



Study on Physio-morphological Characteristics Among Six Rangpur Lime (*Citrus limonia osbeck.*) Strains

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ABSTRACT

Physio-morphological characteristics of six rangpur lime strains were studied at the existing plantation of the Punjab Agricultural University, Ludhiana. A total of 45 characters were evaluated from the trees, leaves, fruit and seed from each plant. The maximum variability was observed for number of seeds per fruit (CV= 32.18), while minimum was found for leaf length (CV = 3.2). The strain *Limonaria Rugosoda* had the highest fruit weight with 358.3 g while minimum was recorded for Texas (76.6 g) rangpur lime. The highest TSS were found in *Limonaria Rugosoda* (8.0 °Brix) while lowest were recorded in Texas (6.4°Brix). Brazilian and Texas strains were early maturing (October-November), while 8744, *Limonaria Rugosoda*, Marmalade and Noreo were late maturing (February–March).

Key words:

Physio-morphology, qualitative and quantitative characters, rangpur lime, strains

INTRODUCTION

Citrus fruits have a prominent place among fruits of tropical and sub-tropical climate and are being grown extensively in this region of world. South-east Asia, Australia, central Africa and islands between Asia and Australia are recognized as important centers of origin of citrus and related genera (Tanaka 1958, Swingle and Reece 1967). In Indian context, north-east India adjoining north Myanmar are claimed to be the primitive centres with regard to origin of citrus species. Citrus is grown in every tropical country and in those regions of sub-tropical countries, where winter temperature do not fall below 0 °C (Reitz 1984).

An orchard system has been defined as "the integration of all the horticultural factors involved in establishing and maintaining a planting of fruit trees" (Barritt 1987). Among a multitude of such

factors is the rootstock. A number of different citrus rootstocks are used in the various citrus-producing areas of the world. The performance of each has been selected as best adapted to the area in which it is used (Syvertsen and Graham 1985). This variation in usage is understandable in view of the differences in soil types, environment, water relations, nutrition, miscellaneous disease complexes involved and other factors (Sites and Reitz 1950).

Morphological study is an essential component for the assessment of diversity and classification. At present, morphological study has still been considered and deployed as an initial step for cultivar identification and diversity assessment with watermelon (Huh et al. 2008), sweet potato (Elameen et al. 2010) and agave (Rodríguez et al. 2009). Furthermore, important horticultural

characters are reported to be controlled by multiple genes (Campos et al. 2005, Liu and Deng 2007) and are of low heritability. Thus, morphological characterization could be an essential component since most of the horticultural characters cannot be evaluated through molecular markers. A large number of citrus species/progenitors of commercial citrus fruits are believed to have originated in India. Despite huge genetic diversity, very little work has been done in the past highlighting the distinguishable morphological features. Proper identification of trees is essential to establish trueness-to-name in commercial channels. Moreover, the testing of advanced selection and of new cultivars is an important aspect of fruit breeding (Harding 1983). However, proper identification and description of new cultivars before release is imperative. Hence this paper is focused on the physical and morphological description of six rangpur lime (*Citrus limonia* Osbeck.) strains for their tree, fruit and seed characteristics. This information will be useful for breeders and geneticist working on citrus rootstock improvement programs.

MATERIALS AND METHODS

The present study was carried out at Punjab Agricultural University, Ludhiana to evaluate physio-morphological characteristics of six rangpur lime (*Citrus limonia* Osbeck.) strains viz., 8744, Brazilian rangpur lime, Limonaria Rugosoda, Marmalade, Noreo and Texas. The experiment was laid out in RBD (Singh et al. 1998) with three replications for each strain and one plant per replication. Morphological characterization of leaves, fruits and seeds was done using descriptors developed for citrus by International Plant Genetic Resources Institute (IPGRI), Rome, Italy Anonymous (1999). Quantitative data were statistically analysed and mean, range and coefficient of variation (CV) were calculated.

Tree morphology was observed as tree shape (ellipsoid/spheroid/obloid), density of branches (sparse/medium/dense), tree growth habit (erect/spreading/drooping), branch angle (narrow/medium/ wide), spine density (absent/low/medium/high), spine shape (curved/straight) and spine length (mm). Leaf

morphology was recorded as leaf division (simple/bifoliolate/trifoliolate/pentafoliolate), leaf lamina length (mm) recorded from petioles base to lamina tip, lamina width (mm) recorded at the widest point, leaf length : width ratio, leaf lamina shape (elliptic/ovate/obovate/lanceolate/orbicular/obcordate), leaf lamina margin (crenate / dentate / entire / sinuate), leaf apex (attenuate / acuminate / acute / obtuse / round / emarginate), petiole wings (absent/present) and shoot tip surface.

Fruit characteristics were studied at fruiting season (early/mid/late), fruit weight (g), fruit diameter and length (mm, average diameter/length of ten fruit), fruit shape (spheroid / ellipsoid / pyriform / oblique / obloid / ovoid), shape off-fruit base (necked / convex / truncate / concave / collared), fruit skin colour (green / green yellow / yellow), fruit surface texture (smooth / rough / papillate / pitted), adherence of albedo to pulp (weak / medium / strong), albedo colour (greenish / white / yellow / pink), fruit attachment to stalk (weak/medium/strong), adherence of segment walls to each other (weak/medium/strong), segment shape uniformity (no/yes), cross-section shape of fruit axis (Irregular/round), fruit axis (solid/semi solid/hollow), pulp colour (white / green / yellow / orange), total soluble solids (°Brix), acidity (%), TSS : acidity ratio, fruit rind thickness, fruit axis diameter and size of oil gland on fruit surface. Seed characteristics were observed as seed shape (fusiform/clavate/ovoid/spherical/cuneiform), number of seeds per fruit, seed length, seed width, seed surface (smooth/wrinkled/hairy) and seed colour (white/yellowish/creamy/green/brown).

RESULTS AND DISCUSSION

Tree and leaf characters

The tree shape was obloid for most of the strains while Limonaria Rugosoda had ellipsoid tree shape (Table 1). The tree growth habit was found similar for all the strains. Medium branch density was observed in 8744 strain, while rest of the strains had dense branch density. The branch angle of six strains was found to be wide with no variation. Spine density and spine shape were also similar for all the strains. Variability was found for shoot tip surface. The shoot tip surface was found to be glabrous for 8744, Brazilian, Limonaria

Table 2. Quantitative tree and leaf characters of rangpur lime strains

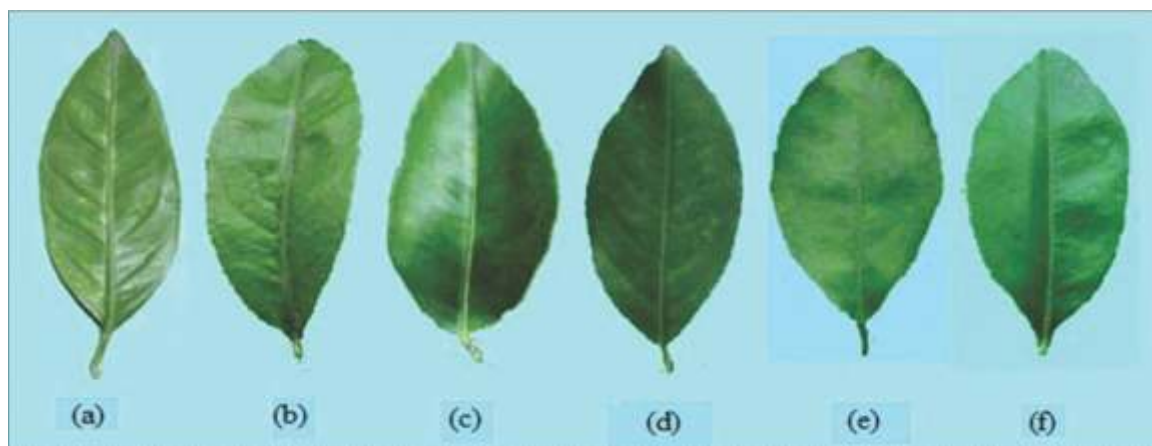
Strains	Leaf length (mm)	Leaf width (mm)	Leaf length:width ratio	Spine length (mm)
8744	81.8	38.4	2.1	13.0
Brazilian	71.2	35.1	2.0	41.3
Limonaria Rugosoda	73.4	39.2	1.8	33.5
Marmalade	79.4	43.4	1.8	20.9
Noreo	81.8	33.4	2.4	15.0
Texas	62.4	29.9	2.0	12.4
Mean	75.0	36.5	2.0	22.7
Range	62.4 - 81.8	29.9 - 43.4	1.8 - 2.4	12.4 - 41.3
CV	3.2	9.4	8.6	10.7

Table 3. Qualitative fruit and seed characters of rangpur lime strains

Characters	8744	Brazilian	Limonaria Rugosoda	Marmalade	Noreo	Texas
Fruit						
Fruiting season	Midseason	Early	Midseason	Midseason	Midseason	Early
Fruit shape	Ellipsoid	Spheroid	Oblique	Spheroid	Ellipsoid	Ellipsoid
Shape of fruit base	Truncate	Convex	Concave-collared	Convex	Convex	Convex
Shape of fruit apex	Rounded	Rounded	Mammiform	Rounded	Truncate	Rounded
Fruit skin colour	Light orange	Yellow	Green-Yellow	Light orange	Orange	Red-orange
Fruit surface texture	Smooth	Rough	Pitted	Pitted	Smooth	Smooth
Adherence of albedo to pulp	Medium	Weak	Strong	Medium	Weak	Medium
Albedo colour	White	White	White	White	Yellow	Yellow
Fruit attachment to stalk	Medium	Medium	Medium	Medium	Weak	Medium
Adherence of segment walls to each other	Medium	Weak	Medium	Medium	Weak	Medium
Segment shape uniformity	No	Yes	Yes	Yes	No	Yes
Fruit axis	Hollow	Semi-Hollow	Semi-Hollow	Hollow	Hollow	Semi-Hollow
Cross-section shape of axis	Irregular	Irregular	Irregular	Irregular	Irregular	Irregular
Pulp flesh colour	Orange	Orange	White	Orange	Orange	Orange
Seed						
Seed shape	Ovoid	Ovoid	Spheroid	Ovoid	Ovoid	Ovoid
Seed surface	Smooth	Smooth	Smooth	Smooth	Wrinkled	Smooth
Seed colour	Brown	Brown	Cream	Cream	Cream	Brown

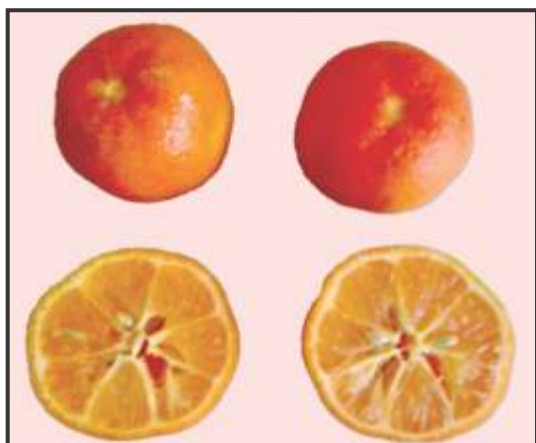
Table 4. Quantitative fruit and seed characters of rangpur lime strains

Characters	8744	Brazilian	Limonaria Rugosoda	Marma lade	Noreo	Texas	Mean	Range	CV
Fruit									
Fruit weight (g)	98.3	145	358.3	88.3	103.3	76.6	144.9	76.6-358.3	8.4
Fruit length (mm)	57.5	60.7	99.8	51.1	61.7	53.4	64.0	51.1-99.8	11.5
Fruit diameter (mm)	57.1	63.8	97.3	48.5	61.4	50.6	63.1	48.5-97.3	6.3
Total Soluble Solids (°Brix)	6.9	7.3	8.0	6.6	7.3	6.4	7.1	6.4-8.0	9.4
Acidity (%)	4.9	4.4	3.9	5.0	3.4	4.2	4.3	3.4-5.0	5.2
TSS : Acid ratio	1.3	1.6	2.0	1.3	2.1	1.5	1.6	1.3-2.1	11.0
Fruit rind thickness (mm)	2.0	2.8	5.5	2.4	2.9	2.6	3.0	2.0-5.5	12.6
Diameter of fruit axis (mm)	5.3	13.6	24.6	9.6	7.4	6.8	11.2	5.3-24.6	14.7
Oil gland size on fruit surface (mm)	0.8	0.9	1.4	0.5	0.7	0.6	0.8	0.5-1.4	13.3
Seed									
Seed length (mm)	9.6	8.7	9.1	8.6	9.8	8.6	9.1	8.6-9.8	12.3
Seed width (mm)	4.4	3.8	4.9	4.5	4.8	4.0	4.4	3.8-4.9	12.6
Number of seeds per fruit	15.0	38.0	25.0	18.2	18.0	12.4	21.1	12.4-38.0	32.18

**Photo 1.** Leaf morphology in six Rangpur lime strains viz., (a) 8744, (b) Brazilian, (c) Limonaria Rugosoda, (d) marmalade, (e) Noreo and (f) Texas

and Noreo Rangpur lime. Segment shape was found uniform in most of the strains except 8744 and Noreo Rangpur lime. Variability was found for fruit axis. The fruit axis was hollow in 8744, Marmalade and Noreo Rangpur lime, semi-hollow in Brazilian, Limonaria Rugosoda and Texas. No variability was found for cross-section shape of fruit axis, it was found to be irregular in all the strains. Pulp flesh was found to be of orange colour in most of the strains except Limonaria Rugosoda,

where it was observed to be white. Seed shape was ovoid in most of the strains, however, spheroid shaped seeds were found in Limonaria Rugosoda. Seed surface was smooth in almost all the strains except Noreo strain, which had wrinkled seeds. Seed colour was brown in 8744, Brazilian and Texas while cream colour seeds were observed in Limonaria Rugosoda, Marmalade and Noreo Rangpur lime (Photo 3). Similar results for fruit and seed characters were obtained by Singh (2006)



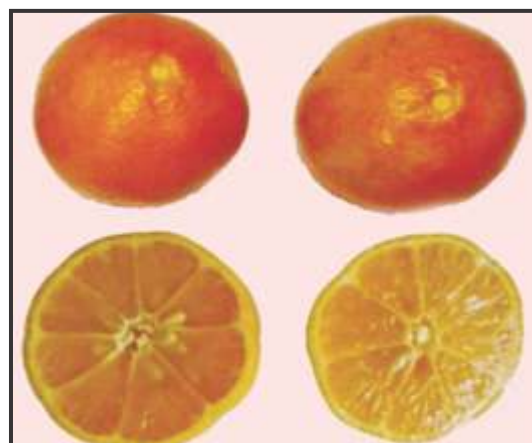
8744



Brazilian



Limonaria Rugosoda



Marmalade



Noreo



Texas

Photo 2. Fruit variability among Rangpur lime strains



8744



Brazilian



Limonaria Rugosoda



Marmalade



Noreo



Texas

Photo 3. Seed variability among rangpur lime strains.

among Rangpur lime strains.

Among fruit and seed characters, variability was found to be maximum for number of seeds per fruit (CV = 32.18) and minimum for acidity (CV = 5.2). The fruit weight indicated that Limonaria Rugosoda fruits were the heaviest (358.3 g), while Texas strain had the lowest fruit weight, being 76.6 g. Limonaria Rugosoda had the maximum fruit length (99.8 mm), while minimum fruit length was recorded in Marmalade strain (Table 4). Fruit diameter was recorded maximum in Limonaria Rugosoda (97.3 mm) and minimum was observed in Marmalade strain (48.5 mm). Limonaria Rugosoda had the highest TSS (8.0°Brix), while minimum in Texas (6.4°Brix). The fruit acidity was found maximum for Marmalade (5%) and minimum was recorded for Noreo (3.4%). TSS : Acid ratio was found to be maximum for Noreo (2.1), while minimum was found for 8744 and Marmalade (1.3 for both strains). Limonaria Rugosoda had the maximum fruit rind thickness (5.5 mm) and the lowest was recorded in 8744 (2.0 mm). Diameter of fruit axis was recorded maximum in Limonaria Rugosoda (24.6 mm) and minimum in 8744 (5.3 mm). Largest oil gland size on fruit surface was observed in Limonaria Rugosoda (1.4 mm) and lowest in Marmalade (0.5 mm). Noreo Rangpur lime had the maximum seed length (9.8 mm), while minimum was recorded in Marmalade and Texas (8.6 mm, for both strains). Seed width was recorded maximum in Limonaria Rugosoda (4.9 mm), while minimum was found in Brazilian Rangpur lime (3.8 mm). Number of seeds per fruit were found maximum for Brazilian strain (38.0) and minimum seeds were observed in strain 8744 (15.0). Bowman et al. (1995) also found the positive relationship between seed size and shape and confirmed that seed shape and size is related with number of seedlings produced in rootstocks.

CONCLUSION

The study showed the existence of wide variation in morphological characters among the Rangpur lime strains. These variations are indicative of the underlying genetic diversity and the influence of environmental factors. Among quantitative traits, the maximum variability was observed for number of seeds per fruit while

minimum was observed for leaf length. Among qualitative traits, variability was observed for tree shape, branch density, shoot tip surface, leaf lamina shape and leaf margin. The strain Limonaria Rugosoda had the highest fruit weight (358.3 g), while minimum was recorded for Texas (76.6 g) Rangpur lime. The highest Total soluble solids were found in Limonaria Rugosoda (8.0 °Brix) and lowest in Texas (6.4°Brix). Strain 8744, Limonaria Rugosoda, Marmalade and Noreo were late maturing (February–March) and hence might be useful in extending the harvesting season.

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