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Evaluation of Some Genotypes of Guava Trees Grown under Alexandria Governorate Condition I. Vegetative Growth, Flowering and Fruit Quality

Wafaa Aly Ahmed Zaki El-Sisy

El-Maamoura Botanical Garden, Alexandria,
Horticultural Institute, Agricultural Research Center, Giza, Egypt

Abstract: This study was carried out during two growing seasons (2011 and 2012) to investigate some morphological and productivity characteristics of fifteen genotypes of seedy guava trees with eight years old, grown in Air Force Institute at El-Maamoura Zone, East of Alexandria, Egypt. This evaluation included morphological characteristics, flowering, yield and fruit quality. The genotypes were analyzed to select promising guava genotypes for fresh consumption and processing to take part in improvement and propagation programs. The best number of new shoots/tree was in genotype No. 10 in both seasons. Whereas, genotype No. 13 gave the best average of shoot length. Genotypes No. 7, 12 &15 gave the highest number of leaves/shoot and genotype No. 7 was the highest one in both seasons. The largest trunk cross section area was in genotype No. 3 in 2011 and 2012. For leaf characteristics, genotypes No. 6&13 gave higher values of leaf width and the longest leaf petiole was in genotypes No. 9&15 in both seasons. While, the best rachis length was in genotypes No. 10 &11 in 2011 and No. 9 in 2012. The maximum leaf area was in genotype No. 6 in both seasons, respectively. For flowering dates, genotypes No. 2 &12 were the earliest, whereas No. 15 was the latest in 2011 and 2012. Concerning flowering, genotype No. 9 gave the maximum of flowers number/tree (468.0-462.5) in 2011 and 2012, respectively. The best final fruit set (%) were in genotypes No 8 in 2011 and No. 6 in 2012. The maximum yield (kg/tree) was in genotype No. 2 (88.85-89.99 kg) in both seasons, respectively. The highest fruit weight was recorded in genotypes No. 10 (277.37g) in 2011 and No. 2 (253.23g) in 2012. The longest fruit was in genotype No. 10 in both seasons. All genotypes gave similar results for fruit width except No. 2, which was the biggest one. The highest firmness was in genotype No. 14 in 2011 and genotype No. 2 in 2012. For fruit pulp thickness, genotype No. 11 gave the highest values (2.37, 2.23 cm) in both seasons. Genotype No. 6 had the minimum test weight of 100 seeds (0.5&0.59g). The low seeds (%) was the best character for fruit quality and associated with genotype No 2 (1.294-1.121%).The highest values of TSS(%) was in genotype No. 6 (14.07-13.73 %) in both seasons and the highest values of V.C were in genotypes No. 2&3 (97.16-87) mg/100ml juice in both seasons, respectively. The highest acidity(%) was in genotypes No. 13&15 (0.793-0.790) in 2011 and No. 6 (1.408) in 2012.The highest total sugars contents (%) was in genotypes No. 4&8 in 2011 and No. 7 in 2012. The results of leaf mineral content N, P, K (%) showed a good health growth. From such results, it can be recommended with genotypes No. 2, 5, 6, 7, 9 &12, which have superior characteristics as pulp thickness, total sugar (%), few seeds, V.C, TSS (%) and yield.

Key words: Genotypes · Evaluation flowering and fruiting · Guava (*Psidium guajava,* L.) · Vegetative growth · Fruit quality.

INTRODUCTION

Guava (*Psidium guajava* L.) is the most important and commercially cultivated fruit crop belonging to the family *Myrtaceae*. It was originated in tropical America, stretching from Mexico to Peru and gradually it became a commercially significant crop in several countries [1]. Guava is a hardy plant that grows in most of soil types.

Corresponding Author: Wafaa Aly Ahmed Zaki El-Sisy, El-Maamoura Botanical Garden, Alexandria, Horticultural Institute, Agricultural Research Center, Giza, Egypt.

Although it can tolerate the low moisture conditions and it can grow in many types of soil condition [2]. This fruit is an excellent source of V.C containing two to five times more than oranges [3]. It is also an excellent source of beta-carotene, lycopene, potassium, soluble fiber and antioxidants, which can act against the "free radicals" that damage cells and cause cancer, diabetes and coronary diseases [4]. It bears heavy crop every year and good economic returns involving very little input. This prompted several farmers to be directed towards taking up guava cultivation on a commercial scale. Guava is a popular fruit, it generally propagates from seeds and trees raised from seedlings, which are known to be variable in plant and fruit characteristics [5]. Each tree considers a separate strain; there are several varieties with differences in shape, size and flesh color, white, yellow or pink. In Egypt, most of guava trees are cultivated from seeds causing genetic variability. In a private orchard belongs to Air Force Institute (A.F.I) in El-Maamoura zone, Alexandria Governorate, Egypt, there are 300 trees (eight years old) cultivated from guava seeds. The characterization, selection and introduction of new guava genotypes with important trails for breading are very important for guava growers. The aim of this work was to select 15 genotypes of guava, which show great differences from others searching for superior genotypes for breading and to spread them for guava growers.

MATERIALS AND METHODS

The present study was carried out during two growing seasons 2011 & 2012 at Air Force Institute (AFI) orchard in El Maamoura zone, east of Alexandria Governorate, Egypt on fifteen guava genotypes selected from 300 genotypes of guava trees (*Psidium Guava*. L.). The experimental trees were about 8 years old, planted at 5x5 meters apart free from pathological and physiological disorders. The trees were irrigated with drip irrigation, the water analysis is shown in Table 1 and soil physical and chemical analysis are shown in Table 2. Average temperature degrees from January to December during 2011 and 2012 seasons are shown in Table 3.

In April of both seasons, 20 shoots/tree were labeled (5 shoots towards each direction) distributed randomly of each tree for carrying out the following measurements:

Vegetative Growth Measurements: Number of new shoots/tree, average shoot length (cm), number of leaves/shoot, average tree height (m) and trunk cross section area (cm^2) was determined at 25 cm above ground surface.

Leaf characteristics: Leaf width (cm), leaf petiole length (cm), leaf rachis length (cm) and leaf area (cm^2).

Flowering and Fruit Set (%): Flowering date, number of flowers /tree and final fruit set (%)/tree were calculated.

Fruiting and Yield/tree (kg): On mid September of 2011& 2012 seasons, 30 fruits from each selected tree were chosen randomly and divided into 3 replicates to determine the following physical parameters: Fruit weight(g), fruit length (cm), fruit width (cm), fruit pulp thickness(cm),fruit firmness,weight of 100 seeds (g) and seeds (%).

Fruit firmness was determined by using the Effegi pressure tester with an 8 mm plunger (Effegi, 48011 Alfonsine, Italy). Number of fruit/tree was recorded and then the yield kg/tree was calculated.

Fruit Chemical Characteristics: Total soluble solids (TSS %) was determined by hand refractometer.

Table 1: Water analysis.

			Cations (meq/l)				Anions (meq/ l)				
Variable	pH	E.C. (dS/m)	Na^+	K^+	Ca^{++}	Mg^{++}	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	SAR
Water	7.22	0.59	2.61	0.15	2.80	3.00	0.00	2.80	3.00	0.10	1.53

Table 2: Physical and chemical analysis of soil site.

							Cations (meq./l)				Anions (meq./l)				
Soil depth (cm)	Sand %	Silt %	Clay %	Texture	pH	EC (dS/m)	Na^+	K^+	Ca^{++}	Mg^{++}	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	SAR
0-30	99	0	1	Sandy	7.90	0.61	4.65	0.69	2.40	0.80	0.00	3.00	3.00	0.10	2.36
30-60	94	5	1	Sandy	7.96	0.86	5.48	2.05	3.71	1.15	0.00	3.56	8.68	0.20	5.38

Table 3: Daily mean of air temperature (ºC) by 10 days period for Alexandria Governorate during 2011& 2012 seasons.

		Temperature (ºC)					Temperature (ºC)		
Month	Period	Max.	Min.	Mean	Month	Period	Max.	Min.	Mean
Jan. 2011	1	18.6	12	15.3	Jan. 2012	1	17.2	9.1	13.2
	2	18.2	10.5	14.1		2	15.1	8.6	11.9
	3	19.4	10	14.7		3	15.4	12.6	13.9
Feb. 2011	1	18.8	11.9	15.4	Feb. 2012	1	17.2	6.7	11.9
	2	19.7	11.4	15.5		2	17.5	9.5	13.5
	3	21.3	9.6	15.4		3	18.2	10	14.1
Mar-11	1	19.6	11.9	15.8	Mar-12	1	18.8	10	14.4
	2	23.1	10.9	17		2	19.8	12.2	16
	3	21.1	13.2	16.6		3	20.8	11.9	16.4
Apr-11	1	22.4	13.7	18.1	Apr-12	1	26	13.6	19.8
	2	26.3	14.4	20.4		2	24.4	14.4	19.4
	3	23	14.9	18.9		3	24.5	13.7	19.1
May-11	1	26.3	18.6	22.6	May-12	1	25.8	16.7	21.2
	2	25.7	16.1	20.9		2	27.8	16.8	22.3
	3	28.1	18.5	233		3	29.8	18.2	24
Jun-11	1	29.2	20.1	247	Jun-12	1	28.6	19.5	24.1
	2	28.2	20.2	24.2		2	29.4	21.7	25.6
	3	28.6	22.1	25.4		3	30.9	23.4	27.2
Jul-11	1	30.1	22.3	26.2	Jul-12	1	31.2	24.2	27.7
	2	31.2	24.3	27.8		2	32.4	24.2	28.3
	3	31.7	25.2	28.4		3	31.7	25.3	28.5
Aug. 2011	1	31.5	31.8	31.5	Aug. 2012	1	32.3	24.8	28.6
	2	25.6	24	23		2	32.4	24.6	28.5
	3	28.6	27.9	27.2		3	31.5	25.5	28
Sep. 2011	1	31.3	23.2	27.3	Sep. 2012	1	30.3	23.7	27
	2	30.7	23	26.9		2	30.5	20.4	25.5
	3	30.5	21.1	25.8		3	28.7	20.4	24.6
Oct. 2011	1	30.9	20.7	25.8	Oct. 2012	1	29.1	19.4	24.3
	2	27	17.1	22.1		2	29	19.4	24.2
	3	25.3	18.5	21.7		3	27.3	17.4	22.4
Nov. 2011	1	24.5	14.9	19.7	Nov. 2011	1	27.3	19.2	23.3
	2	20.7	14.1	17.4		2	25.1	15.5	20.3
	3	21	13.5	17.3		3	23	14	18.5
Dec. 2011	1	21	12.1	16.6	Dec. 2012	1	22	12.9	17.5
	2	20.8	11.2	16		2	19.1	11.4	15.3
	3	18.1	9.6	13.8		3	19.7	9.9	14.8

* Period 1 = (days 1-10), Period 2 = (days 11-20) and Period 3 = (days 21-28/29/31).

Total acidity (%) was determined by titration as described by A.O.A.C [6] in grams of citric acid/100 ml juice.

Vitamin C content (mg ascorbic acid/100 ml juice by using 2, 6 dichlorophenol indophenols blue dyes as described by A.O.A.C [7].

Fruits total sugars were determined by the methods described by Dubois *et al.* [8].

Leaf Chemical Content: N and P leaf content were coloremterically determined and K leaf content was determined against a standard by flame photometer.

Statistical Analysis: The experimental treatments were arranged in a randomized complete blocks design and the obtained data in both seasons were analyzed according to Snedecor and Cochran [9]. Means were compared using LSD test at 0.05 level.

RESULTS AND DISCUSSION

Vegetative Growth Parameters:

Number of New Shoots/Tree: Data presented in Table 4a showed that, the genotype No. 10 in both seasons of study gave the highest number of new shoots (383.5-336.17), while the genotypes No. 13,14 &15 gave

the lowest number ranged from (164.01-115.0) in 2011 and 2012.The other genotypes gave results in between. The results of this study was partially in agreement with those obtained by Santos *et al.* [10], who reported that, the vegetative growth cannot be considered as characteristics of high yielding cultivars. While, El-Sisy and Yousef [11] found that, the number of new shoots/tree ranged from (231.5-1941.75) and from (395-1663.25) in 2003 and 2004, respectively in 7 guava genotypes with red pulp, while white pulp ranged between 496.75-783.25.

Average Length of New Shoots (cm): The results in Table 4a indicated that, the significant average length of new shoots were in genotypes No. 12&13 (51.54, 54.45 cm) in the first season and in genotypes No. 7, 9, 13&14 which varied between (35.84-33.34 cm) in the second season. The lowest average length of new shoots were associated with genotype No. 5&15 (19.94, 20.17 and 20.04, 20.14 cm) in both seasons of study. The other genotypes gave results in between in this respect. These results are in harmony with those obtained by Abou El-Khasheb *et al*. [12], who found that, the strain No. 64 gave significant increase in shoot length (23.5cm) compared with the other strains when they studied 11 trees selected from 70 winter guava trees. While, Patel *et al*. [13] found that, the shoot length ranged between 96.83 cm and 61.75 cm when they studied 11 guava genotypes of five years old.

Average Number of Leaves/Shoot: The results in Table 4a indicated that, the highest average number of leaves/shoot was found in genotypes No. 7&12 (16.65-16.57) in the first season and in the genotype No. 12 &15 (16.34, 16.0) in the second season. The lowest values of average number of leaves/shoots were associated in genotype No. 13 (10.01, 10.0) in both seasons of study. The results of this study are partially in agreement with the findings of Abou El-Khashab *et al*. [12], who found that, the number of leaves/shoot ranged between 14 in strain No. 41 and 8.7 in strain No. 83 when they studied 11 strains of winter guava. While, Patel *et al.* [13] reported that, the number of leaves/shoot varied from 36.83 cm in (RCGH-4) to 45.5 cm in (RCG-3) when they studied 11 guava genotypes of five years old.

Tree Height (m): The tree height of the studied genotype presented in Table 4b was significantly varied from (3.95-4.11 m) in genotype No. 7 and the lowest height was in genotype No. 15 (2.55, 2.70 m) in both seasons of study, respectively. The results of this study are partially in agreement with those reported by Gerhardt *et al.* [14], who studied five guava cultivars and three strains. They reported that, the cultivar RBS2 had the greatest height. These evaluation parameters go in harmony with the results of Dubey *et al.* [15], who evaluated 10 guava cultivars and found that, the plant height ranged between (2.09-2.99 m). In addition, Pandey *et al*. [16] evaluated 11 guava cultivars and found that, the plant height ranged between (3.97-2.29 m). While, Patel *et al*. [13] reported that, the plant height ranged between (3.07-2.04 m) when they studied 11 guava genotypes.

Trunk Cross-Section Area (cm^2): The data in Table 4b indicated that, the significant largest trunk cross section was found in guava genotype No. 3 (554.29, 622.8 cm^2) in 2011 and 2012 seasons. While guava genotype No. 12 gave the lowest value of trunk cross section area (235.33-280.2 cm^2) in both seasons of study. The other genotype gave results in between in this respect. The results of this study were partially agreed with those reported by Gerhardt *et al*.[14]. It was clear that, the environmental condition of investigation regions such as climatic as shown in Table (3) and soil were considered suitable for cultivation of guava tree, which reflect on tree growth as above-mentioned characteristics.

Leaf Characteristics:

Leaf Width (cm): Data presented in Table 5a and Fig. 1 indicated that, the maximum values of leaf width (cm) were in guava genotype No. 13 (6.9 cm) and No. 6 (6.83 cm) in the first season and genotypes No. 6 (7.03 cm) and 13 (6.67 cm) in the second season. While guava genotype No. 15 gave the lowest leaf width (4.9, 4.6 cm) in both seasons of study. The other genotype gave values in between. These results are in harmony with those obtained by El-Sharkawy and Othman [17], who found that, the leaf width ranged between (4.0-5.8 cm) when he evaluated some guava strains.

Leaf Petiole (cm): In Table 5a and Fig.1, the data of leaf petiole (cm) showed that, the higher values were associated with genotypes No. 9&15 (1.1, 1.03 cm) in 2011 and (1.13, 1.0 cm) in 2012. However, the lowest values were in genotypes No. 7 (0.57) and 12&14 gave the same value (0.73 cm) in the first season,and in genotypes No. 1,7&11 (0.67,0.66,0.73 cm) in the second season. The other genotypes results were in between. The results are partially in agreement with those reported by El-Sharkawy and Othman [17], who stated that, the leaf petiole length of five strains of guava ranged from (0.84 to 0.55 cm).

Table 4a: Number of new shoots/tree, average shoot length (cm) and average number of leaves/shoot, of some guava genotypes in 2011 and 2012 seasons.

	Number of new shoots/ tree		Length of new shoots (cm)		Number of leaves/ shoots	
Guava genotype	2011	2012	2011	2012	2011	2012
1	223.50 H	251.34 E	28.22 CED	27.59 CDE	14.51 BCD	11.65 EF
2	251.17 G	240.00 F	29.79 C	30.34 BCD	11.65 FHG	12.50 ED
3	284.34 D	294.17 C	24.00 D-G	23.84 EF	13.00 EFD	12.65 CDE
4	229.00 H	316.17 B	29.34 CD	23.84 EF	10.84 HIG	14.67 A-D
5	307.67 C	272.84 D	19.94 G	20.17 F	10.34 HI	10.84 EF
6	258.67 FG	243.67 EF	30.19 C	31.50 ABC	12.34 EFG	11.00 EF
7	273.84 E	199.15 H	29.10 CD	35.84 A	16.65 A	14.67 A-D
8	228.84 H	206.00 H	27.64 CED	25.84 ED	14.65 BC	15.00 ABC
9	260.00 F	217.50 G	30.14 C	33.42 AB	13.34 CDE	13.00 B-E
10	383.50 A	336.17 A	22.50 FEG	27.84 CDE	12.84 EF	11.84 EF
11	358.00 B	273.67 D	25.72 C-F	33.65 AB	14.65 BC	15.34 AB
12	274.67 E	296.67 C	51.54 A	30.17 BCD	16.57 A	16.34 A
13	161.17 I	164.01 I	54.45 A	33.34 AB	10.00 I	10.00 F
14	137.34 J	168.84 I	38.90 B	34.47 AB	13.00 EFD	11.50 EF
15	115.00 K	115.50 J	20.04 FG	20.14 F	15.00 B	16.00 A
$LSD_{0.05}$	15.80	19.19	5.77	4.58	1.60	2.49

The values followed by the same letter do not differ at 5% level of significance.

Table 4b: Tree height (m) and trunk cross section (cm^2) of some guava genotypes in 2011 and 2012 seasons.

	Tree height (m)		Trunk cross section area (cm^2)	
Guava genotype	2011	2012	2011	2012
1	2.70 M	3.03 H	333.82 I	367.30 EF
2	3.22 G	3.57 C	455.37 D	514.80 BC
3	3.76 B	3.96 AB	554.29 A	622.80 A
4	3.43 D	3.59 C	394.27 G	464.50 CD
5	2.77 L	2.92 H	405.68 F	464.50 CD
6	3.02 I	3.28 EF	441.58 E	503.50 BC
7	3.95 A	4.11 A	234.55 M	370.80 EF
8	3.12 H	3.35 EFD	514.74 C	554.30 AB
9	3.64 C	3.80 B	277.79 L	319.06 FG
10	2.86 K	3.04 GH	527.76 B	604.70 A
11	3.01 I	3.22 FG	292.27 K	375.40 EF
12	2.91 J	3.07 GH	235.33 M	280.20 G
13	3.28 F	3.43 CDE	363.09 H	417.23 DE
14	3.33 E	3.49 CD	527.76 B	581.30 AB
15	2.55 N	2.70 I	310.90 J	350.30 EFG
$LSD_{0.05}$	0.03	0.19	2.52	79.49

The values followed by the same letter do not differ at 5% level of significance.

Leaf Rachis (cm): The data in Table 5b indicated that, the longest values of leaf rachis were found in genotypes No. 1,6,10&11 (15.3,14.83,15.37,15.17 cm) in 2011 and in genotype No. 9 (17.97 cm) in 2012.The shortest leaf rachis was recorded in genotype No. 7 (11.87,11.97 cm) in both seasons of study. The other genotypes gave values in between. Similar results were obtained by El-Sharkawy and Othman [17], who reported that, the leaf rachis length ranged from (13.3-10.43 cm) when they evaluated five guava colons.

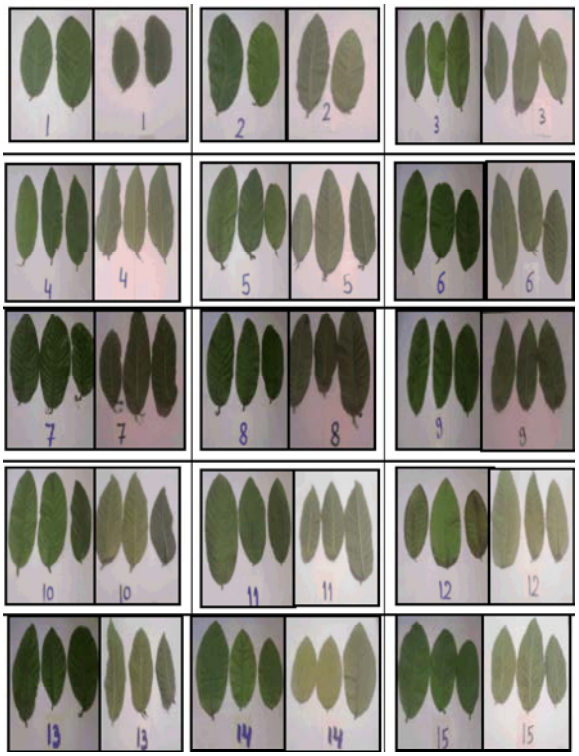

Fig. 1: Guava leaves ; left :face of leaves and right:back of leaves.

Leaf Area (cm^2): Data in Table 5b revealed that, the guava genotype No. 6 excelled the other in leaf area (88.33, 78.33 cm^2) in both seasons of study, respectively. The lowest values of leaf area (cm^2) were associated with genotype No. 15 (30.67, 33.4 cm^2) in both seasons of study,

Table 5a: Leaf width (cm) and leaf petiole (cm) of some guava genotypes during 2011 and 2012 seasons.

Guava genotype	Leaf width (cm)		Leaf petiole (cm)	
	2011	2012	2011	2012
1	6.13 CD	5.97CDE	0.83 BCD	0.67 E
2	5.87 CDE	6.30 BC	0.97 ABC	0.77CDE
3	5.20 FG	5.93 CDE	0.93 A-D	1.03 AB
4	6.20 C	5.17 F	1.10 A	0.97 A-D
5	5.87 CDE	5.73 DE	0.77 CDE	0.83 B-E
6	6.83 AB	7.03 A	0.93 A-D	0.93 A-D
7	6.37 BC	6.13 CD	0.57 E	0.67 E
8	5.57 EF	5.77 ED	0.93 A-D	0.90 A-D
9	6.17 CD	5.73 ED	1.10 A	1.13 A
10	5.23 FG	5.17 F	0.90 A-D	0.93 A-D
11	5.67 DEF	5.57 EF	0.90 A-D	0.73 DE
12	6.27 C	6.43 BC	0.73 DE	0.87 B-E
13	6.90 A	6.67 AB	0.90 A-D	0.90 A-E
14	5.60 EF	5.70 ED	0.73 DE	0.90 A-E
15	4.90 G	4.60 G	1.03 AB	1.00 ABC
$L.S.D_{0.05}$	0.53	0.53	0.22	0.26

The values followed by the same letter do not differ at 5% level of significance.

Table 5b: Leaf rachis length (cm) and leaf area (cm^2) of some guava genotypes during 2011 and 2012 seasons.

Guava genotype	Leaf rachis length (cm)		Leaf area (cm^2)	
	2011	2012	2011	2012
1	15.30 A	13.53 D	76.50 B	66.67 BCD
2	13.80 CD	15.57 B	58.00 C	65.00 CD
3	13.60 CDE	13.33 D	54.33 CD	68.00 CBD
4	14.27BC	11.53 F	50.33 ED	69.30 BC
5	13.97 CD	12.63 E	55.93 CD	64.67 CD
6	14.83 AB	13.23 DE	88.33 A	78.33 A
7	11.87 G	11.97 F	45.17 EF	74.00 AB
8	14.00 BCD	12.67 E	46.00 E	66.33 BCD
9	14.13 BCD	17.97 A	49.00 ED	60.67 D
10	15.37 A	13.53 D	54.67 CD	62.00 CD
11	15.17 A	15.23 B	43.33 EF	42.00 E
12	12.77 EF	13.83 CD	43.67 EF	41.30 EF
13	13.30 DE	14.43 C	38.00 FG	38.00 EF
14	14.17 BC	13.47 D	43.67 EF	42.27 E
15	12.10 FG	14.23 C	30.67 G	33.40 F
$LSD_{0.05}$	0.84	0.64	7.42	8.10

The values followed by the same letter do not differ at 5% level of significance.

respectively. The other genotypes results were in between. The obtained results are in harmony with the findings of El-Sharkawy and Othman [17], who found that, leaf area (cm^2) ranged between (47.16-27.86 cm^2) when they studied five guava colons.

Flowering and Fruit Set (%):

Flowering: Data concerning begging of flowering (Table 6a) showed that, the genotypes No. 2&12 were the earliest, while the genotype No. 15 was the latest one. These observations may be due to the differences between genotypes and environmental conditions (Table 3).

Flowers Number/Tree: The data in Table 6a showed that, the data of flowers number/tree revealed that, the maximum flowers number/tree were in genotypes No. 9,12&14 (468.0,467.85,451.35) in 2011 and in genotypes No. 9,1,12&6 (462.5,459.35,446.65,435.85) in 2012. On the other hand, the genotype No. 8 in both seasons of study gave the lowest number of flowers (272.0, 287.0) in 2011 and 2012, respectively. The other genotypes gave results in between. It was revealed from the results of the present study that, the flowering dates differed from year to year according to trees genotypes and environmental condition (Table 3). Also, these results are partially in line with the results of Abou El-Khashab *et al*. [12], who studied 11 strains of winter guava and found that, the number of flowers/shoot ranged between (16.5-2.3) in strains No. 22&83, respectively.

Fruit Set (%): The average fruit set (%) as shown in Table 6a gave significantly differences in this parameter. The highest values were in genotypes No. 8,3,11&2 with values ranged between (86.71-85.34%) in the first season,and in genotypes No. 6,12,14,2,13&9 with values ranged between (85.43-83.09%) in the second season. The other genotypes gave results in between. Rokba *et al.* [18] reported that, the fruit set as one of the basis for selection of guava genotypes. These results are in line with those obtained by Abou El-Khashab *et al*. [12], who reported that, the fruit set (%) ranged between 100% in strains 67& 41 and 45.3% in strain No. 66 when they studied 11 strains of winter guava. Whereas, El-Sharkawy and Othman [17] reported that, the fruit set (%) ranged between (95.87-81.3%) and between (97.7-82.5%) in both seasons of study in five guava colons.

Fruiting and Yield:

Fruit Number/Tree: In this regard, the results in Table 6b indicated that, the highest values were in genotypes No. 12,2,14& 9 (386.15,363.85,363.5,359.67) in 2011, while genotypes No. 9,12,6 &14 (383.85,378.15,372.35,359.65) in 2012. Also, the lowest values of fruit number/tree were in genotypes No. 1 & 8 (241.65, 235.85) in the first season and in No. 8 (215.85) in the second season. The data of the other genotypes of this study gave results in between. The data were partially in line with those obtained by El-Sisy and Yousef [11] in 7 guava colons with red pulp, the number of fruit ranged between

Table 6a: Days of flower initiation, number of Flowers /tree and final fruit set (%),of some guava genotypes during 2011 and 2012 seasons.

	Beginning of flowering date		Number of Flowers		Final Fruit set (%)	
Guava genotype	2011	2012	2011	2012	2011	2012
1	May 17	May 14	323.00 F	459.35 A	74.81 I	72.24 EF
2	May 13	May 11	426.35 BC	421.65 BC	85.34 ABC	84.22 AB
3	May21	May 20	369.00 E	393.50 DE	85.54 A	80.18 C-F
4	May 20	May 18	327.65 F	358.35 F	83.21 A-D	80.79 A-D
5	May29	May 30	395.50 CDE	406.65 CD	77.88 HG	80.30 C-E
6	May 27	May 25	424.15 BC	435.85 AB	79.06 E-H	85.43 A
7	May 31	June 2	388.00 DE	380.85 DEF	78.26 FGH	81.44 A-D
8	May 20	May 22	272.00 G	287.50 H	86.71 A	75.08 F
9	June 1	June 3	468.00 A	462.50 A	76.85 H	82.99 ABC
10	May 25	May 27	335.00 F	320.00 G	79.15 E-H	80.98 A-D
11	May 23	May 23	416.50CD	403.35 CD	85.44 AB	78.18 EFD
12	May 15	May 12	467.85 A	446.65 AB	82.54 B-E	84.66 AB
13	May 30	June 11	372.65 E	375.00 EF	81.81 C-F	83.91 AB
14	May 19	May 21	451.35 AB	425.85 BC	80.54 E-H	84.45 AB
15	June 15	June 12	333.30 F	305.85 HG	79.79 E-H	82.28 EFD
$LSD_{0.05}$	-	-	32.66	27.67	3.55	4.59

The values followed by the same letter do not differ at 5% level of significance.

Table 6b: Yield /tree (Number of fruit/tree and Kg/tree) of some guava genotypes during 2011 and 2012 seasons.

	Yield/Tree			
	Number of fruit/tree		Kg/tree	
Guava genotype	2011	2012	2011	2012
1	241.65 G	331.85 D	61.61 EF	70.21 CD
2	363.85 AB	355.15 C	88.85 A	89.99 A
3	315.65 ED	310.50 DE	71.87 CD	65.76 ED
4	272.65 F	289.50 E	48.96 G	46.72 F
5	308.00 E	326.50 D	67.70 C-F	82.22 AB
6	335.34 CD	372.35 ABC	74.70 BC	86.84 A
7	303.65 E	310.00 ED	71.30 CDE	38.87 FG
8	235.85 G	215.85 G	59.47 F	46.59 F
9	359.67 B	383.85 A	81.72 AB	64.79 ED
10	265.15 F	259.15 F	73.54 BC	63.55 ED
11	355.85 BC	315.35 D	82.11 AB	75.68 BC
12	386.15 A	378.15 AB	69.94 CED	71.07 CD
13	304.85 E	314.65 D	62.34 EFD	58.52 E
14	363.50 AB	359.65 BC	70.55 CDE	81.71 AB
15	266.00 F	251.65 F	37.95 H	34.91 G
$LSD_{0.05}$	22.85	22.31	9.84	8.60

The values followed by the same letter do not differ at 5% level of significance.

(215-1014.75) and (141.5-1038.75) in 2003 and 2004, respectively. While, white pulp guava gave results (764.25, 752.5) in both seasons. Also, Babu *et al*. [19] studied the performance of eight years old guava selection under Meghalaya condition and concluded that the number of fruits/tree ranged between 184 (selection-1) and 78.66 (selection-13). On the other hand, EL-Sharkawy and Othman [17] found that, the fruit number/tree ranged between 1335 to 282 and between 1896 and 352 in both seasons in 5 strains of seedy guava.

Yield kg/Tree: The result of the tree yield is shown in Table 6b, there were significant differences between the genotypes in the two seasons of study. The highest yield of guava tree in 2011 was associated with genotypes No. 2 (88.85 kg), 9 (81.72 kg), 11 (82.11kg) and 6 (74.7 kg). While genotypes No. 2 (89.99 kg), 6 (86.84 kg), 14 (81.71kg) and 11 (75.86 kg) gave the highest values in 2012. On the other hand, the lowest yield/tree produced by genotypes No. 15 (37.95 kg) and 4 (48.96 kg) in 2011 and genotypes No. 4 (46.72 kg), 7 (46.59 kg) and 15

Table 7: Fruit weight (g), fruit length (cm) and fruit width (cm) of some guava genotypes during 2011 and 2012 seasons.

	Fruit weight (g)		Fruit length (cm)		Fruit width (cm)	
Guava genotype	2011	2012	2011	2012	2011	2012
1	254.90 AB	211.73 ABC	7.90 CDE	8.57 BC	7.63 AB	7.33 AB
2	244.10 CD	253.23 A	7.40 EF	7.83 CD	7.90 A	7.97 A
3	227.90 BCD	148.77 ED	8.30 C	8.50 BC	7.70 AB	7.47 AB
4	179.47 G	161.67 CED	7.23 F	6.80 EF	6.63 D	6.53 CD
5	219.73 D	252.23 A	7.87 C-F	9.07 AB	7.00 BC	7.70 AB
6	223.00 DE	233.20 AB	7.70 C-F	7.60 DE	7.93 A	7.40 AB
7	234.10 BCD	125.17 E	8.13 CD	7.10 DEF	7.53 AB	6.20 D
8	251.70 AC	215.93 ABC	8.23 CD	7.60 ED	7.63 AB	7.47 AB
9	227.17 BCD	168.97 CD	7.73 C-F	7.40 DEF	7.63 AB	7.40 AB
10	277.37 A	245.10 A	9.77 A	9.60 A	7.90 A	7.40 AB
11	230.77 BCD	240.27 AB	8.97 B	8.80 AB	7.67 AB	7.63 AB
12	180.43 G	187.60 CBD	7.70 C-F	7.90 CD	7.10 ABC	7.53 AB
13	204.63 G	186.57 BCD	7.60 DEF	7.87 CD	7.27 ABC	7.23 C
14	194.07 G	227.13 AB	7.63 DEF	8.50 BC	7.90 A	7.83 AB
15	142.83 H	147.63 ED	6.43 G	6.67 F	6.60 C	6.47 D
$L.S.D_{.0.05}$	26.64	54.68	0.65	0.84	0.85	0.71

The values followed by the same letter do not differ at 5% level of significance.

(34.91 kg) in 2012. The other genotypes gave result in between. The data of this study were in line with those of Singh [20] who reported that, under Tripura condition the fruit yield in lucknow 49 ranged from (101.9-44.80 q/ha) in bar of khana during the period from 1988 to 1993. Also, El-Sharkawy and Othman [17] reported that, the yield of 5 guava strains ranged between (46-137.7 kg) and from (50.8-158.2 kg/tree) in both seasons of his study. Patil [21] suggested that, the genetic makeup of the plant plays a vital role in the productivity of the plant, the yield is known to be a polygenic character besides care and management of orchard, age of plant and season are the important factors influencing the yield.

Fruit Characteristics:

Physical Characteristics:

Fruit Weight (g): The data in Table 7 and Fig. 2 indicated that, the maximum fruit weight was associated with genotypes No. 10 (277.37, 245.10g) in both seasons and genotypes No. 2, 5, 6, 11 & 14 (253.23, 252.23, 233.20, 240.27, 227.13g) in the second season. The minimum weight was in genotype No. 15 (142.83 g) in 2011 and genotype No. 7 (125.17 g) in 2012. The other guava genotypes recorded values in between in this respect. El-Sharkawy and Othman [17] reported that, the fruit weight ranged between (180.7-83.4 g) and Gerhardt *et al*. [14] stated that, the greatest mean fruit weight was (77.29 g) when they studied three genotypes of guava. Also, Babu *et al.* [19] studied the performance of eight years old guava selection under Megholaya condition and they concluded that, the fruit weight ranged from (144.2-90 g). While, Pandey *et al.*[16] found that, the fruit weight varied from (275-130g). Also, Patel *et al.* [13] reported that, the highest fruit weight was recorded in cultivar R.C.G.H4 (184.9 g), where the lowest fruit weight was found in sangam (92.48g).

Fruit Length (cm): The data in Table 7 and Fig. 2 showed that, the fruit length was significantly the highest in guava genotype No. 10 (9.77, 9.6 cm) in both seasons and genotypes No. 5&11 (9.06-8.8 cm) in 2012. While, genotype No. 15 (6.43-6.67 cm) gave the lowest values in both seasons of study, respectively. The data of this study were in agreement with those obtained by Gonzalez and Sourd [22] who reported that, there were significant differences between cultivars of guava in fruit dimensions, Azad *et al.* [23] and Yousef [24]. On the other hand Babu *et al*.[19] and Abou El-Khashab *et al.*[12] found that, the fruit length ranged between (8.3-5.9) and from (62.8-50.1), respectively.

Fruit Width (cm): It can be noticed from Table 7 and Fig. 2, most of studied guava genotypes gave significantly the same results with differences in genotypes No. 4&15 (6.63-6.60 cm) in the first season and genotypes No. 4,7,13&15 (6.53-6.2-7.23-6.47 cm) in the second season. The results of this study are in line with those obtained by Ram *et al.* [25], Babu *et al*. [19], Marak and Mukunda [26], Abou El-Khashab *et al.* [12] and Patel *et al.* [13].

Table 8: Fruit firmness (kg/cm), pulp thickness (cm), weight of 100 seeds (g) and seeds (%) of some guava genotypes during 2011 and 2012 seasons.

	Fruit firmness (kg/ cm)		Pulp thickness (cm)		Weight of 100 seeds (g)		Seeds (%)	
Guava genotype	2011	2012	2011	2012	2011	2012	2011	2012
1	2.03 E	5.27 C	1.77 C	1.97 A-D	1.80	1.90	2. 60 C	2.93 B
2	5.07 AB	9.03 A	2.00 ABC	1.90 A-E	1.60	1.55	1.29 F	1.12 E
3	2.83 CDE	2.67 G	1.83 C	1.57 EF	1.70	1.60	1.66 DEF	1.66 CDF
4	4.10 ABC	7.83 B	1.93 BC	1.93 A-D	2.60	1.90	1.76 DE	1.950 CD
5	3.70 BCD	4.13 ED	2.07 ABC	2.00 ABC	1.50	1.70	1.71 DE	1.45 DE
6	4.47 AB	7.37 B	2.07 ABC	2.033 AB	0.50	0.59	1.97 D	2.15 C
7	2.67 CBE	3.00 FG	1.13 D	1.10 G	1.10	1.00	1.95 D	4.022 A
8	4.13 ABC	4.17 ED	2.00 ABC	1.83 B-E	1.40	1.50	2.69 BC	3.132 B
9	1.43 E	1.63 H	2.30 AB	1.90 A-E	1.20	1.32	1.39 EF	2.02 CD
10	3.63 BCD	3.67 EF	2.03 ABC	2.07 AB	1.10	1.40	1.52 EF	1.72 CDF
11	2.80 CDE	3.67 EF	2.37 A	2.23 A	1.30	1.36	1.67 DE	1.60 CDE
12	3.77 BCD	4.47 CED	1.90 C	1.67 CDE	1.60	1.48	3.47 A	3.09 B
13	4.50 AB	4.67 CD	2.00 ABC	1.93 A-D	1.50	1.60	1.75 DE	1.81 CD
14	5.57 A	4.5 CED	1.77 C	1.63 DE	1.60	1.60	2.99 B	2.12 C
15	2.27 ED	4.27 ED	1.37 D	1.27 FG	1.60	1.70	3.48 A	3.36 B
$L.S.D_{0.05}$	1.54	0.95	0.37	0.36	-	-	0.38	0.60

The values followed by the same letter do not differ at 5% level of significance

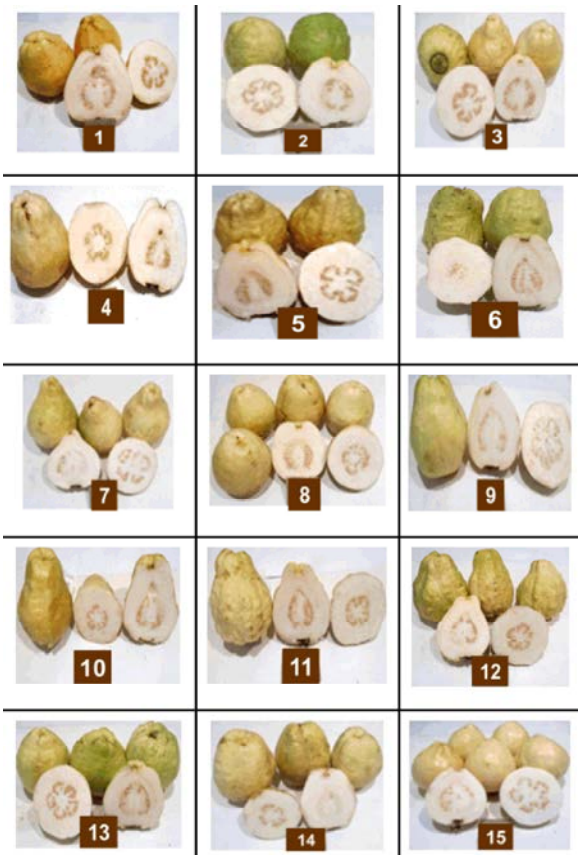

Fig. 2: Cross section views of 15 guava genotypes.

Fruit Firmness: Data in Table 8 and Fig. 2, there were significant differences between guava genotypes in 2011 and 2012 seasons. The highest firmness was associated with genotype No. 14 in 2011 and genotype No. 2 in 2012. Genotype No. 9 gave the lowest value of firmness in both seasons of study. The other genotypes gave results in between in this respect. These results were previously mentioned by Yousef [24] on some guava varieties, he found that the firmness readings ranged from (8-10 kg/cm^2).The firmness value gave base line for using guava fruits for local marketing, transport or storage.

Fruit Pulp Thickness (cm): As shown in Table 8 and Fig. 2, the fruit pulp thickness, guava genotypes No. 11(2.37, 2.23 cm) gave the highest fruit pulp thickness in 2011 & 2012 seasons, respectively. Genotype No. 7 (1.13&1.10) in both seasons, respectively gave the lowest values. The other genotypes recorded values in between. Similar results were partially obtained by Yousef [24], El-Sisy [27] and Abuo El Khashab *et al*. [12].

Weight of 100 Seeds (g): It can be noticed in Table 8 that, the genotype No. 6 had the minimum seed weight (0.5, 0.59g), while genotype No. 4 gave the maximum weight (2.6,1.9 g) in 2011 and 2012 seasons, respectively. The other genotypes gave results in between. This study was enclosed conformity with the finding of Petal *et al.* [13] who found that, the minimum weight of 100 seeds was (0.96 g).

Seeds (%): The highest values of seeds (%) (Table 8) were obtained with genotypes No. 12 & 15 (3.469, 3.477%) in the first season and in genotype No. 7 (4.023%) the second season. The lowest values in both seasons of

Table 9a: Total soluble solids (%) and vitamin C (mg/ 100 ml juice) of some guava genotypes during 2011 and 2012 seasons.

Guava genotype	Total soluble solids (%)		Vitamin C (mg/100ml juice)	
	2011	2011	2011	2012
1	12.93 B	12.93 B	87.31 HI	76.84 GF
2	12.60 BC	12.60 BC	97.01 A	87.09A
3	11.86 CED	11.86CED	97.16 A	87.04 A
4	12.03 CBD	12.03 CBD	88.11 GFH	79.89 ED
5	13.90 A	13.90 A	95.21 AB	87.54 A
6	14.07 A	14.07 A	91.49 CDE	82.46BCD
7	12.53 CB	12.53 CB	90.43 EF	81.20 DE
8	10.87 FG	10.87 FG	93.77 BC	82.39 CD
9	12.37 CBD	12.37 CBD	94.14 B	84.98 AB
10	11.50 DEF	11.50 DEF	89.69 EFG	80.50 ED
11	9.37 H	9.37 H	91.12 DE	81.50 CDE
12	10.77 FG	10.77 FG	89.44 E-H	78.96 EF
13	10.07 GH	10.07 GH	92.89 BCD	84.03 BC
14	12.23 CBD	12.23 CBD	85.03 I	75.1 G
15	11.07 EF	11.07 EF	88.11 GH	79.68 E
$LSD_{0.05}$	0.90	0.90	2.32	2.57

The values followed by the same letter do not differ at 5% level of significance.

Table 9b: Acidity (%) and total sugars (%) of some guava genotypes during 2011 and 2012 seasons.

Guava genotype	Acidity (%)		Total Sugars (%)	
	2011	2012	2011	2012
1	0.61 D	0.17 EFG	11.41B-E	10.68 B-E
2	0.52 E	0.58 C	10.99 B-E	10.91G
3	0.66 CD	0.15 FG	10.40B-E	11.57 BCD
4	0.71 BC	0.22 E	12.43 A	10.99 B-F
5	0.55 E	0.12 G	11.77 BC	10.03 B-G
6	0.74 AB	1.41 A	11.62 BC	10.42 B-F
7	0.65 D	0.21 EF	12.93 AB	12.19 A
8	0.66 CD	0.20 EF	13.11A	11.71 BC
9	0.63 D	0.92 B	12.64 AB	11.89 B
10	0.63 D	0.35 D	11.48 B	11.65 BC
11	0.65 D	0.17 EFG	11.30 CD	11.29 BCD
12	0.72 B	0.16 EFG	10.39 C-G	11.60 BC
13	0.79A	0.15 FG	9.96 IG	9.49 H
14	0.75 AB	0.17 EFG	10.79 C-F	10.314 B-F
15	0.79 A	0.18 EFG	11.85 BC	11.09 B-F
$L.S.D_{0.05}$	0.05	0.07	0.46	0.47

- The values followed by the same letter do not differ at 5% level of significance.

study were in genotype No. 2 (1.294, 1.121%), respectively. The other genotype gave results in between with descending observations. Similar results previously reported by El-Sharkawy and Othman [17] who found that, guava fruits varies in its content of number and weight of seeds. It can be conclude that with the decreasing in seeds (%), the fruit quality will increase.

Fruit Chemical Composition:

Fruit TSS (%): From Table 9a and Fig. 2, it can be noticed that TSS (%) in the studied guava fruits genotypes ranged from (14.07%) in genotypes No. 6 in both seasons to reach (9.4%) in genotype No. 11 in both seasons. The other guava genotypes records were in between. Such results are partially in harmony with those obtained by Abou El-Khashab *et al.*[12] and Patel *et al*. [13] Babu *et al.* [19], Wilson [28] and Yousef [29], who recorded that, the value of TSS (%) ranged between (11.88-9.35 %) when they studied 11 guava genotypes of five years old.

Vitamin C mg/100 ml Juice: Data in Table 9a, indicated that V.C in the fruits of genotypes under this study were in between (97 mg/100 ml in the 1st and 87 mg/100 ml in the 2nd season) for both genotypes No. 2 & 3 and (85, 75 mg/100 ml) in genotype No. 14 in 2011 and 2012, respectively. The other genotypes results were in between. These results are in line with those reported by Pozzo *et al.*[30], who found that, the ascorbic acid content of ten samples of guava fruits ranged from (69.98-74.76 mg/100 g) pulp. While Abuo El Khashab *et al.* [12] found that, the highest V.C content (384.0mg/100 g) when they studied 11 strains of winter guava. Patel *et al.* [13] reported that, the variety of RCG-1 was significantly higher ascorbic acid content (240mg/100g) when they studied 11 genotypes of guava.

Acidity (%): Data presented in Table 9b showed that, the highest acidity (%) for citric acid in juice of fruits were in genotypes No. 13&15 (0.793- 0.790) in the first season and in genotype No. 6 (1.408) in the second season. On the other hand, the rest genotypes gave the lowest values of acidity (%) in fruits. The data of this study about the lowest values were in line with those obtained by Abd-Alla and Salem [31] who reported that, the Egyptian guava pulp contained 3.51% acidity as citric acid on dry weight basis. On the other hand Patel *et al.* [32] found that, the acidity (%) ranged between (0.45-0.65%) and from (0.33-0.81%), respectively among guava varieties and hybrids studied under Meghalaya conditions.

Total Sugar content (%): The data presented in Table 9b showed that, the highest value of total sugar (%) were in guava genotypes No. 4 &8 in the first season and in genotype No. 7 in the second season as they recorded (12.43,13.11&12.19 %), respectively. The lowest value of total sugars (%) associated with guava genotypes No. 9 in both seasons of study (9.69, 9.49 %), respectively.

Table 10: N, P& K (%) contents in leaves of some guava genotypes in 2011 and 2012 seasons.

Guava genotype	N (%) of leaves		P (%) of leaves		K (%) of leaves	
	2011	2012	2011	2012	2011	2012
1	1.50 F	1.46 C	0.29 A-D	0.31 A	1.15 EF	1.26 G
2	2.09 A-D	1.19 E	0.31 A-D	0.26 B	1.17 EF	1.33 FG
3	1.96 B-E	1.45 CD	0.26 C-F	0.22 EFG	2.05 A	1.82 AB
4	1.80 C-F	1.28 ED	0.27 B-F	0.26 B	1.99 AB	1.85 A
5	1.81 C-F	1.27 E	0.27 B-F	0.21 FG	1.85 BC	1.80 AB
6	1.66 EF	1.70 B	0.34 A	0.25 BC	1.85 BC	1.64 CD
7	1.73 DEF	1.92 A	0.29 A-D	0.22 EFG	1.57 D	1.41 EF
8	2.25 AB	1.60 BC	0.28 B-E	0.25 BCD	1.73 C	1.72 BC
9	1.87 C-F	1.99 A	0.32 AB	0.29 A	1.76 C	1.65 CD
10	2.05 A-D	1.56BC	0.31 ABC	0.26 B	1.56 D	1.59 D
11	2.34 A	2.01 A	0.22 F	0.23 C-F	0.96 G	1.04 H
12	1.86 C-F	1.45 C	0.32 AB	0.22 D-G	1.20 E	1.29 G
13	2.23 AB	1.55 BC	0.29 BCD	0.22 EFG	2.07 A	1.81 AB
14	2.15 ABC	1.55 BC	0.23 EF	0.20 G	1.53 D	1.45 E
15	2.11 ABC	2.05 A	0.26 EDF	0.24 B-E	1.03 FG	1.27 G
$L.S.D_{0.05}$	0.37	0.18	0.05	0.03	0.15	0.10

- The values followed by the same letter do not differ at 5% level of significance.

The other genotype gave results in between. These results are in agreement with those obtained by El-Bulk *et al.* [33], who analyzed four guava cultivars and found that, the total sugar content were ranged from (13.7-30.6 %). Pandey *et al.*[16] reported that, the higher content of total sugar was (9.32 %) while lower (6.67%). Moreover, total sugar varied between 8.77% and 4.20% in an evaluation study conducted under Meghalaya conditions Patel *et al.*[32]. However, Abuo El- Khashab [12] reported that, the total sugar content ranged between (1.486-0.516%) when they evaluated 11 strains of winter guava.

Leaf Chemical Content:

Leaf Nitrogen Content: Data in Table 10 showed that, there were significant differences between 15 genotypes, the highest leaf N content were in guava genotypes No. 11,13,14,15,10,8&2 with values ranged from (2.343-2.093 %) in the first season and genotypes No. 15, 11, 9, 7 & 6 with values ranged between (2.047-1.697%) in the second season. The lowest values of leaf nitrogen content were in genotypes No 1& 6 in 2011 and in genotypes No. 2&5 in 2012 with values (1.503, 1.657 %) and (1.193, 1.267%), respectively. Koen and Hobbs [34] indicated that, the optimum leaf nitrogen concentration in guava leaves are within the ranges (1.25-1.40 %). This means that, the data of this study gave good results of guava genotypes in these orchards, which are healthy and consequently give a good yield.

Leaf Phosphorus Content: Leaf phosphorous content in the 15 guava studied genotypes (Table 10) varied from 0.343% in (No. 6) to 0.220% in (No. 11) in the first season and 0.307% in (No. 1) to 0.203% in (No. 14) in the second season. The other genotypes showed intermediate values. These results are in harmony of those obtained by Koen and Hobbs [34], who found that, the optimum leaf P concentration in guava leaves ranged from (0.11- 0.75%).

Leaf Potassium Content: The records of K content in leaves of genotypes under study (Table 10) were from 2.07% in (No 13) to reach 0.96 % in (No. 11) in 2011 and from 1.04% in (No. 11) to reach 1.85 % in (No. 4) in 2012. The other guava genotypes gave results in between in both seasons of study. These results are in line with those reported by Koen and Hobbs [34], who found that, the optimum leaf potassium are ranged from (1.15-1.50 %).

CONCLUSION

In the present study, it can be concluded that the physic-chemical characteristics of fruits were differed due to the variation of climatic conditions of Alexandria Governorate as compared to the other zones in the country. It can be recommended that, the guava genotypes included high fruit quality such as fruit size, total sugars (%), high V.C. high pulp thickness and low acidity (%). Also, the genotypes with high characteristics of vegetative growth, fruiting and the highest fruit set (%) can be chosen for development programs and propagation of the genotypes vegetative.

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