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Assessment of variability in qualitative and quantitative morphological characters of acid lime (*Citrus aurantifolia* Swingle) germplasm

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Abstract
The present variability studies for morphological characters in acid lime (*Citrus aurantifolia* Swingle) were laid out at out at the All India Coordinated Research Project on Fruits, Dr. Y.S.R. Horticultural University, Citrus Research Station, Tirupati during 2020-21 and 2021-22. The experiment was conducted in Randomized Block Design (RBD) with three replications comprising forty genotypes. Significant variation among the genotypes for characters studied like tree shape, tree growth habit, leaf lamina shape, leaf apex, number of stamens, seed shape and seed colour. No variation was noticed for the qualitative characters *viz*., shoot tip colour, leaf lamina attachment, leaf lamina margin, petiole wings, Flower colour, type of flower and anther colour. Variation was noticed for characters like plant height, canopy spread, canopy volume, leaf lamina length, leaf lamina width, petiole wing length, pedicel length, petal length, petal width, spine density, spine length, highest plant height was recorded in selection-16. PKM-1 was recorded with highest canopy spread in the east-west direction, highest canopy volume, highest pedicel length and highest petal width. TAL/94-14 recorded highest canopy spread in the north-south direction compared to other genotypes. The variation studied in the genotypes may be helpful in selection of genotypes for incorporation of desirable characters to offspring.

Keywords: Acid lime, quantitative characters, qualitative characters, variation, offspring

1. Introduction
Citrus fruits are gaining commercial importance and popularity around the world due to their nutritional value as well as possibility to be eaten fresh. Acid lime (*Citrus aurantifolia* Swingle) is a commercial citrus fruit crop cultivated in India with diploid chromosome number 2n=2x=18. After mandarin and sweet orange, acid lime is one of the most vital tropical citrus fruits. It is believed to have originated in South Eastern China and India.

Acid lime belongs to the Citrus genus and the Rutaceae family, but its taxonomic classification is complicated. The compatibility of Citrus species with related genera is the primary cause of this complexity, which creates confusion about the actual number of Citrus species. Many scientists proposed various botanical classifications, but the taxonomic systems proposed by Swingle and Reece (with 16 species) and Tanaka (with 162 species) were widely accepted (Swingle and Reece, 1967) [24]. Acid lime also known as Kagzi lime (Nimboo), has gained more popularity, as it can be used to make pickles and seasonal cuisine in India and other zones of the world. Acid lime is a bushy shrub covered with small sharp spines. Fruit consists of 83.88 percent moisture, 9.96 percent carbohydrate, 1.0 percent protein, 90 mg/100 ml calcium, 20 mg/100 ml phosphorus, 0.3 mg/100 ml iron and 62.90 mg/100 ml vitamin C (Waghaye *et al*. 2019) [25]. Morphological characterization helps towards effective conservation and maintenance of existing genetic diversity. Variability among different genotypes can be assessed with the help of morphological and molecular characterization and variable genotypes can be incorporated in commercial hybrid programmes to develop the desired variety with high yield.

2. Materials and Methods
The present investigation entitled “Assessment of variability in quantitative tree, leaf, floral and seed characters of acid lime” was carried out during 2020-2021 and 2021-2022 at AICRP on fruits, Citrus Research Station, Tirupati, Dr. YSR Horticultural University, and Andhra Pradesh.

The experiment was conducted in Randomized Block Design (RBD) with 3 replications with forty genotypes. Age of the plants was 12 years and spacing of the plants was 6 x 6 m. Experimental material for the current investigation consists of 40 acid lime genotypes (Table.1) which are maintained at the Citrus Research Station, Tirupati.

2.1 Qualitative characters

The tree shape of acid lime genotypes was visually recorded as ellipsoid, spheroid or obloid. Tree growth habit of different genotypes was recorded visually as erect, spreading and drooping. Shoot tip colour was recorded according to the descriptors for citrus provided by Bioversity International, Rome, Italy and was recorded as purple or green. Leaf lamina attachment was studied from petiole length in relation to the leaf lamina length and scored as sessile (petiole absent), brevipetiolate (petiole shorter than leaf lamina) or longipetiolate (petiole longer than or same length as leaf lamina).

Leaf lamina morphologies of several genotypes were visually recorded as follows elliptic, ovate, obovate, lanceolate, orbicular or obcordate. Leaf lamina margin of different genotypes was recorded visually as crenate, dentate, entire or sinuate. Leaf apex was recorded as per shapes given in descriptors for citrus by IPGRI, Italy. They were scored as acuminate, acute, sub-acute, obtuse or oblique.

Ten leaves from each replication were observed to record presence or absence of petiole wing. Type of flowers like male, female, hermaphrodite were observed in each clone and noted. Flower colour and anther colour was visually assessed and documented using the Royal Horticultural Society colour chart (Anon 1966) [1].

2.2 Quantitative characters

The height of three trees from three replications was surveyed using a measuring tape, and the average was recorded in metres (m). Canopy spread of the tree in the North-South (N-S) and East-West (E-W) directions measured using a measuring tape. The canopy spread was calculated by taking the average of both N-S and E-W sides. To determine the typical plant canopy, canopy spread from the East-West (E-W) and North-South (N-S) distribution of a crown was measured in meters and was calculated with the height obtained, the equation outlined by Morse and Robertson (1987) which was given below was utilized to compute the canopy volume.

Canopy volume = 0.5234 x canopy spread (E-W) x canopy spread (N-S) x height

Spine length was measured randomly by using Vernier's callipers. Average length of 10 spines at leaf axil were taken and scored as ≤ 5 mm, 6 - 15 mm, 16 - 40 mm and >40 mm. Number of spines was calculated per 30 cm of shoot length on five shoots randomly for each genotype. The genotypes were categorized as absent, low, medium and high on the basis of spine density on adult tree. The overall length of the leaf was measured from the base of the petiole to the tip of the leaf using a millimetre scale. The width of the leaves was measured with scale from one corner to the other in middle portion and average was recorded in millimetre (mm). The average length of the petiole wing of 10 completely developed petioles per tree was measured with digital Vernier's callipers.

Pedicel length was recorded from ten fully opened flowers per tree with the help of Vernier's callipers. Ten numbers of flowers were taken from each replication and total number of petals was counted.

Ten numbers of flowers were taken from each replication and petal length and petal width was measured with the help of Vernier's callipers. Number of stamens was observed on five fully opened flowers for each genotype and were scored as per the descriptor as < 4 per petal, 4 per petal or > 4 per petal.

The average of the number of completely mature seeds from five fruits per tree was recorded. Ten fully developed seeds from five fruits per tree were weighed, and the average seed weight was recorded in grams.

Table 1: List of genotypes used for the study

S. No	Name of the clone
1.	Tirupati acid lime/94-4
2.	Tirupati acid lime/94-5
3.	Tirupati acid lime/94-7
4.	Tirupati acid lime/94-8
5.	Tirupati acid lime/94-9
6.	Tirupati acid lime/94-11
7.	Tirupati acid lime/94-13
8.	Tirupati acid lime/94-14
9.	Tirupati acid lime/94-17
10.	Tirupati acid lime/95-1
11.	Tirupati acid lime/95-2
12.	Tirupati acid lime/95-3
13.	Selection-3
14.	Selection-7
15.	Selection-8
16.	Selection-16
17.	Selection-17
18.	Selection-18
19.	Selection-20
20.	Selection-21
21.	Selection-25
22.	Selection-27
23.	Selection-30
24.	Selection-32
25.	Selection-33
26.	Sai-sharbati
27.	RHRL-122
28.	RHRL-124
29.	RHRL-159
30.	KL-12
31.	BKS-4
32.	Nalgonda
33.	Periakulam-1
34.	Balaji
35.	Petlur Pulusunimma
36.	Vikram
37.	Pramalini
38.	Punjab lime
39.	Akola lime
40.	Local kagzi lime

3. Results and Discussion

3.1 Qualitative characters

The tree shape of the genotypes was categorized and data clearly shows that out of forty acid lime genotypes studied, spheroid tree shape was recorded in twenty-one (52.5%) genotypes and ellipsoid tree shape was recorded in nineteen (47.5%) genotypes.

Similar results were noticed from the findings of Khankahdani *et al*. (2017) [12] where, spheroid and Obloid tree

shape was observed in Persian lime (*Citrus latifolia*) genotypes and also from the findings of Baswal *et al*. (2016) [2] in grapefruit where, tree shape was noticed spheroid in all the grapefruit genotypes. The data regarding tree growth habit of forty acid lime genotypes studied was recorded and thirty three (82.5%) genotypes has spreading type and tree growth habit of remaining seven (17.5%) genotypes was erect type. Similar findings were noticed by Baswal *et al*. (2016) [2] where, the spreading habit of tree was observed in all the studied grapefruit genotypes and Singh *et al*. (2010) [22] where they found spreading growth habit in all the studied Rangpur lime (*Citrus limonia* Osbeck) genotypes.

Data regarding shoot tip colour showed that green shoot tip colour was recorded in all the forty (100%) acid lime genotypes. None of the genotypes had purple shoot tip colour. Similar results were observed in study conducted by Harjeet *et al.* (2010) [7], where shoot tip colour of all studied rangapur lime (*Citrus limonia* Osbeck) genotypes was green in colour and Rahmat *et al*. (2021) [16], where all the citrus genotypes have green shoot tip colour.

Leaf lamina attachment was scored and all (100%) genotypes were Brevipotiolate where petiole shorter than leaf lamina. The results obtained were in line with Gaikwad *et al.* (2018) [6], where leaf lamina attachment did not show any variation in the studies citrus rootstock genotypes representing four species (*C. jambhiri, C. limonia, C. pseudolimon, and C. macrophylla*).

Leaf lamina shape is a key trait for differentiating genotypes. Genotypes were categorised as elliptic, ovate, obovate, lanceolate, orbicular or obcordate according to the citrus descriptors and out of forty genotypes studied, twenty-two (55%) genotypes were elliptic and eighteen (45%) genotypes were ovate. Findings are similar to Gaikwad *et al*. (2018) [6] who observed wide variation in leaf lamina shape like obcordate, elliptic, ovate, obovate, lanceolate and orbicular in citrus rootstock genotypes studied and Dubey *et al*. (2013) [5] who found variation in leaf lamina shape of different grape fruit genotypes studied.

The margin of the leaves was categorized as crenate, dentate, entire or sinuate according to the citrus descriptors and out of forty acid lime genotypes studied, all the forty (100%) genotypes showed crenate leaf margin. Results were in accordance with Dubey *et al*. (2013) [5] where they found no variation in leaf margin in different indigenous grape fruit genotypes studied and Gaikwad *et al.* (2018) [6] who reported most of the leaves had crenate lamina margin in citrus genotypes studied., while dentate was observed in Alemow 1 and sinuate in AKLRLe 62.

Data regarding leaf apex showed that among forty acid lime genotypes studied, twenty-one (52.5%) genotypes had acute leaf apex shape and nineteen (47.5%) genotypes had obtuse leaf apex shape. These results were in line with by Rahmat *et al*. (2021) [16] where they found variation in different citrus genotypes studied for morphological evaluation. Acid lime genotypes were classified according to the presence or absence of the petiole wings. Among forty acid lime genotypes studied, all the genotypes (100%) had petiole wings. Results were similar to those found by Dubey *et al*. (2013) [5] with no variation in presence or absence of petiole wing as all the grape fruit genotypes are with petiole wing in a study conducted for morphological evaluation.

Presence of male, female and hermaphrodite was observed in the genotypes. All the genotypes had male flowers along with hermaphrodite flowers and none of the genotypes are with female flowers. Similar findings were also observed by Mishra *et al*. (2018) [14] while studying reproductive biology of *Citrus aurantifolia* cv. Kuliana Lime where they observed hermaphrodite and male flowers in the acid lime plants without female flowers. Colour of open flower was white in all forty (100%) of the acid lime genotypes. The results were coinciding with the work of Shilpy *et al*. (2021) [19] where they observed no variation in the floral traits and white flower was recorded in all genotypes in a study conducted in genotypic differentiation of sour lime (*Citrus aurantifolia* Swingle) based on floral traits.

Anther colour was visually observed and all the genotypes (100%) has pale yellow colour anther colour. Similar results were found by Shilpy *et al*. (2021) [19] where they observed no variation in the floral traits and pale yellow anther colour was recorded in all genotypes in a study conducted in genotypic differentiation of sour lime (*Citrus aurantifolia Swingle*).

The seed shape in different acid lime genotypes studies was observed visually and genotypes were categorised according to citrus descriptors. Among all the forty acid lime genotypes studied, clavate seed shape was observed in twenty eight (70%) genotypes and ovoid seed shape was recorded in twelve (30%) genotypes. Clavate seed shape was recorded in a study conducted in rootstocks of Bitter sweet orange, Yumma citrange and Sweet orange by Jaskani *et al*. (2006) [8].

The seed colour in different acid lime genotypes studies was observed visually and genotypes were categorised according to citrus descriptors. Cream seed colour was observed in thirty three (82.5%) genotypes and white seed colour was recorded in seven (17.5%) genotypes. Similar variation in seed colour was found by Harjeet *et al*. (2010) [7] among rangpur lime (*Citrus limonia* osbeck.). Majority of the genotypes had cream colour seeds *in Limonaria Rugosoda*, Marmalade and Noreo Rangpur lime. Seed colour was brown in 8744, Brazilian and Texas genotypes.

3.2 Quantitative characters

Data from Table 2, depict that there was significant difference for tree height ranged from 2.52 to 4.57 m with overall mean of 3.59 m. The maximum tree height (4.57 m) was recorded in selection-16 followed by selection-25 (4.47 m) and selection-25 (4.25 m). However, the minimum tree height (2.52 m) was recorded in selection-8. The plant's maximum height resulted from its robust development, which may have had a certain genetic effect. The prior conclusions were supported by Srinivas *et al.* (2006) [23], where maximum height of plant (4.22 m) and was recorded in LTR-5 strain and the lowest plant height (2.46 m) was recorded in LTR-8 in strains of kagzi lime at latur district of Maharashtra. Similarly, Shinde *et al*. (2004) [20] noticed a maximum plant height of (3.90 m) in the seedling strain of Kagzi lime. Whereas, Mahantesh *et al*. (2015) [15] confirmed that acid lime varieties 'Sai Sharbati' (4.22 m) had the highest plant height, followed by 'PDKV lime' (4.28 m) and 'Mangali Pattu' (4.22 m) with an upright growth habit and Pramalini (3.81 m), Vikram (3.76 m), and Chakradhar (3.52 m).

Canopy spread revealed significant differences among the genotypes studied, which ranged from 2.18 to 4.76 m with a mean spread of 3.44 m. According to the observations, highest canopy spread in east-west directions was noticed in PKM-1(4.76 m), followed by selection-17 (4.65 m), RHRL-122 (4.63 m), TAL/95-3 (4.50 m) and Balaji (4.46 m) which

were superior to other treatments and similar to one another. In contrast, the least canopy spread was observed in TAL/94-9 (2.18 m) followed by TAL/94-8 (2.32 m). The findings in the North-South directions indicated that the canopy spread was maximum in TAL/94-14 (4.74 m), followed by selection-17 (4.60 m), Pramalini (4.58 m), PKM-1 (4.57 m) which were on par to one another and superior to other treatments. Canopy spread was lowest in Local kagzi lime (2.87 m), followed by selection-20 (3.08 m). These results are in accordance with of Jiani and Ghaffoor (1991) [9] who observed maximum canopy spread ranging from 3.60 m to 5.30 m in Hamlin sweet orange variety. Kahlon and Bains (1993) recorded maximum tree spread of (3.90 m) in Barmasi lemon, strain-8. Similarly Josan and kour (2006) [10] observed tree spread ranged from 2.53 to 6.00 m in East-West and 2.90 to 6.05 m in North-South directions, respectively in studied mandarin varieties.

The canopy volume from Table 2, revealed significant differences among the 40 genotypes with a range of 9.99 m^3 to 44.90 m^3. Mean volume of 24.46 m^3 was recorded in the genotypes. The highest canopy volume was recorded in PKM-1 (44.90 m^3), followed by selection-17 (43.06 $m^{3)}$ and Petlur Pulusunimma (40.70m^3). The lowest canopy volume was recorded in Local kagzi lime (9.99 m^3) followed by TAL/95-1 (12.37m^3) and TAL/94-9 (13.60 m^3). Study regarding canopy volume is supported by Desai *et al*. (1994) [4] where maximum canopy volume (8.73 m^3) was noticed in the seedling plant of Kagzi lime to budded plant (5.37 m^3) and Singh *et al*. (2009) [21] who recorded maximum canopy volume in accession IC-285420 (45.13 m^3) of Hill lemon. According to Dubey *et al.* (2013) [5], MS-7 had the highest canopy volume, followed by MS-3, and Valencia had the lowest canopy volume. Similarly, Magno *et al*. (2015) reported that the maximum canopy volume varied from 35.90 m^3 to 44.20 m^3 in all selections of Persian lime.

The genotypes were categorized as ≤ 5 mm, 6 - 15 mm, 16 - 40 mm and >40 mm on the basis of spine length on the shoot. Out of forty acid lime genotypes studied as ≤ 5 mm spine length was observed in twelve (30%) of genotypes, 6 - 15 mm spine length was recorded in twenty (50%) of the studied genotypes. 16 - 40 mm spine length was recorded in eight genotypes (20%) and none of the genotypes were recorded with >40 mm spine length. Similar results were found by Singh *et al*. (2009) [21] in different strains of Rangpur lime (*C. limonia* Osbeck). The Brazilian strain had the longest spine length (41.3 mm), while Texas had the shortest spine length (12.4 mm).

The genotypes were categorized as absent, low, medium and high on the basis of spine density on adult tree. Among forty acid lime genotypes studied, medium spine density was observed in twenty seven (67.5%) of genotypes, high spine density on adult tree was recorded in nine (22.5%) of the studied genotypes. Low spine density was seen in four genotypes (10%) and none of the genotypes were without spines on the shoot. Different spine densities in twenty one citrus genotypes studies for morphological characters were also observed by Rahmat *et al*. (2021) [16] in seedling stage citrus genotypes.

Leaf length from Table 2 revealed significant differences among the genotypes studied with a range of 44.0 mm to 79.33 mm and a mean leaf length of 62.06 mm was noticed. The leaf length was highest in genotype Petlur Pulusunimma (79.33 mm) followed by TAL/94-5 (73.00 mm) and TAL/94-7 (72.70 mm). The lowest leaf lamina length was recorded in genotype selection-30 (44.00 mm) followed by RHRL-124 (50.67 mm). Considerable diversity was found in regard to leaf length and the results were in line with the findings of Santos *et al*. (2003) [18] in diversity studies of Mandarin genotypes and by Baswal *et al*. (2016) [2] in grapefruit genotypes. The difference in leaf breadth was found to be significant for the forty genotypes studied from a range of 29.67 mm to 46.30 mm and the mean leaf breadth of the genotypes recorded 37.20 mm (Table 2). The leaf breadth was highest in TAL/94-7 (46.30 mm), which was on par with other genotypes Balaji (44.67 mm), selection-21 (44.00 mm), selection-8 (43.67 mm), TAL/95-3 (42.70 mm and the lowest value was recorded in RHRL-159 (29.67 mm) followed by KL-12 (31.00 mm)

Considerable variations were observed in leaf breadth similar to the findings of Santos *et al*. (2003) [18] in mandarin genotypes, Baswal *et al*. (2016) [2] in grapefruit genotypes and Rahman *et al*. (2003) in 30 local pummelo accessions.

The genotypes were categorized as 0-10 mm, 10-15 mm and >15 mm on the basis of petiole wing length in leaves. Among genotypes, 0-10 mm petiole length was observed in eight (20%) of genotypes, 10-15 mm was recorded in twenty seven (67.5%) of the studied genotypes. >15 mm wing length was seen in five genotypes (12.5%) and none of the genotypes were without spines on the shoot.

The difference in pedicel length was found to be significant for the forty genotypes studied from a range of 2.29 mm to 4.41 mm and the mean pedicel length of the genotypes recorded 3.46 mm (Table 2). The pedicel length was highest in PKM-1 (4.41 mm), which was on par with other genotypes Balaji (4.39 mm), selection-25 (4.32 mm), Punjab lime (4.31 mm) and the lowest value was recorded in RHRL-124 (2.29 mm) followed by RHRL-122 (2.42 mm). Similar results regarding pedicel length were also observed by Shilpy *et al*. (2021) [19] in sour lime (*Citrus aurantifolia* Swingle) based on floral traits. The maximum pedicel length (4.20mm) was in JMU-Sun, while minimum (2.15 mm) in JMU-Jib.

The Number of petals per flower in different acid lime genotypes studies was observed visually. Among the forty acid lime genotypes studied no variation was present and all (100%) genotypes recorded five petals per flower. Finding regarding number of petals per flower was coinciding with results of Shilpy *et al*. (2021) [19] in sour lime (*Citrus aurantifolia* Swingle) based on floral traits. Number of petals per flower was five in all studied genotypes of acid lime.

The difference in petal length was found to be significant for the forty genotypes studied from a range of 10.99 mm to 14.32 mm and the mean petal length of the genotypes recorded 12.47 mm (Table 2).

The petal length was highest in selection-33 (14.32 mm), which was on par with other genotypes Pramalini (14.17 mm), RHRL-49 (14.15 mm) and the lowest petal length was recorded in TAL/94-4 (10.99 mm) followed by TAL/94-5 (11.00 mm). Results pertaining to petal length were coinciding with results found by Shilpy *et al*. (2021) [19] in sour lime (*Citrus aurantifolia* Swingle) where minimum petal length (11.02 mm) was recorded in JMU-Log and maximum (14.62 mm) in JMU-Uttar. Similarly Baswal *et al*. (2016) [2] observed variation in petal length in sweet orange where Campbell Valencia recorded highest petal length of 29.67 mm.

The difference in petal width was found to be significant for

the forty genotypes studied from a range of 3.09 mm to 5.38 mm and the mean petal length of the genotypes recorded 4.03 mm (Table 2). The petal width was highest in PKM-1 (5.38 mm) followed by local Kagzi lime (5.23 mm), Petlur Pulusunimma (5.21 mm) and the lowest petal width was recorded in TAL/94-5 (3.09 mm) followed by selection-25 (3.18 mm). Results pertaining to petal width were similar to the results found by Shilpy *et al*. (2021) [19] in sour lime (*Citrus aurantifolia* Swingle) where the maximum petal width (5.12 mm) was recorded in JMU Nag and minimum was seen in JMU-Balli (3.19 mm). Similarly Baswal *et al*. (2016) [2] observed variation in petal length in sweet orange where Cutter Valencia had the widest petal widths (23.65 mm).

The Number of stamens in different acid lime genotypes studies was observed visually and recorded as scored as per the descriptor as < 4 per petal, 4 per petal and > 4 per petal. Among the forty acid lime genotypes studied no variation was present and all (100%) genotypes recorded four stamens per petal.

The difference in number of seeds was found to be significant for the forty genotypes studied from a range of 3.67 seeds per fruit to 12.33 seeds per fruit and the mean number of seeds in the genotypes was 9.11 (table 2). The number of seeds was highest in Local (12.33) followed by Punjab lime (11). Selection-18 (10.66), Selection-25 (10.66) and Selection-27 (10.66) were on par to each other. The lowest number of seeds were recorded in TAL/94-14 (3.67) followed by Vikram (4.66).

Less number of seeds per fruit is a desirable characteristic in acid lime. Normally the fruits with less number of seeds may contain a more edible part in the fruits and the maximum number of seeds is desirable for propagation. The number of seeds was more in the cv. Kagzi lime (11.16) (Shinde *et al*. 2004) [20]. Similar results were also observed by Srinivas *et al*. (2006) [23] where number of seeds ranged from 3.67-16.33 in Kagzi lime. Shrestha *et al*. (2012) observed the maximum seed number (10.00) in acid lime of Nepal terai regions. Mahantesh *et al*. (2015) [15] found more seeds in Kagzi lime (12.11), followed by Pramalini (11.38), and Sai Sharbati (10.61).

Deshmukh *et al*. (2015) [3] found the maximum number of seeds in the Mangali Pattu cultivar (14.60) and less in Chakradhar (1.67). Average number of seeds per fruit was observed 5-9 in 29 genotypes and 10-19 in 41 genotypes of acid lime (Shilpy *et al*. 2021) [19].

The difference in seed weight was found to be significant for the forty genotypes studied from a range of 0.78 g to 1.58g and the mean seed weight of the genotypes 1.27g (table 2). The seed weight was highest in PKM-1 (1.58g) followed by Selection-30 (1.55g) and Selection-32 (1.53g). The lowest seed weight was recorded in TAL/94-5 (0.78g) followed by Vikram (0.79g).

Similar results were obtained by Shilpy *et al*. 2021 [19] where maximum seed weight (1.87 g) was found in genotype JMU-Chet (47) and minimum in JMU-Chet (45).

Table 2: Variation in quantitative tree, leaf and flower characters in acid lime clones

Clones	Plant height (m)	Canopy spread (m)		Canopy volume(m^3)	Leaf lamina length (mm)	Leaf lamina width (mm)	Pedicel length (mm)	Petal length (mm)	Petal width (mm)
		East-west	North-south						
TAL/94-4	3.64	2.75	3.23	16.88	66.30	41.30	3.47	10.99	3.37
TAL/94-5	3.54	3.74	4.44	30.74	73.00	41.30	3.24	11.00	3.09
TAL/94-7	3.24	3.14	3.47	18.61	72.70	46.30	4.21	11.24	3.44
TAL/94-8	3.67	2.32	3.51	15.56	55.30	31.30	3.43	11.60	3.66
TAL/94-9	3.39	2.18	3.53	13.60	57.70	34.30	3.36	11.29	3.33
TAL/94-11	3.56	3.47	4.23	27.23	61.70	42.00	3.46	11.81	3.48
TAL/94-13	3.68	2.85	3.70	20.37	61.70	33.70	3.54	11.21	3.60
TAL/94-14	3.33	4.18	4.74	34.54	65.70	38.00	3.23	12.53	3.59
TAL/94-17	3.01	3.02	3.53	16.85	67.30	41.30	3.49	11.80	3.67
TAL/95-1	2.74	2.54	3.40	12.37	56.30	43.30	3.51	11.76	3.53
TAL/95-2	3.31	2.80	3.09	15.01	71.70	33.70	3.78	12.01	3.48
TAL/95-3	3.30	4.50	4.49	34.76	70.30	42.70	3.15	12.19	4.00
SEL-3	3.61	2.57	3.15	15.24	53.00	35.00	3.49	11.26	3.58
SEL-7	3.83	2.99	3.22	19.42	61.70	38.30	3.55	12.82	3.94
SEL-8	2.52	3.48	3.54	16.21	63.00	43.67	3.34	12.54	3.63
SEL-16	4.57	2.65	3.20	20.34	62.67	42.00	3.96	11.94	4.18
SEL-17	4.26	4.65	4.60	43.06	65.67	35.67	3.62	13.23	4.17
SEL-18	3.96	3.78	3.78	29.52	57.67	32.33	3.32	13.63	4.07
SEL-20	3.92	2.58	3.08	16.16	60.67	41.67	2.46	13.75	4.33
SEL-21	4.25	2.80	3.12	19.46	71.67	44.00	2.65	13.55	4.88
SEL-25	4.47	3.33	3.69	28.93	67.67	34.33	4.32	12.06	3.18
SEL-27	4.39	3.10	3.58	25.36	57.00	31.67	4.24	12.73	4.63
SEL-30	3.61	3.70	3.54	24.73	44.00	38.33	3.76	12.14	4.22
SEL-32	4.22	3.23	3.42	24.33	56.67	40.33	3.07	11.90	3.57
SEL-33	3.59	3.64	3.75	25.71	53.00	31.33	2.69	14.32	3.72
RHRL-49	2.64	4.40	4.49	27.17	68.67	36.67	2.75	14.15	3.51
RHRL-122	3.41	4.63	4.30	35.76	55.67	31.67	2.42	13.80	3.98
RHRL-124	3.59	3.02	3.32	18.86	50.67	34.33	2.29	13.80	4.06
RHRL-159	4.27	3.50	3.41	26.77	57.00	29.67	3.21	12.80	4.24
KL-12	4.27	3.60	3.30	26.57	56.00	31.00	3.51	12.98	4.22
BKS-4	3.48	3.63	3.41	22.59	56.67	34.33	3.68	12.03	4.30
Nalgonda	2.71	3.42	3.42	16.44	67.00	34.00	3.15	11.96	3.96

PKM-1	3.94	4.76	4.57	44.90	61.33	32.00	4.41	11.27	5.38
Balaji	3.61	4.46	4.27	36.21	71.67	44.67	4.39	12.45	5.10
Petlur Pulusunimma	4.24	4.29	4.44	40.70	79.33	46.00	3.69	11.22	5.21
Vikram	3.55	3.60	3.50	23.39	64.67	37.33	3.79	12.23	4.49
Pramalini	2.54	4.27	4.58	26.00	62.00	35.33	3.26	14.17	3.73
Punjab lime	3.73	3.49	3.55	24.12	57.00	34.67	4.31	13.39	4.81
Akola Lime	3.47	4.24	4.38	33.79	69.33	36.00	4.24	13.80	4.69
Local kagzi lime	2.65	2.47	2.87	9.99	51.33	32.67	3.09	13.38	5.23
SE m±	0.12	0.14	0.17	1.81	1.80	1.52	0.14	0.45	0.26
CD @ 5%	0.35	0.40	0.49	5.11	5.08	4.28	0.40	1.28	0.75

4. Conclusion

It can be summarized that, in qualitative characters studied among the acid lime genotypes, variation was noticed among the qualitative characters like tree shape, tree growth habit, leaf lamina shape, leaf apex, number of stamens, seed shape and seed colour. No variation was noticed for the qualitative characters *viz*., shoot tip colour, leaf lamina attachment, leaf lamina margin, petiole wings, flower colour, type of flower and anther colour.

Significant variation among the genotypes was observed for quantitative characters. Highest plant height was recorded in selection-16. PKM-1 was recorded with highest canopy spread in the east-west direction, highest canopy volume, highest pedicel length and highest petal width. TAL/94-14 recorded highest canopy spread in the north-south direction compared to other genotypes. Highest leaf length was recorded in PKM-1. No variation was found in characters like number of petals per flower and number of stamens per flower. The variation studied in the genotypes may be helpful in selection of genotypes for incorporation of desirable characters to offspring.

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6. Conflict of Interest

None.

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