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Squash Germplasm Evaluation for some Vegetative Growth, Flowering and Yield Characters

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ABSTRACT

Twenty-two imported genotypes of summer squash (*Cucurbita pepo* L.) were evaluated and compared with cv. Eskandarani for some vegetative growth, flowering and yield characters during the 2014 and 2015 summer seasons under open field conditions at Agricultural Experiment Station, Faculty of Agriculture, Cairo University. Significant differences were found among evaluated genotypes in all studied characters, except fruit bitterness. The highest significant values were found in PEP 1672 (Early Sugar) for plant length, number of branches/plant and number of nodes to the first female flower; in PEP 1692 (White Bush Scallop) for fruit diameter, flesh thickness and flesh thickness/fruit diameter; in PEP 317 (Black Beauty) for fruit length and fruit shape index; in PEP 238 (Zucchini), PEP 263 (Zucchini Black),PEP 317 (Black Beauty), PEP 530 (Zucchini), PEP 1635 (Kürbis, Garten), PEP 1636 (Sakiz Kabak) and PEP 1688(Long White Bush) for average fruit weight; and in PEP 317 (Black Beauty) and PEP 1661 (Aust. Green) for yield.

Keywords: Summer squash, *Cucurbita pepo*, evaluation, fruit quality.

Introduction

Egypt is one of the major summer squash producing countries. According to FAO stat (2010), Egypt ranked as the eighth largest producing country in the world for pumpkins, squash and gourds. Egypt's production of summer squash in 2012 was 310,058 tons, area cultivated was 39,783 feddans, and average production was 7.79 tons / feddan in summer season, while Egypt's production in fall season was 48816 tons, area cultivated was 7730 feddans, and average production was 6.31 tons/feddan (Agriculture Directorates of Governorates, Ministry of Agriculture and Land Reclamation, Egypt, 2013).

Summer squash is the edible immature fruits of *Cucurbita pepo* L., which belongs to the economically important family *Cucurbitaceae*. It is a short-season crop adapted to tropical and subtropical regions. Some *C. moschata* Duchesne varieties are grown for their edible immature fruits. Some *C. maxima* Duchesne varieties are grown for this purpose in South America. Summer squash fruits are harvested when they are shiny. Preferred size ranges from 100 to 200 g, which is usually harvested two and five days past anthesis, depending on growing conditions. If the fruits are not harvested on time, they continue to grow and begin to lose their shininess. Oversize fruits are generally unsaleable (Whitaker and Robinson, 1986; Paris, 1996 and 2008).

Cucurbita pepo is native to North America and can be found growing wild in northeastern Mexico and southern, southeastern, and central USA. As yet undiscovered wild populations might still exist in central or southern Mexico and the wild range might have extended to what is now the northeastern USA (Paris, 2008).

Fruit shape can vary from round to disc shaped to very long. The fruits can be smooth or warted, with or without longitudinal ribs, longitudinal grooves , furrows, or wavy lobes. Exterior color can be green, orange, or yellow, but range in shading and intensity from almost black to almost white and can appear in patterns of longitudinal striping, which can be broad and contiguous, narrow and noncontiguous, irregular, and/or in latitudinal bicolour patterns, all superimposed on barely discernable to obvious light-colored speckling. The color of the mature fruit flesh is most often light yellow-orange, but can range from greenish white to intense orange; it can be relatively thick or thin, and coarsely fibrous and tough to finely fibrous and tender (Paris, 2008).

Eight cultivar groups of summer squash were designated, viz., scallop, crookneck, straightneck, vegetable marrow, cocozelle, zucchini, acorn, and pumpkin. In the scallop group fruit shape is flattened, with scalloped margins. The crookneck group fruit shape is long, peduncular half with narrow, slightly to very curved neck, and a broad stylar half, convex at stylar end. The straightneck group fruit shape is cylindrical with short neck or constriction near the peduncle with broad stylar half. The vegetable marrow group fruit shape is short with length-to-broadest width ratio of 1.5-3.0, tapered cylindrical, narrow at peduncle end, and broad at stylar end. The cocozelle group fruit shape is long to extremely long with length-to-broadest width ratio at least 3.5,

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cylindrical but bulbous at stylar end. The zucchini group fruit shape is uniformly cylindrical, length-to-width ratio 3.5-4.5. the acorn group fruit shape is turbinate, broad at peduncle end, convex at stylar end, and furrowed; while pumpkin group fruit shape is round to spherical, globular, oblate, ovate or obovate (Paris, 1986; 2000 and 2008).

Kasrawi (1995) evaluated forty-one landraces of summer squash for some vegetative, flowering and yield characters. Significant differences for these traits were found among the evaluated landraces.

Mohamed *et al.* (2003) developed five pedigree-inbred lines of zucchini squash (*C. pepo*) from the open pollinated population of cv. Eskandrani. The pedigree selection focused on the enhanced formation of female flowers under adverse climatic conditions of late summer planting in Assiut. Results showed that while a pronounced elevated sex ratio was expressed, the number of leaves / plant, main stem length and number of nodes below the first female flower were reduced compared with the original cultivar. All developed lines greatly surpassed cv. Eskandrani in total fruit yield. Line 12-127-219 gave the highest total yield in both summer and winter seasons. Line 18-136-222 was comparable to line 12-127-219 only when grown in summer. However, line 18-136-222 gave significantly larger portion of total fruit yield that was harvested early than line 12-127-219 and cv. Eskandrani in both seasons.

Al-jebory (2006) evaluated eight genotypes of summer squash and some of their hybrids for some vegetative and yield characters. Significant differences for these traits were found among the evaluated genotypes.

Al-Kummer *et al.* (2009) evaluated six summer squash varieties viz., Local, Middle East, Syrian, Zucchini, Tala, and Bather Elbethor during spring and autumn seasons to estimate the genetic and aspectual variability to the yield and its components. Results indicated high variability between varieties for all studied characters, and variety Tala was highly superior for yield, fruit number / plant, and fruit length and weight. There was a high genetic variation for fruit weight and plant length. There were a high positive and significant correlation coefficients between yield and fruit weight, fruit diameter, number of fruits / plant and sex expression ratio.

Ghobary and Ibrahim (2010) used the inbreeding with selection for three generations to improve summer squash cv. Eskandarani. The estimation of the variability in the original population (P0) and the selected population of third generation (P3) in the studied traits indicated that coefficient of variation decreased from P0 to P3 for all studied traits. Number of days to first female flower decreased by 15.4 % in the P3 population. Average fruit weight, total and marketable number of fruits per plant, and total and marketable fruit yield per plant were increased in the P3 population by 13.4, 35.0, 38.2, 56.3 and 50 %, respectively. Correlation coefficient values (r) for 9 pairs of traits were also estimated. Ovary length at anthesis was positively and significantly correlated with both number of days to first female flower and average fruit weight. Negative correlations were evident between total marketable fruit weight per plant and both number of days to first female flower and ovary length at anthesis. Fruit diameter appeared to be negatively correlated with total number of fruits per plant.

Marie *et al.* (2011) evaluated nine inbreed lines of squash for morphological and yield characters to identify the best lines for use in the breeding program. Results showed genetic variation between the groups for some important economic characters, as the number of fruits per plant, percentage of female flowers, yield per plant, stem length, and number of nodes before the first female flower.

Rakha *et al.*(2012) evaluated ten strains from six *Cucurbita* interspecific hybrids obtained through anther and ovule *in vitro* cultures for some vegetative, flowering and yield characters. Significant differences for these traits were found among the evaluated landraces.

There are two local cultivars of summer squash in Egypt. They are Balady, which is inferior due to its prostrate growth habit and low yield, and Eskandarani, which is high yielding and preferred by both the producer and consumer (Hassan, 2001; El-Adl *et al.,* 2012).

In this study, Eskandarani was used as control to evaluate some imported genotypes of summer squash for some vegetative growth, flowering and yield characters.

Materials and Methods

This study was carried out during the period from 2013 to 2015 at the Agricultural Experiment Station of the Faculty of Agriculture, University of Cairo, Giza, Egypt.

Twenty-two imported genotypes of summer squash (*Cucurbita pepo)* were evaluated and compared with cv. Eskandarani for some vegetative growth, flowering and yield characters during the 2014 and 2015 summer seasons under open field conditions.

Genotypes used in this study are presented in Table 1. Seeds of imported genotypes were kindly provided by IPK-Gatersleben gene bank, Germany. Cv. Eskandarani seeds were obtained from local sources.

Nursery seed sowing was done during the first half of February in both 2014 and 2015 in speedling trays filled with 1:1 mixture of peatmoss and vermiculate. This mixture was enriched with macro and micro elements. Five-weeks old seedlings were transplanted in the open field in a randomized complete block design with three

replicates. Each plot consisted of 1 bed 1.2 m wide and 5 m long. Plants were set 50 cm apart in the bed and were subjected to the common agricultural practices.

Characters measured

1. Vegetative and flowering characters

The following traits were measured: plant length, number of branches/plant, sex ratio (These traits were measured at the end of plant life), incisions of leaf blade, the white mottling on leaf and number of nodes to the first female flower. These traits were determined on at least 5 plants from each plot.

2. Fruit quality characters

The following traits were measured: fruit shape , fruit exterior color**,** fruit length, fruit diameter, fruit shape index, average fruit weight, flesh thickness, flesh thickness/ diameter, flesh color, and fruit bitterness. These traits were measured on at least 5 fruits from each plot three days after anthesis.

3. Yield

Yield was calculated per plot then transformed to ton / feddan (one fed. =4200 m^2).

Statistical analysis was done using Mstat Software.The means were separated using Duncan's multiple range test at 0.05 level of probability (Gomez and Gomez, 1984).

Table 1: List of *Cucurbita pepo* accessions evaluated

Accession number	Accession name	Country of origin
PEP 11	Early Summer Crockneck	USA
PEP 17	Early Prolific Straightneck	Unknown
PEP 238	Zucchini	Italy
PEP 263	Zucchini Black	USA
PEP 281	Zucchina Verde	Italy
PEP 286	Zucchina Precoce	Italy
PEP 317	Black Beauty	Germany
PEP 529	Zucchini	Italy
PEP 530	Zucchini	Italy
PEP 610	Vegetable Marrow	Sweden
PEP 1635	Kürbis, Garten-	Turkey
PEP 1636	Sakiz Kabak	Turkey
PEP 1641	Black Zucchini	Unknown
PEP 1642	Fordhook Zucchini Improved	USA
PEP 1651	Kürbis, Garten-	Israel
PEP 1661	Aust. Green	Unknown
PEP 1672	Early Sugar	Unknown
PEP 1684	Cocozelle Green Bush	Unknown
PEP 1687	Long Green Bush	Unknown
PEP 1688	Long White Bush	Unknown
PEP 1692	White Bush Scallop (Early)	Unknown
PEP 1763	Royal Acorn Large	USA
-	Eskandarani	Egypt

Results and Discussion

Summer squash germplasm evaluated showed significant variation among the evaluated accessions in all studied characters, except fruit bitterness.

1. Evaluation for vegetative and flowering characters

Data obtained on plant length and number of branches/plant for summer squash genotypes evaluated in 2014 and 2015 summer plantings are presented in Table 2. Combined analysis of both seasons showed significant differences for these traits among the evaluated genotypes.

Plant length values for the evaluated genotypes ranged from 61.3 to 508.6 cm. The largest significant plant length was found for accession PEP 1672, meanwhile, accessions PEP 11, PEP17, PEP 263, PEP 281, PEP 317, PEP 1684, and cv. Eskandarani had the least plant length without significant differences among them. Number of branches/plant values for the evaluated genotypes ranged from zero to 5.8. The highest significant number of branches/plant was found in accession PEP 1672. Meanwhile accessions PEP 11, PEP17 and cv. Eskandarani had no branches. In former studies significant differences for these traits were found among the evaluated genotypes of summer squash (Al-jebory, 2006; Al-Kummer *et al.*, 2009; Ghobary and Ibrahim, 2010; Kasrawi, 1995; Marie *et al.*, 2011; Mohamed *et al.*, 2006; Rakha *et al.*, 2012).

Data obtained on sex ratio and number of nodes to the first female flower for genotypes evaluated in 2014 and 2015 summer plantings are presented in Table 3. Combined analysis of both seasons showed significant differences for these traits among the evaluated genotypes.

Number of nodes to the first female flower values ranged from 7.1 to 40.1. The least significant number of nodes to the first female flower was found in accessions PEP 11 and PEP17 without significant differences among them. Sex ratio values for the evaluated genotypes ranged from 0.071 to 0.504. The highest significant sex ratio was found in accessions PEP 11, PEP17, PEP238, PEP 263, PEP 281, PEP286, PEP317, PEP 530, PEP1635, PEP 1636, PEP 1641, PEP 1642, PEP 1661, PEP 1684, PEP 1692 and cv. Eskandarani without significant differences among them, while PEP1672 had the least significant sex ratio. In former studies significant differences in these traits were found among the evaluated genotypes (Al-Kummer *et al.*, 2009; Al-jebory, 2006; Rakha *et al.*, 2012; Mohamed *et al.*, 2006).

Table 2: Mean plant length and number of branches/plant for summer squash genotypes evaluated in the 2014 and 2015 summer seasons[z].

Accession	Plant length(cm)			Number of branches/plant		
	2014	2015	Combined	2014	2015	Combined
PEP 11	66.7 j	61.7 jk	64.2 ij	0.0 h	0.0 c	0.0 i
PEP 17	61.2 j	61.3 jk	61.3 ij	0.0 h	0.0 c	0.0 i
PEP 238	188.4 d-f	201.1 e	194.8 d	1.0 fh	0.3 bc	0.7 g-i
PEP 263	64.9 j	60.6 jk	62.8 ij	0.6 gh	0.2 c	0.4 g-i
PEP 281	71.9 j	72.6 jk	72.3 h-j	2.9 c-e	1.6 bc	2.2 c-f
PEP 286	192.3 d-f	193.0 e	192.7 d	2.4 c-f	1.1bc	1.8 d-g
PEP 317	61.0 j	52.8 k	56.9 j	0.9 f-h	0.2 c	0.6 g-i
PEP 529	320.0 b	345.5 b	332.8 b	4.7 ab	2.6 bc	3.6 bc
PEP 530	163.9 e-g	150.8 f	157.3 e	2.3 c-f	0.9 bc	1.6 e-h
PEP 610	255.8 c	246.1 cd	250.9 c	3.3 b-d	2.2 bc	2.8 b-e
PEP 1635	162.2 e-g	147.4 f	154.8 e	3.6 bc	1.7 bc	2.6 c-e
PEP 1636	138.7 gh	136.2 fg	137.4 ef	0.6 gh	0.2 c	0.4 g-i
PEP 1641	201.3 de	191.7 e	196.5 d	2.0 c-g	0.7 bc	1.3 e-i
PEP 1642	99.7 h-j	98.5 g-j	99.1 gh	2.0 c-g	1.1 bc	1.6 e-i
PEP 1651	215.0 d	209.8 de	212.4 d	1.9 d-g	1.4 bc	1.7 e-g
PEP 1661	125.6 g-i	117.8 f-i	121.7 fg	0.1 h	0.0 c	0.1 hi
PEP 1672	521.9 a	495.3 a	508.6 a	5.3 a	6.3 a	5.8 a
PEP 1684	76.6 j	74.6 jk	75.6 h-j	1.3 e-h	0.4 bc	0.9 f-i
PEP 1687	154.7 fg	141.0 f	147.8 ef	2.1 c-g	0.6 bc	1.3 e-i
PEP 1688	141.4 g	129.1 f-h	135.3 ef	4.6 ab	1.8 bc	3.2 b-d
PEP 1692	90.2 ij	88.9 h-k	89.6 hi	0.6 gh	0.3 bc	0.4 g-i
PEP 1763	275.9 c	266.8 c	271.3 c	5.2 a	3.0 b	4.1 b
Eskandarani	84.0 j	82.4 i-k	83.2 h-j	0.0 h	0.0 c	0.0 i

[z]Values followed by a letter in common, in each column, are not significantly different according to Duncan's multiple range test at P= 0.05.

Table 3: Mean sex ratio and number of nodes to the first female flower for summer squash genotypes evaluated in the 2014 and 2015 summer seasons[z].

Accession	Number of nodes to the first female flower			Sex ratio		
	2014	2015	Combined	2014	2015	Combined
PEP 11	8.13 h	7.10 h	7.62 j	0.510 a	0.498 a	0.504 a
PEP 17	6.87 h	7.33 h	7.10 j	0.487 a	0.479 a	0.483 ab
PEP 238	22.00 d	21.57de	21.78 e	0.327 b	0.309 bc	0.318 a-d
PEP 263	13.10 g	13.43 g	13.27 i	0.312 bc	0.318 b	0.315 a-d
PEP 281	18.10 ef	19.03 de	18.57 f-h	0.195 de	0.204 d-f	0.199 a-d
PEP 286	21.23 d-e	21.90de	21.57 e	0.170 d-g	0.179 d-g	0.174 a-d
PEP 317	15.87 fg	16.77 fg	16.32 h	0.226 cd	0.236 cd	0.231 a-d
PEP 529	29.57 bc	29.60 bc	29.58 c	0.097 e-g	0.118 f-i	0.108 cd
PEP 530	20.87 de	20.00 de	20.43 ef	0.133 d-g	0.144 e-i	0.139 a-d
PEP 610	28.57 bc	29.77 bc	29.17 cd	0.093 e-g	0.107 g-i	0.100 cd
PEP 1635	18.77 d-f	19.57 de	19.17 fg	0.151 d-g	0.163 d-i	0.157 a-d
PEP 1636	18.03 ef	16.67 fg	17.35 gh	0.215 d	0.228 de	0.222 a-d
PEP 1641	19.23 d-f	18.57 de	18.90 fg	0.161 d-g	0.172 d-h	0.166 a-d
PEP 1642	18.80 d-f	19.13 de	18.97 fg	0.177 d-f	0.187 d-g	0.182 a-d
PEP 1651	26.90 c	27.33 c	27.12 d	0.104 e-g	0.116 g-i	0.110 cd
PEP 1661	19.47 d-f	18.10 ef	18.78 f-h	0.158 d-g	0.175 d-h	0.166 a-d
PEP 1672	40.43 a	39.67 a	40.05 a	0.063 g	0.079 i	0.071 d
PEP 1684	18.87 d-f	19.53 de	19.20 fg	0.152 d-g	0.170 d-h	0.161 a-d
PEP 1687	21.33 de	22.20 de	21.77 e	0.119 d-g	0.133 f-i	0.126 b-d
PEP 1688	26.53 c	27.57 c	27.05 d	0.101 e-g	0.114 g-i	0.108 cd
PEP 1692	16.67 f	17.47 f	17.07 gh	0.456 a	0.452 a	0.454 a-c
PEP 1763	31.90 b	33.00 b	32.45 b	0.071 fg	0.090 hi	0.081 cd
Eskandarani	16.77 f	17.23 f	17.00 gh	0.318 bc	0.320 b	0.319 a-d

[z]Values followed by a letter in common, in each column, are not significantly different according to Duncan's multiple range test at P= 0.05.

Data obtained on incisions of leaf blade for summer squash genotypes evaluated in 2014 and 2015 summer plantings are presented in Table 4. Differences were detected in incisions of leaf blade among evaluated

genotypes. White mottling of leaves was absent in all genotypes, except accessions PEP 610 and PEP 1661 which had faint and medium white mottling, respectively. Kasrawi (1995) evaluated 41 summer squash landraces for incisions of leaf blade and white mottling on leaf and found significant differences among the evaluated genotypes in these traits.

2. Evaluation for fruit quality characters

Data obtained on fruit shape, fruit color and protrusion of fruit ribs for genotypes evaluated in 2014 and 2015 summer plantings are presented in Table 4. In both seasons, there was obvious differences for these traits among the evaluated genotypes. *C. pepo* (squash, pumpkins and gourds) is highly polymorphic with respect to fruit size, shape, and color (Paris, 2008). In former studies significant differences in these traits were found among the evaluated genotypes for summer squash (Kasrawi, 1995; Rakha *et al.*, 2012).

Data obtained on fruit length, fruit diameter and fruit shape index for genotypes evaluated in 2014 and 2015 summer plantings are presented in Table 5. Combined analysis of both seasons showed significant differences in these traits among the evaluated genotypes.

Table 4: Mean incisions of leaf blade, fruit shape, fruit color and protusion of fruit ribs for summer squash genotypes evaluated in the 2014 and 2015 summer seasons.

Accession	Incisions of leaf blade	Fruit shape	Fruit color	Protrusion of fruit ribs
PEP 11	Medium	Crock neck shaped	Yellow	Strong
PEP 17	Deep	Straight neck shaped	Yellow	Absent
PEP 238	Very deep	Cylindrical	Molted green	Strong
PEP 263	Deep	Cylindrical	Light green	Strong
PEP 281	Very deep	Cylindrical	Striped green	Absent
PEP 286	Deep	Pear shaped	Striped green	Strong
PEP 317	Medium	Cylindrical	Molted green	Absent
PEP 529	Medium	Cylindrical	Light green	Strong
PEP 530	Medium	Cylindrical	Molted light green	Strong
PEP 610	Very deep	Cylindrical	Light green	Absent
PEP 1635	Shallow	Cylindrical	Light green	Strong
PEP 1636	Medium	Cylindrical	Light green	Absent
PEP 1641	Medium	Cylindrical	Molted green	Medium
PEP 1642	Very	Cylindrical	Molted green	Strong
PEP 1651	Deep	Cylindrical	Light green	Strong
PEP 1661	Very deep	Cylindrical	Striped green	Strong
PEP 1672	Medium	Globular	Green	Strong
PEP 1684	Very deep	Cylindrical	Striped green	Medium
PEP 1687	Deep	Cylindrical	Molted green	Strong
PEP 1688	Very deep	Cylindrical	Light green	Strong
PEP 1692	Medium	Disc shaped	Light green	Strong
PEP 1763	Medium	Heart shaped	Green	Strong
Eskandarani	Deep	Cylindrical	Light green	Strong

Table 5. Mean of fruit length, fruit diameter and fruit shape index in summer squash genotypes evaluated in the 2014 and 2015 summer seasons.[z]

Accession	Fruit length (cm)			Fruit diameter (cm)			Fruit shape index		
	2014	2015	Combined	2014	2015	Combined	2014	2015	Combined
PEP 11	4.83 jk	5.13 lm	4.98 k	2.28 m	2.33 ij	2.31 j	2.13 hi	2.22 h	2.18 gh
PEP 17	8.19 e-g	8.70 f-h	8.45 fg	2.37 lm	2.17 j	2.27 j	3.48 ef	4.06 c-g	3.77 de
PEP 238	5.82 ij	6.32 jk	6.07 j	3.23 ef	3.19 de	3.21 d	1.80 i	2.03 bc	1.91 hi
PEP 263	9.13 de	9.54 e-g	9.34 e	3.51 de	3.55 cd	3.53 c	2.61 g	2.70 c-e	2.66 f
PEP 281	11.40 b	11.72 bc	11.56 bc	2.52 j-m	2.58 g-j	2.55 h-j	4.52 bc	4.55 c-e	4.54 b
PEP 286	7.32 gh	7.66 hi	7.49 hi	3.01 f-h	3.07 ef	3.04 d-f	2.44 gh	2.51 g	2.47 fg
PEP 317	13.79 a	13.75 a	13.77a	2.73 g-l	2.78 e-i	2.76 f-h	5.08 a	4.99 c-f	5.04 a
PEP 529	4.99 jk	5.25 kl	5.12 k	2.97 f-i	3.00 e-g	2.98 d-f	1.68 i	1.76 b	1.72 i
PEP 530	7.85 fg	8.57 gh	8.21 gh	3.94 bc	3.62 c	3.78 c	2.01 hi	2.37 fg	2.19 gh
PEP 610	7.76 fg	7.96 hi	7.86 gh	2.89 f-j	2.93 e-g	2.91 e-g	2.70 g	2.76 e-g	2.73 f
PEP 1635	10.78 b	11.13 b-d	10.96 b-d	3.06 fg	2.90 e-h	2.98 d-f	3.55 ef	3.86 c-e	3.71 e
PEP 1636	10.80 b	11.48 bc	11.14 b-d	3.24 ef	3.07 ef	3.16 de	3.33 f	3.78 bc	3.56 e
PEP 1641	7.22 gh	7.74 hi	7.48 hi	3.71cd	3.79 c	3.75 c	1.97 hi	2.05 c-f	2.01 hi
PEP 1642	9.58 cd	9.84 ef	9.71 e	2.62 h-m	2.60 g-j	2.61 hi	3.65 ef	3.80 b-d	3.73 e
PEP 1651	8.86 d-f	9.38 e-g	9.12 ef	2.40 k-m	2.45 h-j	2.42 ij	3.67 ef	3.84 d-g	3.76 de
PEP 1661	10.69 bc	11.10 b-d	10.89 cd	2.69 g-l	2.63 f-i	2.66 g-i	3.97 de	4.23 c-f	4.10 cd
PEP 1672	4.32 kl	4.75 lm	4.54 kl	4.22 b	4.43 b	4.33 b	1.03 j	1.10 b	1.06 j
PEP 1684	11.66 b	11.27 bc	11.46 b-d	2.80 g-k	2.87 e-h	2.83 f-h	4.20 cd	4.00 c-f	4.10 cd
PEP 1687	9.36 de	9.98 de	9.67 e	2.59 i-m	2.61f-j	2.60 hi	3.61 ef	3.85 b-d	3.73 e
PEP 1688	10.67 bc	10.60 c-e	10.64 d	2.52 j-m	2.55 g-j	2.54 h-j	4.23 cd	4.17 bc	4.20 bc
PEP 1692	3.59 l	3.98 m	3.79 l	5.67 a	5.52 a	5.60 a	0.64 j	0.73 a	0.69 k
PEP 1763	6.54 hi	7.10 ij	6.82 ij	1.41 n	1.37 k	1.39 k	4.71 ab	5.36 i	5.04 a
Eskandarani	11.40 b	12.22 b	11.81 b	2.73 g-l	2.58 g-j	2.66 g-i	4.18 cd	4.77 c-e	4.48 b

[z]*Values followed by a letter in common, in each column, are not significantly different according to Duncan's multiple range test at P= 0.05.*

Fruit length values for the evaluated genotypes ranged from 3.79 to 13.77 cm. The largest significant fruit length was found for accession PEP 317, while PEP 1672and PEP 1692 had the least fruit length without significant differences among them. Fruit diameter values for the evaluated genotypes ranged from 1.39 to 5.60 cm. The largest significant fruit diameter was found in accession PEP 1692, while PEP 1763 had the least fruit diameter. Fruit shape index for the evaluated genotypes ranged from 0.69 to 5.04. The largest significant fruit shape index was found in accessions PEP317 and PEP 1763 without significant differences among them, while PEP 1692 had the least fruit shape index. In former studies significant differences in these traits were found among the evaluated genotypes (Al-jebory, 2006; Al-Kummer et *al.*, 2009; Ghobary, and Ibrahim, 2010; Marie *et al.*, 2011; Rakha *et al.*, 2012).

Data obtained on average fruit weight and yield for genotypes evaluated in 2014 and 2015 summer plantings are presented in Table 6. Combined analysis of both seasons showed significant differences in these traits among the evaluated genotypes.

Table 6: Mean of average fruit weight and yield of summer squash genotypes evaluated in the 2014 and 2015 summer seasons[z].

Accession	Average fruit weight (g)			Yield (ton / feddan)		
	2014	2015	Combined	2014	2015	Combined
PEP 11	15.54 hi	17.03 hi	16.28 k	0.32 jk	0.38 l-n	0.35 j
PEP 17	27.73 h	28.84 h	28.29 j	1.07 c-g	1.39 c-g	1.23 ef
PEP 238	68.16 ab	66.66 ab	67.41 a-d	1.28 b-f	1.44 c-g	1.36 e
PEP 263	74.87 ab	73.08 ab	73.97 ab	1.33 b-e	1.46 c-f	1.39 de
PEP 281	66.58 a-d	65.34 a-d	65.96 b-d	1.21 c-f	1.22 e-h	1.22 ef
PEP 286	42.99 g	43.07 g	43.03 hi	0.87 f-h	0.81 i-k	0.84 gh
PEP 317	73.25 ab	71.40 ab	72.33 a-c	1.93 a	1.97 ab	1.95 a
PEP 529	61.44 b-f	60.48 b-f	60.96 d-f	0.25 jk	0.30 mn	0.28 jk
PEP 530	74.98 ab	73.33 ab	74.15 ab	1.06 c-g	1.04 g-i	1.05 fg
PEP 610	51.58 e-g	51.39 e-g	51.49 gh	0.07 k	0.10 n	0.08 k
PEP 1635	76.4 ab	74.49 ab	75.44 ab	1.69 ab	1.62 b-e	1.65 b-d
PEP 1636	78.48 a	76.08 a	77.28 a	1.02 d-g	1.09 f-i	1.06 fg
PEP 1641	53.23 c-g	52.66 c-g	52.94 e-g	1.03 d-g	0.95 h-j	0.99 fg
PEP 1642	70.99 ab	69.25 ab	70.12 a-d	1.63 ab	1.71 a-c	1.67 bc
PEP 1651	64.34 a-e	63.43 a-e	63.89 cd	0.97 e-h	0.98 hi	0.98 fg
PEP 1661	52.27 d-g	51.61 d-g	51.94 f-h	1.69 ab	2.02 a	1.85 ab
PEP 1672	40.81g	41.41 g	41.11 i	0.42 i-k	0.58 j-m	0.50 ij
PEP 1684	66.96 a-c	65.74 a-c	66.35 b-d	1.44 b-d	1.28 d-h	1.36 e
PEP 1687	62.04 b-f	61.07 b-f	61.56 de	0.77 g-i	1.07 f-i	0.92 gh
PEP 1688	78.00 a	75.78 a	76.89 a	1.46 bc	1.43 c-g	1.45 c-e
PEP 1692	48.66 fg	48.60 fg	48.63 g-i	0.58 h-j	0.73 i-l	0.66 hi
PEP 1763	12.09 i	12.44 i	12.27 k	0.38 i-k	0.48 k-n	0.43 ij
Eskandarani	66.63 a-d	65.10 a-e	65.86 b-d	1.65 ab	1.67 a-d	1.66 b-d

[z]Values followed by a letter in common, in each column, are not significantly different according to Duncan's multiple range test at P= 0.05.

Average fruit weight values for the evaluated genotypes ranged from 12.27 to 77.28 g. The largest significant average fruit weight was found in accessions PEP 238, PEP 263, PEP 317, PEP530, PEP1635, PEP 1636, PEP1642, and PEP 1688 without significant differences among them, while accessions PEP 11 and PEP 1763 had the least average fruit weight without significant differences among them. Yield values for the evaluated genotypes ranged from 0.08 to 1.95 ton /feddan. The highest significant yield was found in accessions PEP 317 and PEP 1661 without significant differences among them, while PEP 529 and PEP 610 had the lowest yield without significant differences among them. In former studies significant differences in these traits were found among the evaluated genotypes of summer squash (Al-jebory, 2006; Al-Kummer *et al.*, 2009; Ghobary, and Ibrahim, 2010; Marie *et al.*, 2011; Mohamed *et al.*, 2003).

Data obtained on flesh thickness and flesh thickness/ diameter for summer squash genotypes evaluated in 2014 and 2015 summer plantings are presented in Table 7. Combined analysis of both seasons showed significant differences in these traits among the evaluated genotypes.

The largest significant flesh thickness was found in accession PEP 1692, while the least flesh thickness was found in accession in PEP 1763. The largest significant flesh thickness/diameter was found in accession PEP 1692, while the least flesh thickness/diameter was found in accessions in PEP 286, PEP 530, PEP 1641 and PEP 1672 without significant differences among them. Significant differences in these traits were previously found among 41 genotypes of summer squash (Kasrawi, 1995).

No differences were found among the evaluated accessions in fruit bitterness. All studied accessions had white flesh color except PEP 1672 which had yellow flesh. It belongs to the pumpkin group whose flesh turns to orange in the mature stage.

Considering yield, accessions PEP 317 (Black Beauty) and PEP 1661(Aust. Green) produced the highest significant yield, while accessions PEP 1635 (Kürbis, Garten) and PEP 1642 (Fordhook Zucchini Improved) and

cv. Eskandarani significantly ranked second (Table 6). The high yielding ability of PEP 317 was due to its high sex ratio and its high values of fruit length, average fruit weight and fruit shape index.

Table 7: Mean of flesh thickness and flesh thickness / fruit diameter for summer squash genotypes evaluated in 2014 and 2015 summer seasons[z].

Accession	Flesh thickness (cm)			Flesh thickness/ fruit diameter		
	2014	2015	Combined	2014	2015	Combined
PEP 11	0.353 ef	0.366 h	0.360 h	0.313 f-i	0.317 g-i	0.315 gh
PEP 17	0.453 b-f	0.511 c-g	0.483 c-f	0.380 b-d	0.473 a	0.427 b
PEP 238	0.543 b-d	0.566 bc	0.557 bc	0.340 d-i	0.360 e-g	0.350 fg
PEP 263	0.513 b-d	0.544 c-e	0.528 b-e	0.290 hi	0.310 g-i	0.300 hi
PEP 281	0.510 b-d	0.544 c-e	0.527 b-e	0.407 bc	0.423 a-d	0.415 b
PEP 286	0.343 f	0.455 g	0.400 gh	0.230 jk	0.300 hi	0.265 ij
PEP 317	0.433 b-f	0.533 c-f	0.482 c-f	0.317 e-i	0.390 c-f	0.353 d-g
PEP 529	0.553 bc	0.611 b	0.582 b	0.377 b-e	0.410 b-e	0.393 b-e
PEP 530	0.410 c-f	0.477 fg	0.445 fg	0.210 k	0.267 i	0.238 j
PEP 610	0.400 c-f	0.488 e-g	0.443 fg	0.280 ij	0.340 f-h	0.310 h
PEP 1635	0.510 b-d	0.544 c-e	0.527 b-e	0.337 d-i	0.380 d-f	0.358 d-f
PEP 1636	0.567 b	0.566 bc	0.567 b	0.350 c-h	0.377 d-f	0.363 c-f
PEP 1641	0.400 c-f	0.522 c-f	0.460 e-g	0.217 k	0.280 i	0.248 j
PEP 1642	0.490 b-f	0.555 b-d	0.523 b-e	0.373 b-f	0.430 a-d	0.402 bc
PEP 1651	0.397 d-f	0.500 d-g	0.447 fg	0.333 d-i	0.410 b-e	0.372 c-f
PEP 1661	0.420 b-f	0.533 c-f	0.477 d-f	0.313 f-i	0.403 b-e	0.358 d-f
PEP 1672	0.457 b-f	0.611 b	0.535 b-e	0.220 k	0.280 i	0.250 j
PEP 1684	0.500 b-e	0.533 c-f	0.515 b-f	0.360 c-g	0.380 d-f	0.370 c-f
PEP 1687	0.490 b-f	0.555 b-d	0.523 b-e	0.377 b-e	0.427 a-d	0.402 bc
PEP 1688	0.533 b-d	0.566 bc	0.552 b-d	0.423 b	0.447 a-c	0.435 b
PEP 1692	1.380 a	1.255 a	1.327 a	0.487 a	0.460 ab	0.473 a
PEP 1763	0.210 g	0.266 i	0.240 i	0.300 g-i	0.403 b-e	0.352 e-g
Eskandarani	0.500 b-e	0.544 c-e	0.522 b-e	0.367 b-f	0.423 a-d	0.395 b-d

[z]Values followed by a letter in common, in each column, are not significantly different according to Duncan's multiple range test at P= 0.05.

On the other hand, high yield of accession PEP 1661 was due to its high sex ratio, relatively large fruit length and fruit shape index. High yielding ability of accession PEP1635 was due to its high sex ratio and its relatively high values for fruit length, average fruit weight and flesh thickness. High yield of accession PEP1642 was due to its high sex ratio and its relatively high values of average fruit weight and flesh thickness. High yielding ability of cv. Eskandarani was due to its high sex ratio, relatively large fruit length and relatively large average fruit weight (Tables 3, 5, 6 and 7). Accessions PEP 317 (Black Beauty), PEP 1661 (Aust. Green), PEP 1635 (Kürbis, Garten), PEP1642 (Fordhook Zucchini Improved) and cv. Eskandarani can be used as good materials to start hybrid development program to improve yield and fruit quality.

References

Al-jebory, K.D.H., 2006. Heterosis and genotypic, phenotypic and evironmental correlations for several characters of summer squash. The Iraqi Journal of Agriculture Sciences, 37(3):45-58.

Al-Kummer, M. K., Al-Hamadany, S. Y. H. and A. A. H. Al Juboori, 2009. Genetic variability, expectant genetic advance and phenotypic correlation for yield and its components in summer squash (*Cucurbita pepo* L.).Mesopotamia Journal of Agriculture, 37 **(**2): 105-111.

El-Adl, A.M., A. H. Abd El-Hadi, H. M. Fathy, and M.A.Abdein, 2012. Molecular genetic evaluation of seven varieties of summer squash**.** Journal of American Science, 8(5):41-48.

FAOSTAT, 2010. Food and Agricultural Commodities Production; online:http://faostat.fao.org (Accessed 11 September 2015).

Ferriol, M. and B. Picó, 2008. Pumpkin and Winter Squash, pp. 317-349.In: J.Prohens, and F.Nuez (eds.). Handbook of Plant Breeding. Vegetables I. Springer, Heidelberg .

Ghobary, H. M.M and Kh. Y. Ibrahim, 2010. Improvement of summer squash through inbreeding and visual selection. J. Agric. Res., Kafer El-Sheikh Univ., 36:340-350.

Gomez, A. K. and A.A.Gomez, 1984. Statistical Procedures for Agricultural Research. 2 nd ed. John Wiley & Sons Pub., pp.139-153.

Hassan, A.A., 2001. Cucurbits. Al-Dar Al-Arabia for Publishing and Distribution , Cairo , Egypt (in Arabic).

Kasrawi, M.A.,1995. Diversity in landraces of summer squash from Jordan. Genetic Resources and Crop Evolution, 42: 223-230.

Marie, A. K., M. Y. Moualla, and M.G.Boras, 2011. Study of the most important morphological and productivity characters of the inbreed lines of squash *Cucurbita pepo* L. Demashk University of Agricultural Sciences Journal, 27(1):337-350.

Mohamed, M.F., E.F.S.Refaei, and G.I. Shalaby, 2003. Growth and yield of inbred zucchini squash (*Cucurbita pepo* L.) lines developed under adverse climatic conditions. Assiut Univ. Bull. Environ. Res, 6(1):109-114.

Paris, H. S.,1986. A proposed subspecific classification for *Cucurbita pepo*. Phytologia, 61:133–138.

Paris, H.S.,1996. Summer squash: history, diversity, and distribution, HortTechnology 6:6–13.

Paris, H.S., 2008. Summer Squash, pp. 351-379.In: J. Prohens, and F. Nuez (eds.). Handbook of Plant Breeding.Vegetables I. Springer, Heidelberg.

Paris, H. S., 2000. History of The Cultivar Groups of *Cucurbita pepo*. Horticultural Reviews, 71–170.

Rakha, M.T., E.I. Metwally, S.A. Moustafa, A.A. Etman, and Y.H.Dewir, 2012. Evaluation of regenerated strains from six *Cucurbita* interspecific hybrids obtained through anther and ovule in vitro cultures. Australian Journal of Crop Science, 6(1):23-30.

Whitaker, T. W. and R.W. Robinson, 1986. Squash Breeding, pp. 209 -242. In: M. J. Bassett (ed.). Breeding Vegetable Crops. AVI Publishing Co., Westport, Connecticut.