzed genotypes, indicating an important source of genetic diversity that can be used in future breeding programmes. Considering morphological characters, six genotypes viz. CL 03, CL 07, CL 08, CL 16, CL 18 and CL 53 were selected as promising for further evaluation.

Keywords: Morphological characterization, lemon, and variability

INTRODUCTION

Lemon (*Citrus limon* L.) is one of the most popular fruit crop under the genus *Citrus*. The genus *Citrus* is the world's leading tree-fruit crop belongs to the subfamily Aurantioideae, family Rutaceae and order Sapindales. Different hypotheses have been formulated on the origin of *Citrus*. In general, *Citrus* is believed to have originated in the tropical and subtropical regions of Southeast Asia and then spread to other continents. Hodgson (1967) reported that lemon is originated in north eastern India and Burma and grown throughout the world.

Compared to other lemon producing countries of the world, the production of lemon in Bangladesh is very low due to lack of proper attention for varietal improvement. There are many genotypes of lemon having diverse characters in different parts of the country. Those genotypes are available in the market without any uniformity and standardization in nomenclature. Characterization of existing lemon germplasm may create a good opportunity for the breeder in the improvement of the crop. The present study is carried out in aiming to infer the genetic variability and thus ensuring proper utilization of available germplasm.

MATERIALS AND METHODS

In the present study, 69 lemon genotypes, collected by "Collection, Evaluation, Conservation and Utilization of Land races and Wild relatives of some Important Vegetables and Fruits of Bangladesh (CVFB)" project at Department of Horticulture, Bangladesh Agricultural University, Mymensingh, from the different parts of Bangladesh were used as plant materials.

The investigation was carried out to evaluate the variability and characterization of 69 lemon genotypes using morphological character during the period of 2005-2006. Each genotype was considered as the treatment of the experiment. The experiment was laid out in the Randomized Complete Block Design (RCBD) with three replications. One genotype represented one treatment and one plant in a genotype represented one replication. The distance from plant to plant was 5 m and row to row was 5 m.

Data recorded

Green fruits were harvested at edible stage. The maximum fruits were harvested during May-July/2006 and some fruits were harvested during January-February/2007. The data on different morphological and biochemical parameters from 69 lemon genotypes were recorded according to the Descriptors for Citrus (IPGRI, 1999).

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RESULTS AND DISCUSSION

From the results of the experiment, it was observed that there was wide range of variability among the genotypes of lemon in both qualitative and quantitative characters under study. Remarkable variation was observed in different qualitative characters. Shape of plant was from ellipsoid to spheroid, growth habit from spreading to upright, density of branches from dense to sparse, shoot tip colour from light green to purple, shape of leaf from elliptic to ovate, margin of leaf from dentate to wavy, colour of flower bud from greenish to purple. Shape of fruit from ellipsoid to spheroid, colour of fruit epicarp from light green to yellowish green, surface of epicarp from smooth to rough, fruit axis from solid to hollow, colour of seed from yellow to pinkish yellow and shape of seed from ovoid to globose. Hodgson (1967) found lemon trees were of three growth habit such as upright, spreading and open. Hossain (1983) stated ovate shape leaf and light green colour in case of seedless lemon. Rahman (2002) found the surface of variegated lemon smooth with some ribs but in case of BARI Lebu-1, BARI Lebu-2 and semi seedless lemon were medium rough.

There was significant variation in all quantitative characters under the study. The tallest plant (2.32 m) was observed in genotype CL 19 followed by CL 40 (2.26 m). The shortest plant (0.82 m) was recorded in genotype CL 13 (Table 1).

Table 1. Morphological characters of plant and fruit of 69 lemon genotypes

Genotypes	Plant height (m)	Area of leaf (cm ²)	%Fruit set	Length of fruit (cm)	Diameter of fruit (cm)	Weight of fruit (gm)	Fruit volume (c.c.)	No. of fruits /plant
CL 01	1.87	28.71	47.42	7.17	6.08	140.48	156.11	100.25
CL 02	2.15	20.69	48.15	7.77	6.50	150.36	189.45	121.32
CL 03	1.84	32.05	31.27	6.51	5.74	117.92	131.00	165.76
CL 04	1.60	25.95	31.41	6.07	5.30	84.76	171.73	59.36
CL 05	1.78	35.48	29.56	6.75	5.40	97.96	108.33	86.88
CL 06	1.89	26.74	27.43	7.14	6.29	162.78	164.78	78.28
CL 07	1.76	30.92	38.41	8.80	5.29	113.63	123.11	82.76
CL 08	1.85	23.70	33.69	8.99	5.58	100.69	155.22	108.44
CL 09	2.12	38.33	37.41	7.11	5.51	130.19	145.72	177.37
CL 10	1.74	29.83	41.36	6.70	5.87	119.89	140.00	100.46
CL 11	1.82	30.83	15.92	6.20	5.57	108.62	110.18	98.17
CL 12	1.90	27.33	20.48	6.23	6.10	150.17	137.02	30.64
CL 13	0.82	19.49	26.47	10.83	7.70	212.77	322.41	55.71
CL 14	1.94	16.65	43.84	7.86	6.38	92.24	143.11	96.13
CL 15	1.50	23.31	21.00	7.95	6.85	107.37	120.13	37.84
CL 16	1.85	34.43	47.07	7.50	6.07	111.93	130.11	167.88
CL 17	1.87	18.14	26.35	7.37	6.33	122.48	164.33	44.45
CL 18	1.89	29.87	48.65	8.13	6.29	130.26	144.44	145.49
CL 19	2.32	35.36	37.97	10.20	7.00	158.88	261.92	97.30
CL 20	1.87	19.35	10.39	7.10	6.11	97.19	129.89	25.00
CL 21	1.88	34.88	48.48	8.53	6.93	135.32	153.89	138.46
CL 22	0.97	17.77	29.50	7.35	5.80	115.85	125.89	17.85
CL 23	2.07	37.50	43.50	10.59	7.33	180.39	263.67	97.34
CL 24	2.00	35.10	24.57	7.05	6.40	162.37	152.00	71.11
CL 25	1.97	33.18	45.17	10.57	7.57	217.73	338.56	98.21
CL 26	2.06	28.43	30.63	9.20	7.93	281.67	309.95	68.28
CL 27	1.90	32.97	30.23	9.37	5.87	106.47	142.28	100.94
CL 28	1.76	33.56	39.71	9.42	5.77	108.98	176.67	135.40
CL 29	1.95	27.75	44.37	6.70	5.89	170.76	171.28	80.39
CL 30	1.75	30.37	34.65	8.13	5.97	137.32	106.22	117.32
CL 31	1.80	29.74	49.64	8.65	5.32	107.44	135.56	253.80
CL 32	1.83	23.51	46.57	8.73	5.47	112.81	128.67	140.52
CL 33	1.84	27.71	43.84	7.09	5.93	118.05	129.87	77.43
CL 34	1.76	23.47	32.02	8.10	5.03	107.90	98.09	62.50
CL 35	2.23	45.75	7.00	9.80	6.20	225.39	195.41	13.09
CL 36	1.87	30.74	25.14	7.90	6.23	127.33	161.11	18.45
CL 37	2.05	45.32	7.66	11.37	7.00	223.97	294.32	14.21
CL 38	1.82	26.67	16.74	8.20	5.87	115.61	142.83	30.24

Table 1 (Cont'd.)

Genotypes	Plant height (m)	Area of leaf (cm ²)	%Fruit set	Length of fruit (cm)	Diameter of fruit (cm)	Weight of fruit (gm)	Fruit volume (c.c.)	No. of fruits /plant
CL 39	1.85	30.39	37.91	9.07	6.77	210.88	255.66	69.00
CL 40	2.26	39.67	7.96	14.23	6.74	215.46	312.56	16.94
CL 41	1.54	33.36	13.87	8.37	5.37	88.64	126.20	54.32
CL 42	1.83	28.68	40.23	10.57	6.55	157.65	214.98	117.24
CL 43	1.82	28.90	30.34	7.22	5.71	129.91	124.67	38.50
CL 44	1.79	27.73	37.67	8.99	4.87	117.39	146.09	117.10
CL 45	1.75	29.77	37.42	8.33	5.37	111.86	127.22	88.70
CL 46	1.94	32.82	32.28	9.20	6.23	179.34	162.77	51.57
CL 47	2.01	38.33	32.31	8.96	5.86	173.77	154.44	52.35
CL 48	1.68	24.62	26.80	4.80	4.70	77.26	96.33	28.22
CL 49	1.55	26.63	23.41	7.93	5.40	100.89	105.64	43.34
CL 50	1.76	23.47	41.17	9.15	5.70	126.95	129.21	84.42
CL 51	1.80	27.39	38.68	9.29	5.58	130.67	146.43	83.22
CL 53	1.87	31.48	47.16	7.65	5.82	125.43	128.33	169.63
CL 54	1.84	34.21	30.97	6.09	6.98	176.77	147.44	94.29
CL 55	1.83	32.27	32.55	9.20	6.15	105.51	205.22	99.18
CL 56	1.90	31.69	13.97	12.73	7.54	320.80	317.77	61.32
CL 57	1.85	32.21	11.77	13.93	8.02	362.63	455.55	24.39
CL 58	1.87	35.26	16.77	7.92	6.84	171.37	184.74	80.00
CL 59	1.91	33.13	22.36	9.39	7.28	221.11	243.32	50.32
CL 60	1.98	22.34	46.40	11.15	7.30	233.68	231.56	100.32
CL 61	1.81	31.63	13.32	10.16	6.67	260.75	248.44	45.60
CL 62	1.71	22.37	19.05	7.10	5.97	209.73	225.67	19.72
CL 63	1.87	21.33	28.61	10.67	7.54	222.22	253.22	80.31
CL 64	1.89	21.59	26.43	13.79	7.88	220.63	404.44	47.17
CL 65	2.00	37.98	16.09	9.10	6.78	151.24	142.65	40.49
CL 66	2.16	37.28	33.43	9.24	6.70	175.35	186.77	100.21
CL 67	1.82	25.71	17.26	8.74	7.03	151.01	185.55	25.22
CL 68	1.83	38.47	22.26	8.67	6.54	135.28	162.78	90.96
CL 69	1.62	21.13	32.15	8.73	5.47	102.18	127.33	113.68
CL 70	1.72	23.24	11.01	5.20	4.75	96.79	91.10	25.81
Max	2.32	45.75	49.64	14.23	8.02	362.63	455.55	253.80
Min	0.82	16.65	7.00	4.80	4.70	77.26	91.10	13.09
Mean	1.84	29.52	30.51	8.62	6.24	152.60	179.99	80.12
CV (%)	1.86	12.41	5.11	7.30	7.08	0.98	4.29	2.01
LSD (0.01%)	0.84	7.81	3.32	1.34	0.94	3.18	16.49	3.43

Hossain (1983) reported that plant height in lime ranged from 0.5 to 3.0 m. Leaf area varied significantly among the genotypes and ranged from 16.65 to 45.75 cm². The genotype CL 35 had the highest leaf area (45.75 cm²) which was statistically different from the rest of the genotypes. The lowest leaf area was recorded in genotype CL 14. Awtar *et al* (2001) recorded the greatest leaf area (25.99 mm²) in accession 8784 compared to the lowest leaf area (20.16 mm²) in local strain of lime.

A significant variation was observed in case of percent fruit set among the genotypes of lemon under the study (Table 1). The highest percentage of fruit set (49.64 %) was recorded in genotype CL 31, while the lowest (7.00 %) in CL 35. This character affected positively on yield of lemon i. e. as increase of percent fruit set would increase yield. Significant variation in fruit length was observed among the genotypes of lemon. The longest fruit (14.23 cm) was produced by genotype CL 40 followed by CL 57 (13.93 cm) and CL 64 (13.79 cm), which were statistically identical. The lowest fruit length (4.80 cm) was found in genotype CL 48 (Table 1). In fruit diameter, noticeable variation was observed. The maximum diameter

of fruit (8.02 cm) was recorded in genotype CL 57 and minimum (4.70 cm) was in genotype CL 48. Average weight of fruit was varied significantly among lemon genotypes. The highest fruit weight (362.63 g) was obtained from genotype CL 57, which was statistically different from other genotypes. The genotype CL 48 produced fruits of the lowest weight (77.26 g). Variability of fruit weight in lime was reported by Prasad and Rao (1989) which support the result of present study.

The highest fruit volume (455.55 cm³) was obtained from genotype CL 57 which was statistically different from remaining genotypes. The lowest fruit volume (91.10 cm³) was found in CL 70. The number of fruits per plant differed significantly among 69 lemon genotypes under study (Table 1). The plants of CL 31 produced the highest number of fruits (253.80), which was statistically different with rest of the genotypes and the lowest number (13.09) was found in CL 35. This character has positively association with yield but negative association with diameter of fruit. Among the studied genotypes, the thickness of rind varied significantly. The fruits of genotype CL 56 showed highest thickness (1.12 cm) followed by genotype CL 66 (1.10 cm), which was statistically different. The thinnest rind (0.45 cm) was observed in CL 23 (Table 2).

Table 2. Internal fruit characters and yield of 69 lemon genotypes

Genotypes	Rind thickness (cm)	Juice content (ml)	% TSS	% Acidity	Ascorbic acid (mg/100ml)	No. of seeds/ fruit	Weight of 100 seeds (gm)	Yield/ plant (kg)
CL 01	0.63	36.51	6.54	5.65	28.71	133.00	11.03	17.26
CL 02	0.93	35.51	7.13	5.82	41.29	93.67	10.90	18.56
CL 03	0.54	48.66	6.20	5.42	46.62	64.11	9.05	19.61
CL 04	0.63	25.70	6.33	5.35	33.46	116.12	8.98	5.07
CL 05	0.68	34.24	6.40	5.50	34.92	56.00	9.14	8.85
CL 06	0.92	36.86	6.65	5.79	33.49	86.45	11.00	12.95
CL 07	0.53	65.14	6.84	5.91	44.58	0.00	0.00	13.45
CL 08	0.55	60.56	6.75	5.87	48.70	18.11	10.73	12.02
CL 09	1.00	42.82	6.56	5.65	40.31	82.11	10.32	20.63
CL 10	0.68	45.00	6.83	5.89	24.82	75.22	11.01	12.22
CL 11	0.62	26.35	6.80	5.87	37.95	65.22	7.00	11.24
CL 12	0.81	32.43	6.00	5.42	48.74	68.89	12.87	4.16
CL 13	0.80	65.42	7.10	6.21	42.44	101.00	14.71	11.65
CL 14	0.65	30.00	6.03	5.27	27.51	83.59	8.94	8.90
CL 15	0.97	28.42	5.80	5.82	39.94	58.16	10.18	5.97
CL 16	0.64	48.27	6.55	5.65	41.13	76.23	13.53	17.20
CL 17	0.69	26.47	7.17	5.64	49.16	115.78	10.07	5.58
CL 18	0.66	48.00	6.40	5.35	42.45	70.00	12.58	19.54
CL 19	0.95	51.45	6.90	5.83	47.43	96.23	17.02	15.61
CL 20	0.67	33.44	6.80	5.47	32.54	35.01	10.09	4.47
CL 21	0.52	65.33	6.80	5.87	32.47	75.67	10.84	18.73
CL 22	0.67	27.64	5.85	5.09	39.98	22.50	6.71	2.40
CL 23	0.45	49.91	6.50	5.50	29.90	128.77	12.81	17.40
CL 24	0.57	52.27	6.00	5.21	44.67	0.00	0.00	14.01
CL 25	0.65	73.26	6.78	5.87	49.93	103.00	12.62	21.57
CL 26	0.95	68.60	6.70	5.35	42.46	135.33	18.94	19.60
CL 27	0.63	33.57	6.20	5.37	34.69	26.78	9.05	13.33
CL 28	0.64	48.02	6.60	5.73	49.47	0.00	0.00	14.66
CL 29	0.60	36.87	6.60	5.73	42.94	53.22	7.72	12.31
CL 30	0.63	37.53	6.80	5.87	42.45	0.00	0.00	13.92
CL 31	0.65	37.20	6.43	5.42	39.97	0.00	0.00	25.69
CL 32	0.67	45.35	5.73	5.42	37.53	0.00	0.00	15.13
CL 33	0.52	41.30	6.67	5.35	27.15	20.67	12.58	9.14

Table 2 (Cont'd.)

Genotypes	Rind thickness (cm)	Juice content (ml)	% TSS	% Acidity	Ascorbic acid (mg/100 ml)	No. of seeds/fruit	Weight of 100 seeds (gm)	Yield/plant (kg)
CL 34	0.50	49.57	6.70	5.79	39.97	10.64	8.27	6.67
CL 35	0.72	43.01	6.63	5.73	39.65	93.33	8.92	1.93
CL 36	0.60	54.07	6.43	5.50	47.49	32.99	14.46	2.30
CL 37	0.75	42.63	6.93	5.99	45.96	91.39	13.78	2.95
CL 38	0.81	27.50	5.83	5.13	34.51	83.70	12.94	3.47
CL 43	0.65	38.67	6.86	5.94	47.45	101.78	9.00	5.79
CL 44	0.52	44.07	6.81	5.89	37.14	100.65	10.36	13.67
CL 45	0.67	35.15	6.87	5.94	44.96	43.88	9.19	11.39
CL 46	0.65	48.27	6.72	5.82	44.98	90.55	14.92	9.22
CL 47	0.55	45.19	6.47	5.42	45.43	52.22	15.55	10.28
CL 48	0.56	24.26	6.79	5.87	37.41	34.67	10.55	2.39
CL 49	0.60	37.85	6.57	5.65	49.96	35.00	9.60	4.46
CL 50	0.67	37.14	6.63	5.73	42.45	45.22	11.12	10.16
CL 51	0.63	48.10	6.55	5.65	47.44	35.44	10.33	9.68
CL 53	0.65	35.12	6.67	5.79	45.59	51.34	13.03	17.53
CL 54	0.60	48.54	6.45	5.50	34.96	75.56	16.04	19.53
CL 55	0.63	30.24	6.20	5.42	37.60	62.33	12.02	11.35
CL 56	1.12	50.54	6.00	5.65	27.17	50.22	17.31	19.50
CL 57	1.00	52.54	6.77	5.87	29.62	118.00	16.30	8.70
CL 58	0.98	37.30	6.42	5.50	49.44	45.78	14.71	12.69
CL 59	0.95	33.27	6.60	5.13	32.42	124.44	15.62	14.08
CL 60	0.55	53.91	6.40	5.50	27.47	95.67	14.48	23.34
CL 61	1.03	25.03	6.13	5.27	22.47	60.68	15.22	10.20
CL 62	1.05	33.24	6.61	5.73	22.47	101.92	11.08	4.05
CL 63	0.79	42.37	6.56	5.65	19.99	146.67	15.30	17.40
CL 64	0.57	57.75	6.27	5.42	34.67	90.77	16.36	10.38
CL 65	0.85	33.93	6.70	5.82	29.93	100.64	13.51	5.84
CL 66	1.10	33.86	6.95	6.03	27.64	93.33	11.76	17.21
CL 67	0.70	33.86	6.75	5.79	24.48	123.77	9.89	3.72
CL 68	0.53	33.85	6.67	5.79	22.21	86.32	14.06	12.19
CL 69	0.64	25.70	6.54	5.65	27.47	71.46	12.58	11.34
CL 70	0.52	31.13	6.75	5.82	47.12	32.22	10.28	2.45
Max	1.12	73.26	7.17	6.21	49.96	146.67	18.94	25.69
Min	0.45	24.26	5.73	5.09	19.99	0.00	6.33	1.93
Mean	0.71	41.75	6.54	5.64	37.86	67.93	11.18	11.62
CV (%)	7.53	4.14	0.62	1.35	3.06	2.80	9.34	9.11
LSD (0.01%)	0.12	3.69	0.10	0.17	2.47	4.06	2.23	2.26

Hossain (1983) found medium rind thickness, average fruit weight from 41.20 g to 158.50 g in lemon. The highest amount of juice per fruit was observed in genotype CL 25 (73.26 ml) followed by genotype CL 40 (72.40 ml), which was statistically identical and lowest amount (24.26 ml) was found in CL 48 (Table 2). Rahman (2002) reported the length of BARI Lebu-1 was 11.50 cm and observed high variability of juice content in lemon ranging from 14.0 ml to 88.0 ml.

Significant variations were also observed in respect of TSS and acidity (Table 2). A remarkable significant variation was observed among lemon genotypes in respect of ascorbic acid content. The highest amount of ascorbic acid (49.96 mg/100ml juice) was calculated in genotype CL 49 followed by

CL 25 (49.93 mg/100ml juice), which was statistically identical. The lowest amount (19.99 mg/100ml juice) was found in CL 63 which was significantly different with other genotypes. The maximum number of seeds (146.67) was found in CL 63, which was significantly higher than other genotypes. The genotypes CL 07, CL 24, CL 28, CL 30, CL 31, CL 32 and CL 40 were found seedless. Hossain (1983) found average number of seeds per fruit from 0.00 to 114.0 in lemon, which are in line with present findings. Weight of 100 seeds significantly varied and ranged from 6.33 to 18.94 g.

Among 69 lemon genotypes, variation of yield per plant was found significant. It ranged from 1.93 to 25.69 kg. The highest yield of fruit per plant (25.69 kg) was recorded in genotype CL 31 which was statistically different with other genotypes under study. The genotype CL 35 imparted the lowest fruit yield (Table 2). Desai *et al.* (1994), Prasad and Rao (1989) and Ranpise and Desai (2003) also observed variability of juice content and high variability of yield per plant among different lime accessions.

Considering all of the characters under study, some promising genotypes viz., CL 03 (19.61 kg), CL 07 (13.45 kg), CL 08 (12.02 kg), CL 16 (17.20 kg), CL 18 (19.54 kg), and CL 53 (17.53 kg) were selected for further evaluation with a view to develop new variety(s) of lemon.

Acknowledgement

The author is grateful to USDA funded project (Project No. 99/21/USDA: Grant # BG-ARS-108) for providing materials and necessary experimental facilities to conduct this research.

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