

## Original Research Article

### **Evaluation of acid lime (*Citrus aurantifolia* Swingle) genotypes for growth, yield and quality attributes**

#### **ABSTRACT**

A study on evaluation of acid lime genotypes for growth, yield and quality traits was carried out at Citrus Research Station, Vannikonenthal, Manur Taluk and Tirunelveli district during the year 2021–2023. There were 25 acid lime genotypes used in this experiment. Observation on quantitative traits viz., tree height (m), tree spread (m), canopy spread (m<sup>2</sup>), tree girth (cm), leaf lamina length (cm), number of fruits/tree, mean fruit weight (g), fruit length (cm), fruit girth (cm), fruit volume (cc), number of seeds per fruit and yield of fruits/tree (kg) were recorded. In addition, qualitative traits data such as total soluble solids (°Brix), acidity (%), juice content (ml), juice content percentage (%) and ascorbic acid content (mg/100g) were also recorded. Observations were recorded in more than eight years old acid lime trees. The present study results revealed that genotype SCA 19 recorded the highest values for the traits such as tree height (3.49 m), tree spread ((3.58 m<sup>2</sup> E-W; 3.74 m<sup>2</sup> N-S), canopy spread (6.57 m<sup>3</sup>), leaf lamina length (58.40 mm) and tree girth (13.66 cm). However, genotype SCA 06 registered the lowest tree spread character. In the case of yield traits, genotype SCA 19 registered the highest values for the traits like number of fruits per tree (1080), mean fruit weight (58.75 g), yield per tree (57.89 kg per tree), number of seeds (9.10), fruit length (8.50 cm), fruit girth (4.90 cm) and fruit volume (54.81 cc). Regarding quality traits, SCA 19 observed the highest quality traits such as TSS (6.71°Brix), acidity (6.78 %), ascorbic acid content (26.50 mg/100 g), fruit juice percentage (52.1 %) and juice content (46.0 ml). Hence, acid lime genotype SCA 19 recommended for further evaluation in different parts of Tamil Nadu.

**Keywords:** Acid lime, *Citrus aurantifolia*, Genotypes, Evaluation, Growth, Yield, Quality

#### **INTRODUCTION**

Citrus is one of the most important fruit crops of the world and grown in more than 100 countries. India ranks first in production of acid lime in the world (2.54 million metric tonnes) and cultivated in an area of 0.282 million ha with productivity of 10.17 MT per ha).

Acid lime (*Citrus aurantifolia* Swingle) is one of the most important fruits in India considered to be indigenous to India, and is extensively cultivated in many states under tropical and subtropical climatic conditions. India is the largest producer of acid lime in the world (IIFPT, 2021). Acid lime also known as Kagzi lime (Nimboo), Mexican lime has gained more popularity, as it can be used to make pickles and seasonal cuisine in India and other zones of the world. In India, it is extensively cultivated in Maharashtra, Andhra Pradesh, Telangana, Karnataka, Tamil Nadu, Gujarat and Bihar. In Tamil Nadu, it is commercially cultivated at Tirunelveli, Tenkasi, Tuticorin, Perambalur, Madurai, Theni, Dindigul, Virudhunagar, Coimbatore and Vellore districts. In Tirunelveli district, acid lime fruits can be harvested throughout the year. Demand of acid lime fruit is always higher round the year, particularly during the summer months when the price goes up and fetches higher prices. The fruits having bigger size with more juice content with less number of seeds are always in market demand. The variation among different acid lime cultivars with regard to growth, bearing habits, yield, colour and quality were reported by earlier works in different parts of the country (Singh and Lal, 1982; Ingle *et al.* 2000; Kumar *et al.* 2011; Rajamanickam, 2023). Studies on performance of varieties of acid lime have been scanty in Maharashtra. There seems to be not studies on the varietal performance in this region. With this view, the present experiment on evaluation of acid lime genotypes for growth, yield and quality attributes was conducted during 2021 – 2023.

## **MATERIALS AND METHODS**

The present investigation was carried out at Citrus Research Station, Vannikonenthal, Manur Taluk, Tirunelveli district of Tamil Nadu during 2021 – 2023 with an aim to study the morphological characters evaluation acid lime genotypes, extent of variability among acid lime genotypes and to identify the high yielding and better performing genotypes. A total of 25 acid lime genotypes were used for the study. The place of collections of acid lime genotypes were presented in Table 1. The experiment was laid out in a randomized block design and replicated twice. Ten years old acid lime trees were selected for evaluation. The recommended cultivation practices were followed as per the crop production guide, 2020 (Anon, 2020). Observation on quantitative traits *viz.*, tree height (m), tree spread (m), canopy spread (m<sup>2</sup>), tree girth (cm), leaf lamina length (cm), number of fruits/tree, mean fruit weight (g), fruit length (cm), fruit girth (cm), fruit volume (cc) and yield of fruits/tree (kg) were recorded. In addition, qualitative traits data such as total soluble solids (°Brix), acidity (%), juice content (ml), juice content percentage (%) and ascorbic acid content (mg/100g) were observed. Evaluation of total soluble solids (TSS) was estimated by the digital

refractometer with results expressed in °Brix. Juice content, juice percentage, acidity and ascorbic acid content were estimated using procedures described by Ranganna(1986).The data was subjected to statistical analysis as per the method was suggested by Panse and Sukhatme (1967).

## RESULTS AND DISCUSSION

The growth parameters of 25 acid lime genotypes and the results presented in Table 2. The significant variance was observed among the genotypes. The findings revealed among the genotypes SCA 19 recorded the highest tree height of 3.49 m followed by SCA 20 (3.28 m) while SCA 02 registered the lowest tree height of 2.45 m. The maximum height of the tree might be due to the vigorous growth and genetic influence. This is in concurrence with the earlier findings of Srinivas *et al.* (2006) and Mahantesh *et al.*, (2015) in acid lime. In the present study, the highest tree spread was recorded in genotype SCA19 (3.58 m<sup>2</sup> E-W; 3.74 m<sup>2</sup> N-S) followed by SCA -25 (3.42 m<sup>2</sup> E-W;3.60 m<sup>2</sup> N-S). The lowest tree spread was noticed in SCA 06 (2.61 m<sup>2</sup> E-W; 3.04 m<sup>2</sup> N-S). Regarding tree girth, the highest values was exhibited in genotype SCA 19 followed by SCA 20 (13.66 cm). The lowest tree girth was found in genotype SCA 01 (11.25 cm). The same trend was noticed in leaf lamina length also. The maximum leaf lamina length was observed in genotype SCA 19 (58.40 mm) whereas the lowest leaf lamina length was registered in genotype SCA 01 (44.20 mm). The maximum canopy volume exhibited in genotype SCA 19 (6.57 m<sup>3</sup>) followed by genotype SCA 20 (6.49 m<sup>3</sup>) whereas the lowest canopy volume was registered in genotype SCA 08 (4.17 m<sup>3</sup>). The differences in the morphological traits in different genotypes of acid lime fruits are probably due to their genetic makeup as well as due to the influence of climatic factors. This is in accordance with the findings of Khurshid *et al.*(2004). Tree spread and tree volume is an important character which contributes significantly on yield of tree as it supports primary branches as well as secondary branches essential for fruit bearing. The present study report is in accordance with the findings of earlier workers of Desai *et al.* (1994) in Kagzi lime and Prasanna *et al.*(2023) in acid lime.

In the case of fruiting traits, significant variation was observed among the different acid lime genotypes (Table 3). Genotype SCA 19 recorded the highest values of the traits such as fruit length (8.50 cm), fruit width (4.90 cm) and fruit volume (54.81 cc) followed by SCA 23 (8.41 cm; 4.62 cm; 50.20 cc) whereas the lowest fruiting traits registered in genotype SCA 01 (5.49 cm; 4.10 cm; 42.58 cc). With regard to mean fruit weight, SCA 19 recorded the highest fruit weight (58.62 g), followed by SCA 20 (53.36 g) whereas the lowest fruit weight was noticed in SCA 13 (45.30 g). This might be due to round the year flowering, fruiting,

productive branchelets and canopy volume which lead to enhanced number of fruits per tree. The environmental conditions also influenced the variations among genotypes was observed on some of the fruiting traits. Fruiting characters directly correlated with the yield and have good market acceptability. This is in accordance with the earlier finding of Jawaharlal *et al.*(1989); Rajamanickam (2023).

The data clearly indicated that the treatments differed significantly with respect to the fruit yield (kg/tree). Genotype SCA 19 recorded the highest yield of 57.89 kg per tree followed by SCA 25 (51.38). However, the lowest yield per tree was found in SCA 13 (30.51 g per tree). Wide variation was observed among the different genotypes with respect to growth and yield traits and this may be attributed to their genotypic differences. Saraswathy *et al.* (2011) reported that great variation in fruit size was noticed in sapota. This is in conformity with the findings of earlier workers Kumar *et al.* (2011) in acid lime; Rajamanickam (2019) in tamarind. In the present study, number of fruits per tree showed wide variance among the genotypes studied and ranged from 652 to 1080. The highest values was registered in genotype SCA 19 (1080 fruits/tree) and the lowest was noticed in SCA 1 (652 fruits/tree). More vegetative development leads to a faster rate of photosynthesis which produced more number of fruits per tree. This is in accordance with the findings of Prasanna *et al.* (2023) and Rajamanickam (2022). The number of seeds per fruit varied significantly and ranged from 4.64 to 9.10. The highest seeds per tree registered in the genotype SCA19 (9.10) whereas the lowest seeds was observed in genotype SCA 11 (4.64). Rajamanickam (2023) recorded the highest seeds per fruits in PKM1 variety under Sankarankovil conditions.

Quality parameters such as TSS, juice content, juice percentage, acidity and ascorbic acid were evaluated in all the 25 genotypes and the results presented in table 4. The genotype SCA 19 recorded the highest TSS (6.71°Brix) followed by genotype SCA 25 (6.56 °Brix) whereas the lowest TSS was exhibited in genotype SCA 21 of 6.10 °Brix. The increase in TSS might be due to conversion of starch and their insoluble carbohydrate into soluble form of sugar which is responsible for increasing the TSS content (Hulme, 1970). This is in conformity with the findings of earlier workers Prasanna *et al.* (2023) in acid lime. The juice percentage (52.1 %) and juice content (46.0 ml) recorded the highest in genotype SCA 19 whereas the lowest juice percentage (37.20 %) and juice content (42.80 ml). This might be due to phenotypic characters of the genotypes. In the present study, acidity (6.780 %) and ascorbic acid (26.50 mg/100 g) recorded the highest in genotype SCA 19 and the lowest acidity (6.15 %) and ascorbic acid content (23.41 mg/100g) were noticed in genotype SCA 14. The variation in ascorbic acid content may be attributed as a varietal character and due to

favourability of seasonal conditions. This is in accordance with earlier findings of Srinivas *et al.* (2006) in Kagzi lime; Mandal and Thokchom, (2018) in mango.

## CONCLUSION

The present study it was concluded that genotype SCA 19 recorded the highest values for the growth traits such as tree height (3.49 m), tree spread ((3.58 m<sup>2</sup> E-W; 3.74 m<sup>2</sup> N-S), canopy spread (6.57 m<sup>3</sup>), leaf lamina length (58.40 mm) and tree girth (13.66 cm), yield traits like number of fruits per tree (1080), mean fruit weight (58.75 g), yield per tree (57.89 kg per tree), number of seeds (9.10), fruit length (8.50 cm), fruit girth (4.90 cm), fruit volume (54.81 cc) and quality traits such as TSS (6.71 °Brix), acidity (6.78 %), ascorbic acid content (26.50 mg/100 g), fruit juice percentage (52.1 %) and juice content (46.0 ml). Hence genotype SCA 19 recommended for further evaluation in different parts of Tamil Nadu.

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Table 1. Acid lime accessions collected from Tamil Nadu used in the study

Sl. No.	Accessions number	Place of collection
1.	SCA -1	Puliyankudi, Tenkasi
2.	SCA -2	Vannikonenthal, Manur, Tirunelveli
3.	SCA -3	Puthukulam, Kayathar, Tirunelveli
4.	SCA -4	Melaneelitha Nallur, Tirunelveli
5.	SCA -5	Vannikonenthal, Manur, Tirunelveli
6.	SCA -6	Koodalur, Vasudevanallur, Tenkasi
7.	SCA -7	Subramaniapuram, Puliyankudi, Tenkasi
8.	SCA -8	Muthaliarpatti, Ambasamuthiram, Tirunelveli
9.	SCA -9	Thiruviruthanpulli, Cheranmahadevi, Tirunelveli
10.	SCA -10	Thiruviruthanpulli, Cheranmahadevi, Tirunelveli
11.	SCA -11	Pattangadu, Cheranmahadevi, Tirunelveli
12.	SCA -12	Pattangadu, Cheranmahadevi, Tirunelveli
13.	SCA -13	Vadakuveeravanallur, Cheranmahadevi, Tirunelveli
14.	SCA -14	Villichery, Kovilpatti, Thoothukudi
15.	SCA -15	Donalur, Valliyur, Tirunelveli
16.	SCA -16	Valasai, Villiseri, Thoothukudi
17.	SCA -17	Puliyankudi, Tenkasi
18.	SCA -18	Puliyankudi, Tenkasi
19.	SCA -19	Senthamaram, Puliyankudi, Tenkasi
20.	SCA -20	Karisalkulam, Sankarankovil, Tenkasi
21.	SCA -21	Karisalkulam, Sankarankovil, Tenkasi
22.	SCA -22	Punnaiyapuram, Kadayanallur, Tenkasi
23.	SCA -23	Punnaiyapuram, Kadayanallur, Tenkasi
24.	SCA -24	Punnaiyapuram, Kadayanallur, Tenkasi
25.	SCA -25	Chinthamani, Puliyankudi, Tenkasi

Table 2. Growth characters of acid lime genotypes under Sankarankovil conditions

S. No.	Genotypes	Tree height (m)	Tree spread (m <sup>2</sup> )		Canopy volume (m <sup>3</sup> )	Tree girth (cm)	leaf lamina length (mm)
			E-W	N-S			
1.	SCA 01	2.80	3.12	3.41	4.97	11.25	44.20
2.	SCA 02	2.85	3.09	3.46	4.36	11.32	55.30

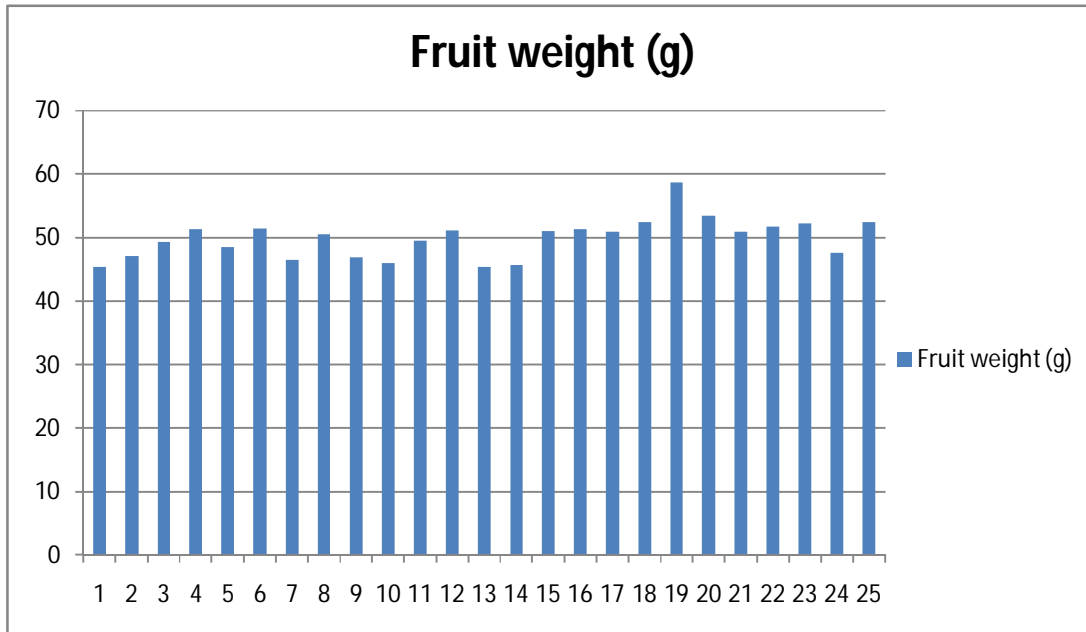
3.	SAC 03	2.78	2.95	3.21	4.24	12.83	51.40
4.	SCA 04	2.95	2.85	3.14	4.40	13.21	52.20
5.	SCA 05	2.78	2.64	3.12	4.38	11.55	53.10
6.	SAC 06	3.10	2.61	3.04	4.27	11.50	56.30
7.	SCA 07	3.14	2.78	3.25	4.51	12.29	54.80
8.	SCA 08	2.89	2.70	3.21	4.17	11.26	55.10
9.	SAC 09	2.70	3.10	3.65	5.09	12.58	56.20
10.	SCA 10	2.85	3.24	3.52	5.33	13.18	53.60
11.	SCA 11	3.02	2.98	3.32	4.92	13.21	54.20
12.	SAC 12	2.80	3.14	3.45	5.01	12.86	57.80
13.	SCA 13	2.91	3.19	3.52	5.39	11.87	54.20
14.	SCA 14	2.49	2.91	3.55	4.33	12.45	55.30
15.	SAC 15	2.85	2.87	3.24	4.37	12.80	51.40
16.	SCA 16	2.96	3.16	3.47	5.35	12.49	48.90
17.	SCA 17	2.48	2.86	3.28	3.84	13.47	47.50
18.	SAC 18	2.85	3.40	3.39	5.53	12.92	49.30
19.	SCA 19	3.49	3.58	3.74	6.57	14.50	58.40
20.	SCA 20	3.28	3.29	3.54	6.49	13.66	51.41
21.	SAC 21	3.20	3.39	3.45	6.17	13.50	55.20
22.	SCA 22	3.12	3.25	3.49	5.99	13.40	54.20
23.	SCA 23	2.84	3.20	3.40	5.09	12.95	51.10
24.	SAC 24	2.95	2.90	3.20	4.52	12.55	53.30
25.	SCA 25	3.24	3.42	3.60	6.44	12.40	55.50
	SEd	0.0134	0.0148	0.0103	0.0462	0.0481	0.1888
	CD (P=0.05 %)	0.0380	0.0421	0.0293	0.1315	0.1367	0.5367

Table 3. Fruiting and yield parameters of acid lime genotypes under Sankarankovil conditions

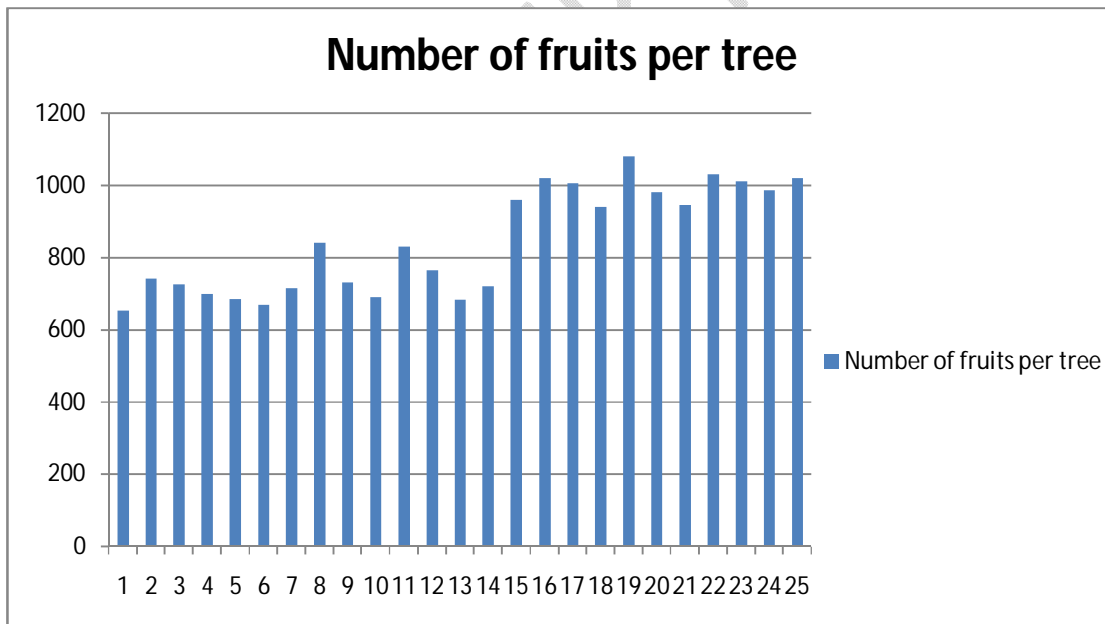
S. No.	Genotypes	Fruit length (cm)	Fruit width (cm)	Mean fruit weight (g)	Fruit volume (cc)	Number of fruits per tree	Number of seeds per fruit	Yield per tree (kg/tree)
1.	SCA 01	6.49	4.10	45.32	42.58	652	5.21	31.88
2.	SCA 02	6.82	4.70	47.02	44.38	742	6.45	33.28
3.	SAC 03	6.65	5.0	49.20	47.21	725	5.52	33.76
4.	SCA 04	6.70	4.30	51.30	48.90	698	5.23	33.37
5.	SCA 05	6.51	4.35	48.50	46.10	685	4.14	31.22
6.	SAC 06	6.84	4.51	51.42	48.52	669	8.07	32.50
7.	SCA 07	7.25	4.20	46.50	43.65	715	6.42	31.74
8.	SCA 08	7.50	4.25	50.42	43.20	840	7.30	36.08
9.	SAC 09	7.62	4.39	46.82	43.85	730	5.43	32.78
10.	SCA 10	7.10	3.89	45.89	48.89	690	5.24	30.64
11.	SCA 11	7.58	4.36	49.50	47.10	830	4.64	40.85
12.	SAC 12	7.80	4.32	51.10	48.30	765	6.51	38.91
13.	SCA 13	7.60	4.15	45.30	37.85	684	6.33	30.51
14.	SCA 14	8.20	4.12	45.60	43.54	720	4.80	31.83
15.	SAC 15	8.70	4.27	51.04	48.58	960	7.42	47.78
16.	SCA 16	7.30	4.21	51.33	49.80	1020	7.32	50.24
17.	SCA 17	6.90	4.00	50.88	47.69	1005	6.84	49.13
18.	SAC 18	7.60	3.90	52.39	50.13	940	6.91	47.46
19.	SCA 19	8.50	4.90	58.62	54.81	1080	9.10	57.89
20.	SCA 20	8.20	4.45	53.36	50.90	980	5.82	50.94
21.	SAC 21	8.14	4.30	50.80	48.10	945	6.41	46.06
22.	SCA 22	7.50	4.10	51.65	48.68	1030	7.64	51.10
23.	SCA 23	8.41	4.62	52.13	50.20	1010	7.43	50.65
24.	SAC 24	8.35	4.60	47.50	44.49	985	8.54	44.65
25.	SCA 25	8.20	4.40	52.33	49.80	1020	7.35	51.38
	SEd	0.0388	0.0123	0.1801	0.2023	8.4688	0.0423	0.5092
	CD (P=0.05%)	0.1104	0.0343	0.5121	0.5753	24.0807	0.0934	1.4479

Table 4. Quality parameters of acid lime genotypes under Sankarankovil conditions

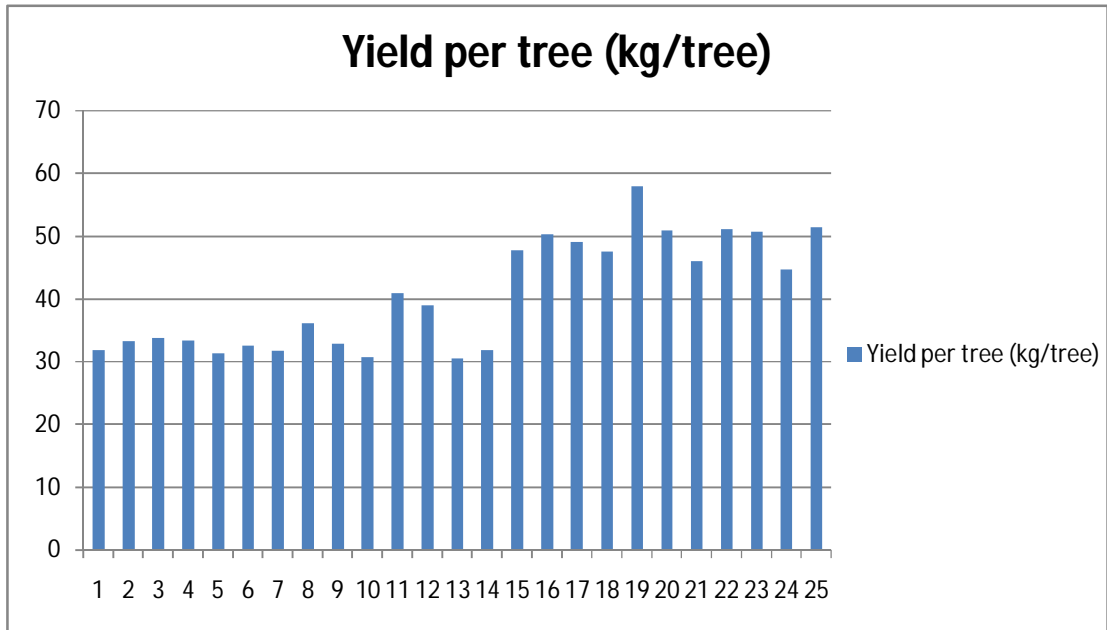
S. No.	Genotypes	Total Soluble Solids (°Brix)	Juice content (ml/fruit)	Juice percentage (%)	Acidity (%)	Ascorbic acid content (mg/100g)
1.	SCA 01	6.25	37.20	42.80	6.21	26.34
2.	SCA 02	6.37	44.60	42.60	6.60	24.50
3.	SAC 03	6.50	40.10	48.56	6.63	25.40
4.	SCA 04	6.47	39.20	43.67	6.40	26.10
5.	SCA 05	6.31	36.54	45.80	6.50	24.32
6.	SAC 06	6.50	37.50	46.02	6.521	25.54
7.	SCA 07	6.28	41.30	46.58	6.245	24.40
8.	SCA 08	6.42	42.50	44.47	6.43	26.20
9.	SAC 09	6.45	40.90	44.78	6.25	25.84
10.	SCA 10	6.39	38.80	45.66	6.32	24.50
11.	SCA 11	6.51	38.30	44.79	6.46	24.62
12.	SAC 12	6.30	39.50	45.54	6.38	25.30
13.	SCA 13	6.25	41.30	45.62	6.38	26.14
14.	SCA 14	6.41	40.10	43.80	6.15	23.41
15.	SAC 15	6.35	45.00	42.31	6.670	24.70
16.	SCA 16	6.54	40.40	42.58	6.552	25.40
17.	SCA 17	6.52	41.20	44.23	6.448	26.21
18.	SAC 18	6.20	45.00	45.41	6.748	26.00
19.	SCA 19	6.71	46.00	52.10	6.780	26.50
20.	SCA 20	6.31	39.80	51.65	6.424	25.20
21.	SAC 21	6.10	45.0	44.22	6.472	24.30
22.	SCA 22	6.35	39.0	48.10	6.48	25.40
23.	SCA 23	6.45	45.10	50.20	6.34	26.25
24.	SAC 24	6.38	44.10	47.05	6.64	25.60
25.	SCA 25	6.56	41.20	48.30	6.65	26.42
	SEd	0.0076	0.1606	0.1554	0.0096	0.0485
	CD (P=0.05 %)	0.0217	0.4566	0.4419	0.0272	0.1378



**Fig. 1. Fruit weight (g) of twenty five acid lime genotypes under Sankarankovil condition**



**Fig.2. Number of fruits per tree of twenty five acid lime genotypes under Sankarankovil condition**



**Fig. 3.** Yield per tree (kg/tree) of twenty five acid lime genotypes under Sankarankovil condition

UNDER PEER REVIEW